CHAPTER 6 - OTHER HAZARDS: RISKS AND MITIGATION

CHAPTER CONTENT

6.1 LEVEE FAILURE

About Chapter 6

Chapter 6 assesses a variety of hazards and risks other than the three primary hazards of earthquakes, floods, and wildfires examined in Chapter 5. Levee failure is one of several phenomena identified as secondary or cascading hazards triggered by the primary hazards. Other secondary hazards include landslides, tsunamis, climate-related impacts, and volcanoes. In addition to secondary hazards, two other

classes are included. One, simply titled "other" hazards, is characterized by technological errors or biological impacts which can be systemic and/or widespread. The other, titled "additional" hazards, is characterized by more isolated, localized, and/or infrequent disaster incidents. See Section 4.3.2 for a discussion of the hazard classification system.

6.1.1 IDENTIFYING LEVEE HAZARDS

There are several areas in California that use levees to protect land from peak flood levels and/or to protect land that is below sea level. The first type of levee should be designed to withstand peak flood levels that are caused by rapid snow melt or intense rainfall within the watershed. Examples are the levees along the Russian River or the Sacramento River near Sacramento. The second type of levee should be designed to withstand nominal water levels on a continuous basis as well as peak flood levels. Examples are the levees throughout the San Francisco Bay-San Joaquin-Sacramento Delta region.

The Significance of Levees

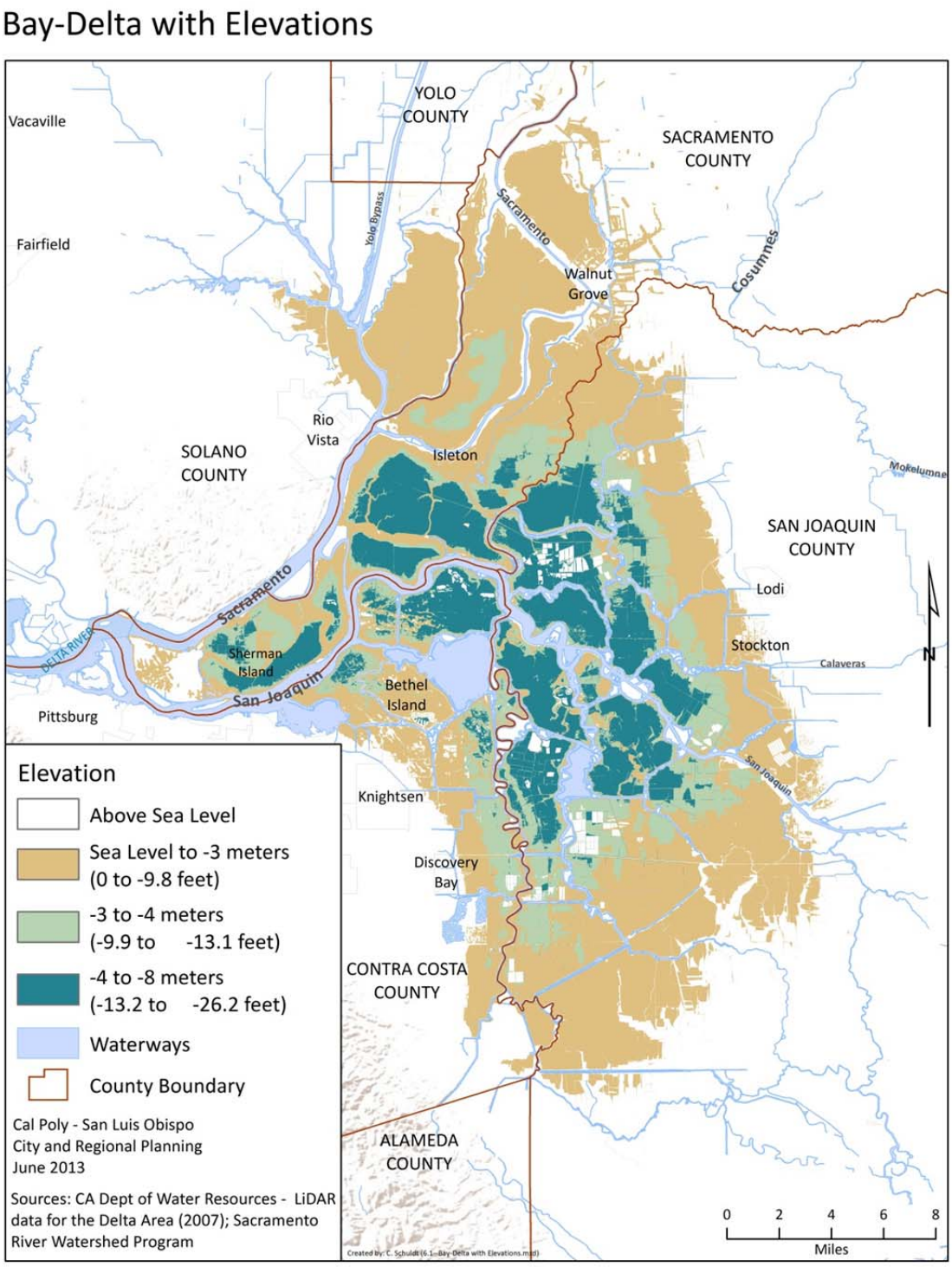
The San Francisco Bay-San Joaquin-Sacramento Delta region (a.k.a. "the Delta") contains levees critical for delivering irrigation water to 3 million acres and drinking water to over 23 million people. A failure in one of the Delta levees in 1972 interrupted the state and federal water supply systems and required approximately 500,000 acre-feet of fresh water to restore export water to acceptable quality (Senate Hearings on the 1972 Levee Failure at Brannan- Andrus Islands). Recent studies indicate the levees in the Delta are susceptible to significant damage in a near-field seismic event.

CALFED's "Seismic Vulnerability of the Sacramento-San Joaquin Delta Levees" report of April 2000 concluded that 3 to 10 failures are likely to occur on critical Delta levees during a 100-year earthquake. These failures would likely stop the export of Delta water until water quality is restored. Aside from the potential impact on water delivery to Southern California and the San Francisco Bay Area, the encroachment of brackish or seawater into the Delta could have a significant environmental impact on salt-sensitive species. The Delta also has many fuel storage facilities and oil and gas pipelines located within the region. These lines may fail during a seismic event and cause large-scale spills that would also inhibit the export of Delta water and severely affect one of the nation's largest natural salt water habitats.

Building of these levees began circa 1850 to protect or reclaim floodplains for agricultural purposes. The soil was rich for growing crops because of the river-deposited silts or river-nourished backwater peats in these locations, but these types of soils generally make for poor foundation material for levees. The original levees from this era were not engineered until about the 1940s and 1950s. The levees have been augmented since then to produce the current system.

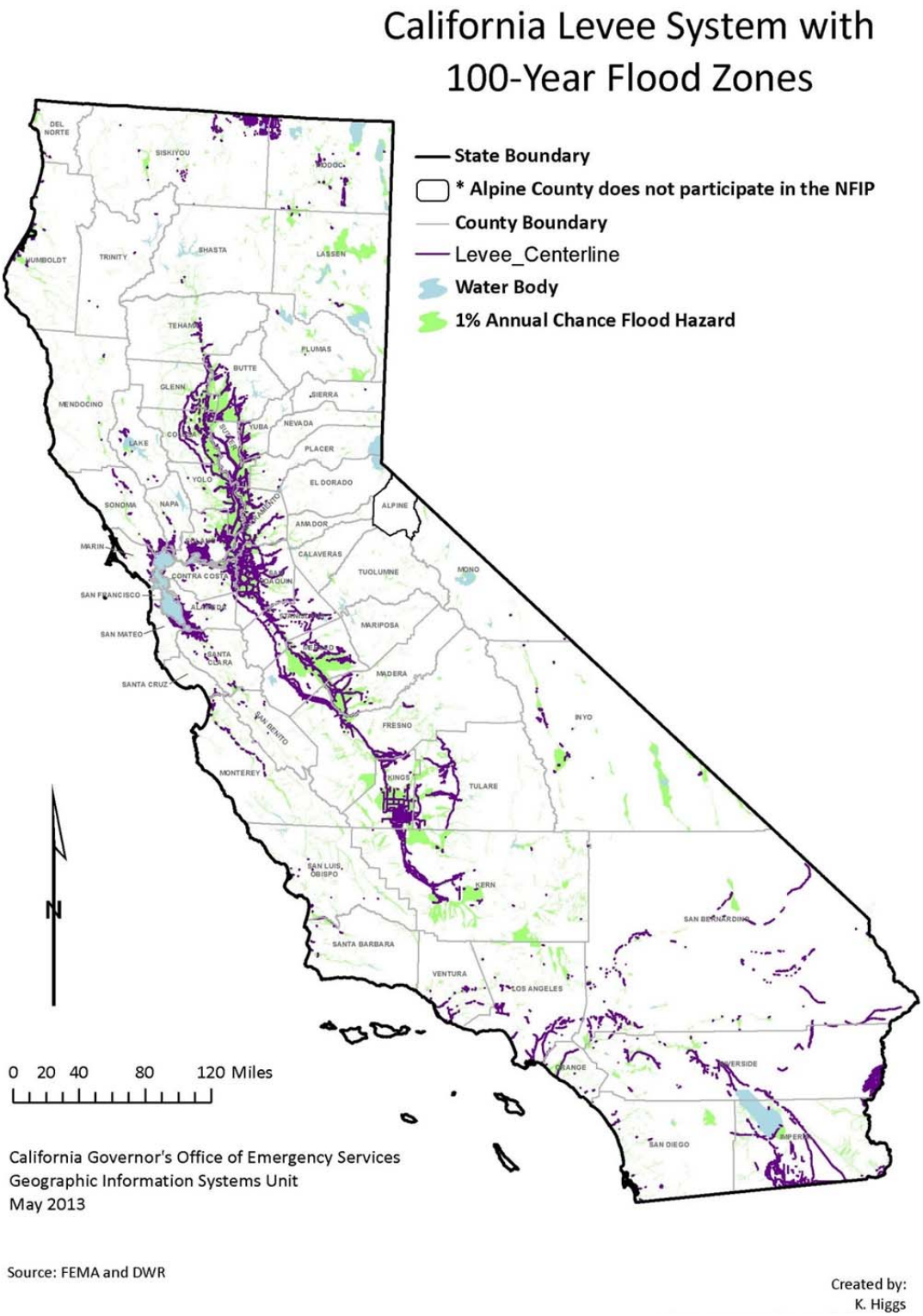
During the Gold Rush, hydraulic mining was prevalent in the headwaters of the rivers that feed the Bay-Delta. Huge amounts of sediment were flushed downstream as a by-product of hydraulic mining. To prevent buildup of this sediment, levees were built and/or heightened to increase flows through the low-lying areas to aid in moving the sediment pulses through the Delta. With the 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. Land behind the levees will continue to drop in elevation with the addition of potential sea level rise exacerbating the situation.

MAP 6.A: Bay-Delta Elevations Relative to Mean Sea Level (after DWR 1993)



Map 6.A shows the general configuration of levees and waterways in the Bay-Delta area. Most levees in California are in the Bay-Delta (over 1,000 kilometers) and, for the most part, protect land that is at or below sea level. As can be seen in Map 6.A, there are vast areas in the Delta that are currently below sea level.

MAP 6.B: California Levee System with 100-Year Flood Zones



Map 6.B shows the pattern of levees in relation to National Flood Insurance Program (NFIP) 100-year floodplains in California. The greatest concentration of levees is in the Central Valley area. Lesser concentrations are found in the San Francisco Bay Area and Southern California. (*Online or download viewers can zoom in for a closer view of the information on this map.)*

In California, levees protect farmland, ranchland, rural residential areas, urban residential areas, and infrastructure such as roads, highways, and waterways or canals. The Bay-Delta is a complex system where there are three rivers bringing in fresh water, tidal fluctuations that cycle salt water or brackish water, and the Central Valley and State Water projects that carry fresh water to upward of 23 million citizens in Central and Southern California. Approximately 60 percent of the water supply of the San Francisco Bay Area is also extracted from or passes through the Delta. In addition to the risks to the water system posed to the area from Delta levee failures, the Bay Area also has numerous substandard levees protecting both low-lying and below-sea-level urban areas and infrastructure, including the Oakland International Airport.

Levee Stability

The stability of levees is a function of several variables. Three main loading functions related to levee failure are water level changes, ground shaking, and static loading (Moss and Eller, 2007). Water level changes can be due to peak flood levels or rapid draw-down; both are known to adversely affect the stability of levees. Ground shaking is a function of earthquakes in and around the levees but can occur up to 100 kilometers or more away and still affect levee performance. Static loading represents the nominal loading conditions that regularly exist, but documented levee failures have occurred with no adverse conditions other than static loading (for example, with the Jones Tract failure in 2004).

The levees in the Bay-Delta are designed nominally to 100-year design flood levels. This should be put into perspective with the levee system that was built to protect the city of New Orleans against 250-year design flood levels but recently failed catastrophically due to Hurricane Katrina at flood levels much lower than the design (Seed, et al. 2006).

Levee Failure Mechanisms

Six main failure mechanisms are a function of the three loading functions. The six mechanisms are bearing failure, sliding failure, slump or spreading failure, seepage failure, erosion failure, and overtopping, which may be described as follows (Moss and Eller, 2007):

1. A bearing failure in levees is typically deep-seated and is most likely induced by seismic ground shaking. Failure is commonly triggered by a seismic event that either causes a loss of soil strength or produces destabilizing inertial loading conditions.

2. A sliding failure may occur if the foundation soil has a weak or brittle zone resulting in a preferred failure plane. Both seismic-induced inertial loading and high water levels can cause sliding failures.

3. Slumping and spreading can be generated by two loading conditions. Cyclic loading from earthquakes may generate increased pore pressures and reduced soil strength, leading to volumetric and/or deviatoric strains in the foundation. The same results can also occur due to increased pore pressures from high water levels and increased seepage.

4. Seepage is one of the most common failure mechanisms in levees. Levees are built in fluvial depositional environments, and it is common to find levees with an existing sandy layer beneath the foundation. The sandy layer can be a conduit for flow underneath the levee, resulting in critical conditions at the inboard (or landside) toe. This leads to erosion of the foundation during high water or a consistent weakening of the foundation over a long period of time, both eventually leading to failure. Biogenic agents can also lead to destabilizing seepage. This can include rodent holes, tree roots, or other biological activity that create conduits for seepage.

5. High velocity flows can erode material from the outboard or waterside of the levee, which may lead to instability and failure. Erosion can occur at once or over time as a function of the storm cycle and the scale of the peak storms.

6. The failure mechanism of overtopping occurs when high water exceeds the elevation of the levee crest. The water energy is then concentrated at the inboard toe of the levee, leading to soil erosion and decreased levee stability. Overtopping failure can be exacerbated by decreased levee crest height due to land subsidence.

Re-Engineering the Levees

The U.S. Army Corps of Engineers (USACE) has endeavored to re-engineer the older levees and to build new levees to increasing design standards. One of the biggest issues of the existing levee system, particularly in the Bay-Delta, is the quality of the foundation material on which the levees are founded. Two seismic concerns related to California levees are liquefaction potential of levees founded on granular or sandy soils, and cyclic failure and post-cyclic deformations of levees founded on peaty organic soils. Some non-seismic concerns related to California levees are ensuring sufficient levee height to withstand peak flows, armoring levees against toe or face erosion, preventing detrimental seepage through and beneath levees, and mitigating against degradation of levee integrity due to biological agents or time-based strength degradation of levee materials.

One of the important lessons learned from the New Orleans levee failures (Seed, et al., 2006) was that levees can be designed and built to appropriate standards, but the juncture where two levees abut or join or where a levee abuts or joins a floodwall should also be designed and built to the same standards. A number of failures in and around New Orleans can be attributed to this juncture or interface between different levees built at different times using different designs or under different jurisdictions. Regardless of how well-built each levee was, the interface or connection was substandard and failure occurred at that location. In engineering terms, levees are considered a series system, a chain of connected engineered components. Levee hazard mitigation must be conducted on a system wide basis, and a levee system, as with any series system, is only as strong as the weakest "link" in the chain.

6.1.2 PROFILING LEVEE HAZARDS

A list of levee failures in the Bay-Delta from 1900 to the present is shown in Table 6.A. 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.

Table 6.A: Bay Delta Levee Failures, 1900-Present

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, 1972, 1981, 1983
Big Break	2,200	1927
Bishop Tract	2,100	1904
Bouldin Tract	5,600	1904, 1907, 1908, 1909, 1972
Brack Tract	2,500	1904
Bradford Island	2,000	1950, 1983
Brannan Island	7,500	1902, 1904, 1907, 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

Delta Island/Tract	Total Acres Flooded	Year Flooded
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
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
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
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: DWR, 2006; DWR Public Affairs Chief Ted Thomas, personal communication, 2006; USACE, 2006

6.1.3 ASSESSMENT OF STATE AND LOCAL VULNERABILITY AND POTENTIAL LOSSES

The list of levee failures in Table 6.A also documents the consequences of the levee failures in terms of area of land flooded per failure. The consequences of failure are critical for profiling the hazard and developing a rational risk-based assessment. Ultimately the consequences are in terms of dollar figures associated with crop loss, building destruction, life loss, or salt water intrusion that brings to a halt the pumping of fresh water to Central and Southern California.

Climate Change and Levees

Increased flood frequency in California is a predicted consequence of climate change. Mechanisms whereby climate change leads to an elevated flood risk include sea level rise, more intense daily precipitation events, and shifts in the seasonal timing of river flows. As sea levels rise, flood stages in the Sacramento-San Joaquin Delta of the San Francisco Bay estuary may also rise, putting increasing pressure on Delta levees. This threat may be particularly significant because recent estimates indicate the additional force exerted upon the levees is equivalent to the square of the water level rise. Estimates using historical observations and climate model projections suggest that extreme high water levels in the Bay and Delta will increase markedly if sea level rises above its historical rate. These extremes are most likely to occur during storm events, leading to more severe damage from waves and floods (DWR, 2006; California Climate Change Center, 2006).

6.1.4 CURRENT LEVEE FAILURE HAZARD MITIGATION EFFORTS

Progress Summary 6.A: Levee Hazard Mitigation

Progress as of 2013:

Levee Evaluation and Repair
DWR is undertaking unprecedented efforts to evaluate and upgrade aging and deteriorating levees along the Sacramento River and San Joaquin River valleys and the Delta. Funding for the levee evaluation efforts is provided through the two large flood control bonds, Propositions 84 and 1E, approved by California voters in November 2006. To expedite efforts to protect these communities, levee evaluations are being conducted in a fast-track manner over a two- to three-year period. Information on levee evaluations, including technical evaluations and surveys and a fact sheet, is available at:
http://www.water.ca.gov/levees/evaluation/

To date, nearly 250 levee repair sites have been identified with more than 100 of the most critical sites having already been repaired. Repairs to others are either in progress or scheduled to be completed in the near future and still more repair sites are in the process of being identified, planned, and ranked. More information on the DWR's levee repair efforts, including a history of California levees, levee evaluation information, and levee repair sites, can be found at:
www.water.ca.gov/levees/

DWR's Levee Evaluations Program
DWR's Levee Evaluations Program includes the Urban Levee Geotechnical Evaluations (ULE) Project and the Non-Urban Levee Evaluations (NULE) Project. The ULE Project addresses approximately 470 miles of State-Federal Project (Project) Levees and appurtenant non-State-Federal Project (non-Project) levees located in the central valley protecting populations of 10,000 people or more. NULE addresses the remaining Project and non-Project levees protecting populations of fewer than 10,000 people.

Urban Levee Evaluations (ULE) Project
The ULE Project evaluates levees that protect more than 10,000 people. The ULE Project, evaluate urban State/Federal project levees, including appurtenant non-project levees to determine if they meet defined geotechnical criteria and, if appropriate identify remedial measure(s) to meet those criteria. The goals of the ULE Projects include:

- Support the CVFPP, federal and local flood management projects, local FEMA certification efforts and the legislative mandate of urban, 200-year flood protection by 2025
- Support federal & local flood management programs by providing geotechnical data, analysis and remedial alternatives to local, State, and federal stakeholders
- Improve geotechnical information exchange methods between state, local and Federal flood management agencies
- Identify critical levee repairs

ULE Geotechnical Evaluation Report (GER)
The GER is comprised of two volumes that present cumulative geotechnical evaluation results for the studied area. Volume 1, Existing Conditions, reports ULE Project analysis results for existing levee conditions and identifies levee reaches/segments that do not meet the design and/or 200-year flood protection criteria. Volume 2, Remedial Alternatives, reports ULE Project conceptual remedial alternatives and associated costs for those reaches/segments that do not meet criteria based on the results of the GER Volume 1. Volume 2 also evaluates the study area levees for seismic vulnerability but does not include conceptual remedial alternatives or associated costs.

Non-Urban Levee Evaluation (NULE) Project
The NULE Project is part of DWR's Levee Evaluations program established through FloodSAFE with the primary purpose to evaluate non-urban/State-Federal Project Levees and appurtenant non-Project Levees that protect less than 10,000 people. The NULE Project determined whether the non-urban levees meet defined geotechnical criteria and, if appropriate, identified remedial measure(s) to meet those criteria. The goals of the NULE Project include:

- Support the CVFPP and CVFED projects
- Support federal and local flood management programs by providing geotechnical data, analysis, and conceptual remedial alternatives and their costs to local, state, and federal agencies
- Improve geotechnical information exchange methods among state, local, and federal flood management agencies.
- Identify locations where critical levee repairs may be needed.

Two phases have been developed to meet the NULE project goals:

NULE Phase 1 – Geotechnical Assessment Report (GAR)
The phase 1 assessment consisted of non-intrusive studies and preparation of the Geotechnical Assessment Report (GAR). Over 1,200 miles of non-urban Project Levees and over 300 miles of appurtenant non-urban non-Project Levees were included in Phase 1 of the GAR. The GAR contained a compilation of existing data about the levees, levee systems and historical levee performance. The compiled data were reviewed for levee construction information, subsurface information, and past performance descriptions. Each levee segment was assigned a hazard category. Tools and methodology were developed to consistently assess levee segments based on systematic, consistent, repeatable analysis that correlated geotechnical data with levee performance history. Conceptual remedial alternatives and associated cost estimates were prepared and are presented in a Remedial Alternatives and Cost Estimate Report (RACER).

NULE Phase 2 – Geotechnical Overview Report (GOR)
Phase 2 assessment builds on Phase 1 results in DWR selected study areas, which generally consist of levees protecting populations greater than 1000 people. Phase 2 consisted of targeted field explorations, laboratory testing, and analyses to identify levees not meeting criteria established for the NULE Project. The field work and laboratory testing will be summarized in the Geotechnical Data Reports (GDR). The analysis of existing conditions and remedial alternatives will be summarized in the Geotechnical Overview Reports (GOR). The GOR will be divided into two volumes with Volume 1 describing the existing conditions which includes the study area overview, methodology, and analysis results. Volume 2 will contain remedial alternatives for levees that do not meet criteria, and includes analyses of remedial alternatives and conceptual cost estimates.

The West Sacramento GER and the GAR and RACER reports are completed. The GER and GOR reports will be completed over the next two years. DWR is planning to make these reports available electronically when completed. Digital copies of the GAR and RACER are currently available upon request. Please contact Steve Mahnke at *916-574-1460* to request copies.

Best Practices Highlight 6.A: Hamilton City Flood Damage Reduction and Ecosystem Restoration Project (pending)

Hamilton City is located along the Sacramento River about 85 miles north of Sacramento in Glenn County. Given its proximity to the Sacramento River the city has an extensive history of flood evacuations and flood fighting to avoid failure of the private "J" levee. The "J" levee, built in the early 1900's to contain flows in the Sacramento River, failed twice in the 1970s and has required emergency reinforcement five times since 1983. The "J" levee does not meet current construction standards and could fail even with river levels below the top of the levee.

The community's pending flood damage reduction and ecosystem restoration project aims to reduce flood risk and damages, to repair the river ecosystem through restoration of river function and improved habitat, and to form successful partnerships between stakeholders in the process.

A 2004 feasibility study by the U.S. Army Corps of Engineers (USACE) and the Reclamation Board of the State of California determined that the project could reduce the chance of flooding from once in every 10 years to once in every 75 years with an expected $577,000 decrease in annual flood damages.

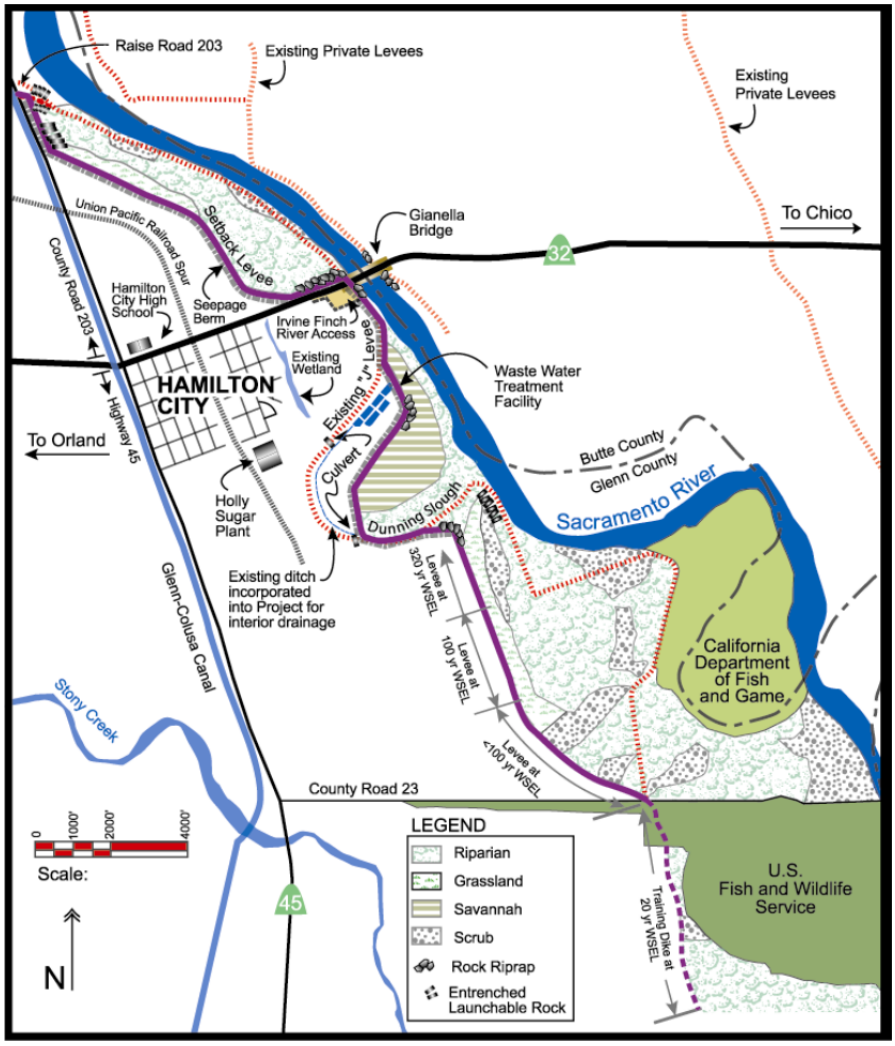
The project which includes a 6.8-mile set-back levee, 1,450 acres of flood plain, and 1,361 acres of habitat restoration, is projected to cost $52.4 million. Nearly 85 percent of the land needed for the project is being donated by The Nature Conservancy with acquisition funding provided by the Department of Water Resources. The project's success to date is attributed to:

- Strong partnership, a high level of trust among stakeholders, and strong communication
- Combining project purposes with strong partnerships, resulting in increased project resources
- USACE multiple purpose project policy

While still pending, this project exemplifies using nature as an integral project component to meet flood mitigation needs. It is a potential, innovative solution for an area that would otherwise not be eligible for a standard levee construction project. The proposed location of the set-back levee will create a flood plain area that will serve dual purposes of providing flood protection and restoring natural habitat. Spreading the river banks apart will increase the capacity of the river and decrease erosion and maintenance needs on the levee while creating river connectivity that will improve species habitat.

The Senate Appropriations Committee approved the project in July 2013. The project now awaits a portion of federal funding. For more information on the project, visit: http://www.sacramentoriver.org/srcaf/index.php?id=hamilton_city

Hamilton City Flood Damage Reduction and Ecosystem Restoration Plan



Source: Hamilton City Feasibility Report 2004

6.2 LANDSLIDES AND OTHER EARTH MOVEMENTS

6.2.1 IDENTIFYING LANDSLIDE HAZARDS

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

A landslide is the breaking away and gravity-driven downward movement of hill slope materials, which can travel at speeds ranging from fractions of an inch per year to tens of miles per hour depending on the slope steepness and water content of the rock/soil mass. Landslides range from the size of an automobile to a mile or more in length and width and, due to their sheer weight and speed, can cause serious damage and loss of life. Their secondary effects can be far-reaching; for example, catastrophic flooding can result from the sudden release of river water impounded by landslide debris or slope failure of an earthen dam.

Although the area affected by a single landslide is less than that of earthquakes, landslides are pervasive in California's mountainous terrain and occur far more often, resulting in cumulative losses approaching $200 million in a given year. Average annual landslide losses in California are estimated at about $100 million. Because landslides occur as isolated events in both time and location, and there is presently no systematic means in place for documenting their losses, landslide hazard is often underestimated or goes unrecognized in the policy arena, even though landslides continue to cause millions of dollars in cumulative damage to California's homes, businesses, and infrastructure.

6.2.2 PROFILING LANDSLIDE HAZARDS

Landslides are classified into many different types based on form and type of movement. They range from slow-moving rotational slumps and earth flows, which can slowly distress structures but are less threatening to personal safety, to fast-moving rock avalanches and debris flows that are a serious threat to structures and have been responsible for most fatalities during landslide events. Many large landslides are complex, being a combination of more than one landslide type. This is well-illustrated by the famous 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 but also caused 10 fatalities as the occupants had no time to escape.

Areas of Landslide Risk

Landslide risk is high in the coastal regions of California, which is home to much of the state's population, industry, and infrastructure. Particularly hazardous terrain lies where weak rock layers are inclined in the same direction as the mountain slope which is found in many areas of California. The Franciscan Formation, which makes up much of the Northern California Coast Ranges, contains weak rock and that is both easily eroded and landslide prone. Because past decades of development have been continuing to spread into mountainous terrain where hazard exposure is high, most reported landslide losses occur in these regions, as illustrated in the cumulative landslide occurrences resulting from the 1995 El Nino winter storms, shown in Map 6.C.

Debris flows can cause damage to structures and endanger lives in hillside areas, and can also run out beyond the mountains. Alluvial fans are geologic features built by successive runoff spreading out on the broad fan-like surface as debris-laden floods or debris flows. As residential and business land use has expanded onto these mountain-front alluvial fan areas, more lives and property is at risk from debris laden floods and debris flows.

A home in Marin County destroyed by debris flow triggered by intense rains, February 1998

Source: USGS

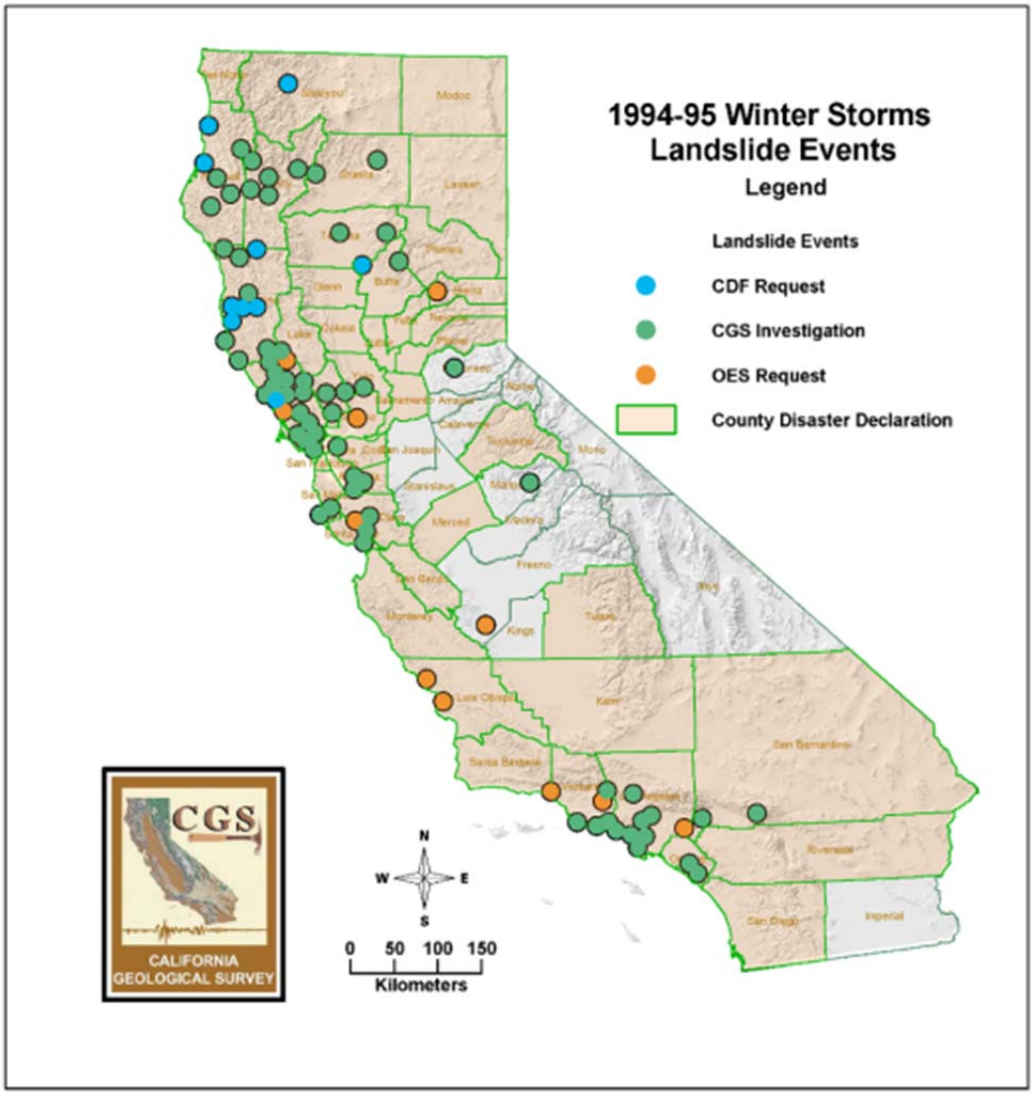
Debris laden floods and debris flows from Oak Creek, Inyo County spread out on an alluvial fan and damaged the Mt Whitney Fish Hatchery and homes in the low area between alluvial fans (on left).

Photo by K. Babione, from Wagner et al, CGS 2012

The California Geological Survey (CGS), working with the California Department of Water Resource's (DWR) Alluvial Fan Floodplain Evaluation and Delineation (AFFED) project, has developed geologic maps of Quaternary surficial deposits for nearly 35,000 square miles of southern California. These maps provide geologic information on the general distribution of alluvial fans, as well as differentiation of geologic deposits that may represent the location of potential debris laden floods and debris flows. As part of the AFFED project these maps are intended to provide local agencies making land use decisions with the necessary tools to understand the characteristics and potential hazards.

It has been recognized that debris laden floods and debris flows on alluvial fan floodplains often issued from watersheds burned during the previous fire season (Eaton, 1935). The concern for debris flows following wildfires is particularly acute in the Los Angeles Basin where urban areas encroach upon alluvial fans. Research by the US Geological Survey in the western United States has refined the understanding of debris flows generated from recently burned watersheds (USGS, 2005).

MAP 6.C: 1994-1995 Winter Storm Landslide Events



Map 6.C shows landslide damage reports investigated by the California Geological Survey (CGS) during the 1995 El Nino winter storms. Orange-shaded counties are those declared federal disaster areas during the 1994-1995 winter season. Other El Nino winter seasons revealed similar patterns of landslide occurrences. Even though the map shows only one season, it provides a pattern of landslide propensity when soils are liquefied.

This statewide pattern of occurrences repeats itself during heavy winter seasons, which generally coincide with El Nino Southern Oscillation in the Pacific Ocean. Every few years, warm equatorial waters are driven northward, bringing moisture-laden air that results in more frequent and severe winter storms in California. The added weight of rain-saturated hill slopes and the weakening of slopes caused by the pressure the groundwater exerts on porous hillside materials are triggering agents of slope failure. Improved forecasting of El Nino events now provides advanced warning to better prepare for and respond to potential slope failures and flood events.

Chart 6.A: Multivariate ENSO Index

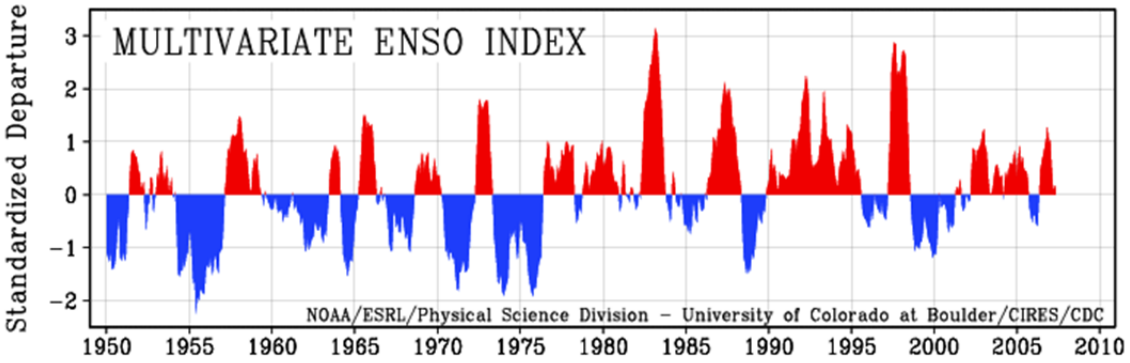


Chart 6.A shows a history of El Nino occurrences. The red region corresponds to warmer sea surface temperatures, which bring unusually moist air into the north Pacific, producing wetter winters and more intense landslide and debris flow activity in California.

Chart 6.B: Property Losses

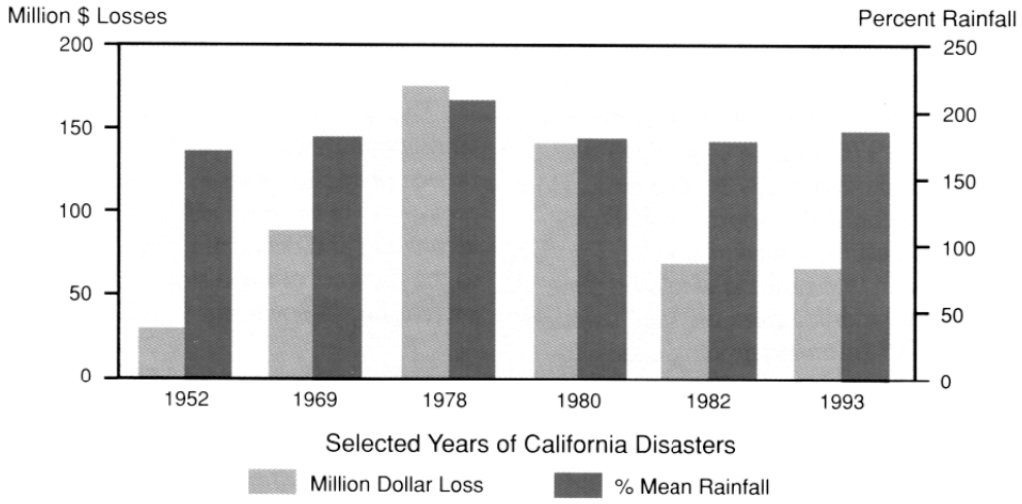
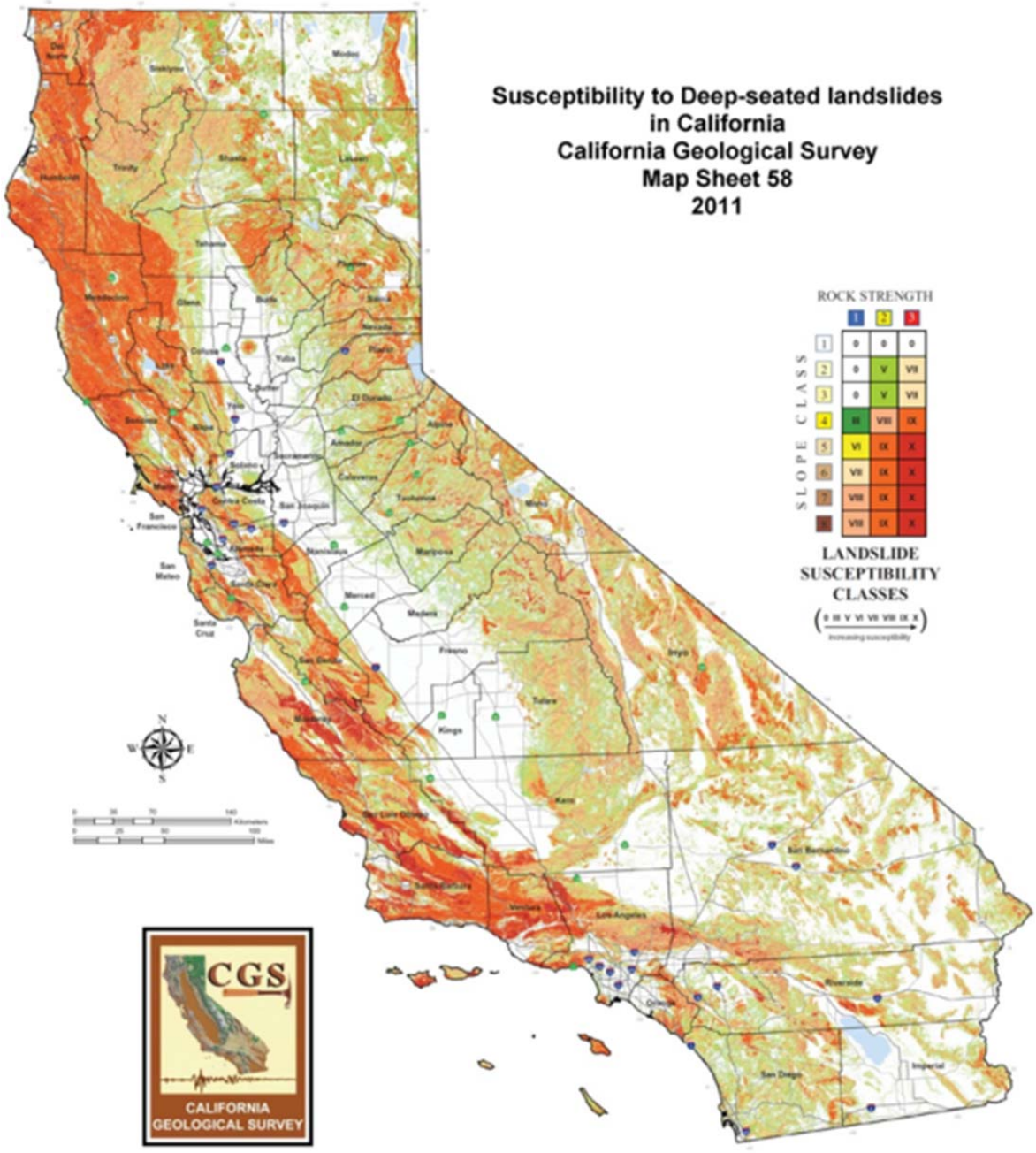


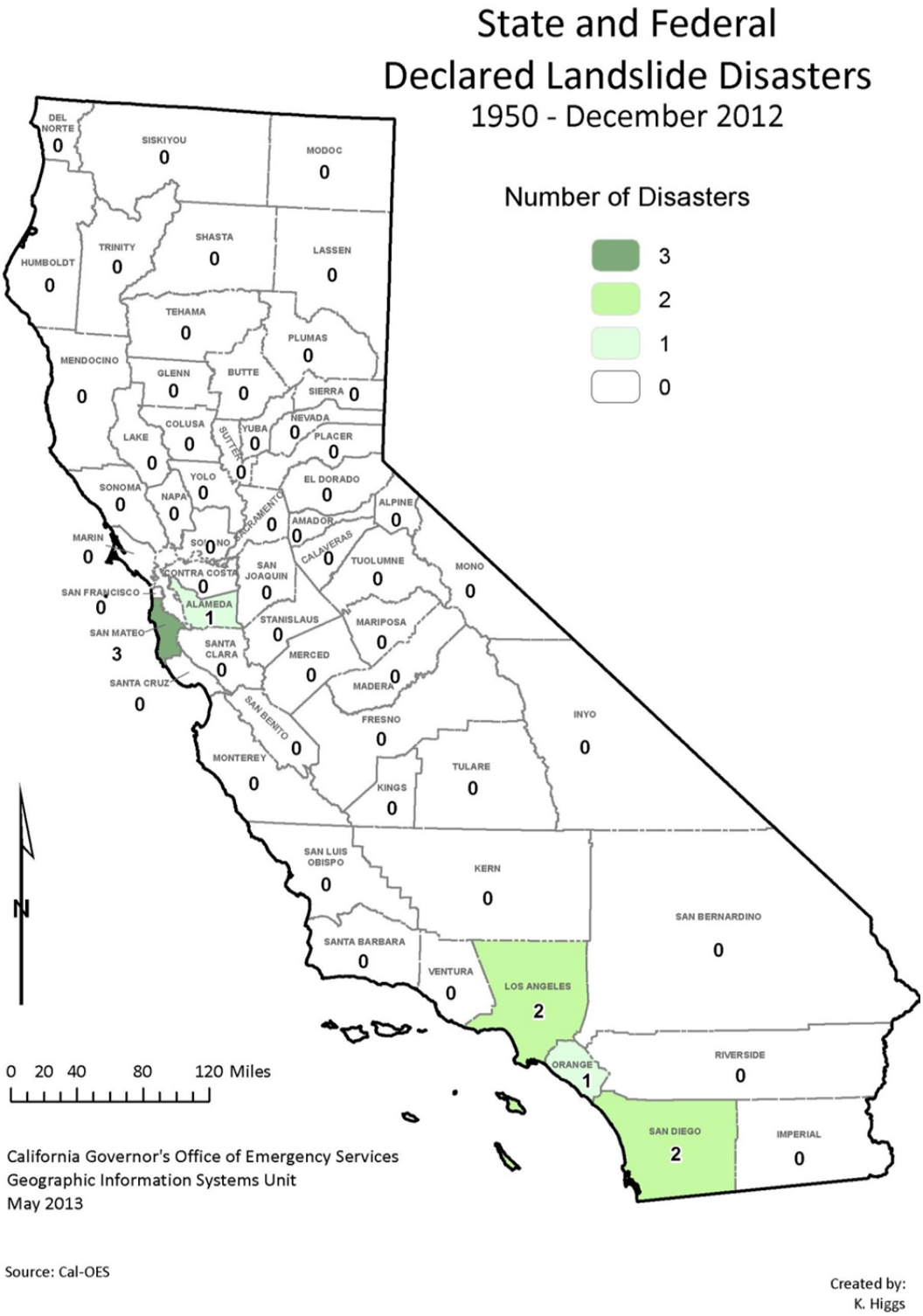
Chart 6.B shows property losses from storm events in California (Barrows 1993).

MAP 6.D: Relative Susceptibility to Deep-seated Landslides in California



General landslide susceptibility in California can be estimated from the distribution of weak rocks and steep slopes as shown in Map 6.D. High and moderate landslide susceptibility, combined with high rainfall or high earthquake potential leads to high landslide hazard in coastal California. (See Map 5.F). *(Online or download viewers can zoom in for a closer view of the information on this map.)*

MAP 6.E: State and Federal Declared Landslide Disasters, 1950-December 2009



Map 6.E shows state and federally declared landslide disasters by county from 1950 to December 2012. Note that despite frequent local occurrence of landslides, they are rarely large enough to qualify for a disaster declaration. Additionally, large landslides, mudslides, and debris flows are frequently included under other disaster categories.

Earthquakes and Landslides

Although less frequent, the most devastating landslides worldwide have been triggered by earthquakes. Strong ground shaking can add the additional forces necessary to weaken and cause slopes that are already distressed by gravity to fail. The greatest landslide disaster in history occurred in 1920 in central China, where a Magnitude 8.5 earthquake caused weak, wind-deposit slopes to collapse into a densely populated valley, killing an estimated 180,000 people.

Besides additional forces, earthquake shaking can 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 a juvenile detention facility and an earth-fill dam 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.

Besides blocking the flow of streams and causing the potential for catastrophic flooding by sudden release of impounded waters, landslides can collapse into water bodies causing very large, destructive splash waves. In 1958, a Magnitude 8 earthquake collapsed a hillside into Lituya Bay, Alaska, which caused a water splash wave that reached 1,720 feet up the mountain slope, stripping all vegetation. A massive landslide into the Vaoint Reservoir in Italy in 1963 caused a tremendous water splash wave that swept 800 feet over the top of the dam, causing a major flood that killed an estimated 2,600 people below. Grading during construction of reservoirs and alteration of the groundwater regime due to the impounded water can weaken the adjacent hillsides, which must be taken into consideration during design and construction.

Climate Change and Landslides

Climate change may result in precipitation extremes (i.e., wetter wet periods and drier dry periods). While total average annual rainfall may decrease only slightly, rainfall is predicted to occur in fewer, more intense precipitation events. 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 (CNRA, 2009; California Climate Change Center, 2009).

6.2.3 ASSESSMENT OF VULNERABILITY AND POTENTIAL LOSSES

The impact of natural hazards on the built environment generally depends on exposure (proximity to the hazard and its severity) and the vulnerability of engineered structures (structure type, design, age). The closer a structure is to a hazard event, the more damage that is likely to be sustained, while the larger a hazard event is, the greater its impact at a given distance. Brick buildings resist storm and fire damage better than wood construction; however, these buildings – particularly unreinforced masonry – are less resilient against earthquakes. The resistance a structure of a given type will have against natural hazards depends on the building code in effect at the time of construction and how closely its provisions are followed.

Codes improve with time, so newer construction generally performs better than older construction. While structures can be designed to resist the forces of gravity, wind, and earthquakes, it is not economically feasible to design structures to resist the large earth movements that can accompany large landslides. Landslide losses primarily result from hazard exposure (high population densities in mountainous terrain), however, rather than inferior structural design.

The two main types of structures that are vulnerable to landslides are buildings and “lifelines” (such as utility and transportation lines). Table 6.B lists notable landslides and debris flows in California.

Typical landslide damage to homes caused by intense ground deformation of the landslide mass in Anaheim Hills, Orange County, 2005. The slow movement of the slide allowed residents to evacuate.

Buildings

Landslides directly damage engineered structures in two general ways: 1) disruption of structural foundations caused by differential movement and deformation of the ground upon which the structure sits, and 2) physical impact of debris moving down-slope against structures located in the travel path. As a landslide breaks away from a slope and moves, it deforms the ground into an undulating, hummocky surface broken up by fissures and scarps.

When situated on top of a landslide, the deformation distresses structural foundations and the structures themselves by settlement, cracking, and tilting. This can occur slowly, over years, or rapidly within days/hours. A water-saturated, fast-moving debris flow (called “mudslides” by the media) can destroy all in its path, collapsing walls and shifting structures off their foundations. The 2005 La Conchita Landslide in Ventura County traveled with such force that it destroyed 30 homes, scraping many off their foundations and piling them, one on top of another, three high.

Table 6.B: Notable Historic Landslides and Debris Flows in California

Location	Year	Impact[a]
La Canada	2009-2010	Post-Station Fire debris flows with early damage claims at $58 million and Los Angeles County cleanup costs at over $30 million (2009 dollars)
La Conchita	2005	Destroyed 30 homes, killed 10 people
Laguna Beach	2005	Destroyed 18 homes, damaged 8 others. Slide repair cost: $21 million. Cost of damage: $35 million
Mission Peak	1998	--
Laguna Niguel	1998	Destroyed 9 homes and 57 condominiums. $12 million awarded to homeowners in lawsuit; $16 million to stabilize slope[b]
Rio Nido	1998	Destroyed 37 homes. 140 residents were evacuated[c]
Laguna Beach	1998	Destroyed 18 homes, damaged 300 others. Killed two people[d]
La Conchita	1995/2005	Destroyed 6 homes[e]
Anaheim Hills	1993	Destroyed 30 homes, damaged 200 others. Cost: $12 million
Big Rock Mesa	1979/1983	Destroyed 13 homes. Cost: $114 million. Damage to Highway 1 cost: $1.26 billion[f]
Laguna Beach	1978	Destroyed 19 homes, damaged 45 others. Cost: $62 million[g]
San Fernando	1971	Cost $354 million
Saugus-Newhall	1971	Cost $312 million
Palos Verdes	1956, intermittently	More than 100 homes severely damaged or destroyed. Cost: $34 million; $68 million in damage settlements[h]

[a] *Dollar amounts are adjusted to 2006 dollars*
[b] http://anaheim-landslide.com/laguna.htm
[c] http://www.sonoma.edu/geoloy/wright/rioslide.htm
[d] http://wrgis.wr.usgs.gov/wgmt/elnino/scampen/laguna/index/html
[e] http://www.geog.ucsb.edu/~jeff/projects/la_conchita/apcq2001_article/apcq2001_article.html
[f] http://www.ci.malibu.ca.us/download/index.cfm?fuseaction=download&cid=3144
[g] http://www.consrv.ca.gov/cgs/geologic_hazards/landslides/Bluebird%20Canyon%20Landslide%20Cover.pdf
[h] http://seis.natsci.csulb.edu/VIRTUAL_FIELD/Palos_Verdes/pvportuguese.htm

Utilities and Transportation

In addition to buildings, utilities and transportation structures are vulnerable to the impact and ground deformation caused by slope failures. They present a particular vulnerability because of their geographic extent and susceptibility to physical distress. Lifelines are generally linear structures that, because of their geographic extent, have a greater chance of being affected by ground failure (hazard exposure).

Extension, bending, and compression caused by ground deformation can break lifelines. Failure of any component along the lifeline can result in failure to deliver service over a large region. Once broken, transmission of the commodity through the lifeline ceases, which can have catastrophic repercussions down the line: loss of power to critical facilities such as hospitals, impaired disposal of sewage, contamination of water supplies, disruption of all forms of transportation, release of flammable fuels, and so on. Therefore, the overall impact of lifeline failures, including secondary failure of systems that depend on lifelines, can be much greater than the impact of individual building failures.

A fast-moving debris flow caused the loss of 10 lives; 30 homes were swept off foundations and piled three high when a water-saturated hillside broke loose during heavy rains in La Conchita, Ventura County, 2005.

The cost of damage to lifelines is a substantial part of the overall social impact. Recent studies have shown that Caltrans spends an average of $50 million per year repairing and mitigating landslide damage. Other lifeline operators (local governments and utilities) may spend a similar amount. The economic impact of landslide damage to lifelines can be much greater than direct repair costs, but there are no estimates of the total indirect costs. In one illustrative example, a small slide east of Watsonville in 1998 cost under $1 million to repair the local road and drainage facilities. Repair of a natural gas pipeline and restoration of gas service to a large area cost over $10 million. Half of the restoration costs were for personnel to re-light approximately 60,000 pilot lights in the affected area (Schuster et al, 1998).

6.2.4 CURRENT LANDSLIDE HAZARD MITIGATION EFFORTS

Exposure to landslide hazards can be reduced by effective land use planning and hillside development practice. 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 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 rock/soil mass in place.

Local Government Responsibilities

Managing landslide risk is primarily the responsibility of local government where planning and building departments serve as lead agencies. Over 80 percent of California cities have landslide/mudslide ordinances, design standards, or guidelines for hillside development. California's Seismic Hazards Mapping Act designates landslide zones wherein cities and counties are required to condition construction permits upon adequate landslide site investigation and agreed-upon mitigation. These efforts have proven effective in reducing losses over the past decades, but not all jurisdictions that face potential landslide hazards have such instruments, nor has zoning of all landslide-prone areas been completed under the state program.

Best Practices Highlight 6.B: Devil's Slide Tunnel Project

Devil's Slide, located on the coast of California between Pacifica and Montara, is described by the California Department of Transportation (CalTrans) as, "an unstable ocean-facing cliff highly prone to rock falls and slippage."[57] Since original construction of State Route 1 across the steep, geologically unstable cliff in the 1930's, there have been an ongoing series of slides which have caused safety problems as well as closures along the stretch of highway. Starting with a major landslide event in 1940 which destroyed much of the road, intermittent landslides occurring during winter storms have resulted in an ongoing periodic cycle of costly reconstruction and destruction.

In the late 1950's a possible highway bypass route to Devil's Slide was identified which led to opposition by concerned groups, due to potential environmental impacts. In the 1990's further consideration of a tunnel alternative began and was determined to be reasonable and feasible, leading to voter approval of the Devil's Slide Tunnel Initiative (Measure T) in 1996. This initiative amended the Local Coastal Plan to include the tunnel project as the only feasible highway bypass option for State Route 1 at Devil's Slide. Following completion of the environmental review process, ground breaking for construction of the tunnels occurred on May 6, 2005.

Boring of the tunnels started in September 2007 and was completed in 2011. The tunnel project consists of the following elements: 1) new realignment along State Route 1, 2) two parallel 4,000 foot tunnels, 3) two parallel 1,000 foot bridges at the north portal approach, 4) an operations and maintenance center (OMC) south of the tunnels and 5) public access features for hikers and bicyclists. As part of the project CalTrans has given the bypassed portion of the road and 70 nearby acres to San Mateo County to operate as a public park.

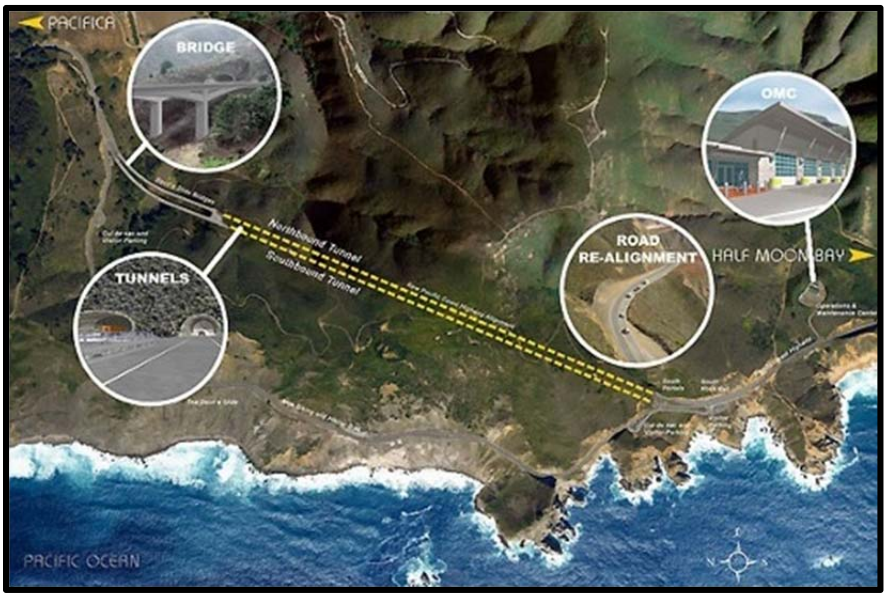
The tunnels, officially named the Tom Lantos Tunnels after late congressman Tom Lantos, opened to traffic in March 2013. The tunnels are the first to open in California in almost 50 years. The completion of the tunnel project allowing bypass of the geologically unstable slide area mitigates safety problems, costly repairs and risk of permanent failure. More information about the tunnel project can be found at: http://www.dot.ca.gov/dist4/dslide/

Devil's Slide Tunnel South Portal

Source: California Department of Transportation website: http://www.dot.ca.gov/dist4/dslide/

[57] Devil's Slide Fact Sheet, California Department of Transportation

Devil's Slide Tunnel Project Schematic by CalTrans



Source: California Department of Transportation website: http://www.dot.ca.gov/dist4/dslide/

California Landslide Loss Reduction Plan

California's Landslide Hazard Identification Act established the Landslide Hazard Identification Program in 1986 within the Department of Conservation, California Geological Survey, which prepared maps of landslide hazards and distributed them to local governments. The program terminated by sunset law in 1995. Since then, much of the activity has been superseded by the Seismic Hazards Mapping Act, which provided for identification of landslide zones of investigation beginning in 1998. Because most of California is subject to seismic hazard and landslides can be triggered by earthquake shaking, coordinated efforts to reduce landslide losses in California are, in effect, integrated into California's Earthquake Loss Reduction Plan which is prepared and updated regularly by the California Seismic Safety Commission.

Nationwide Efforts

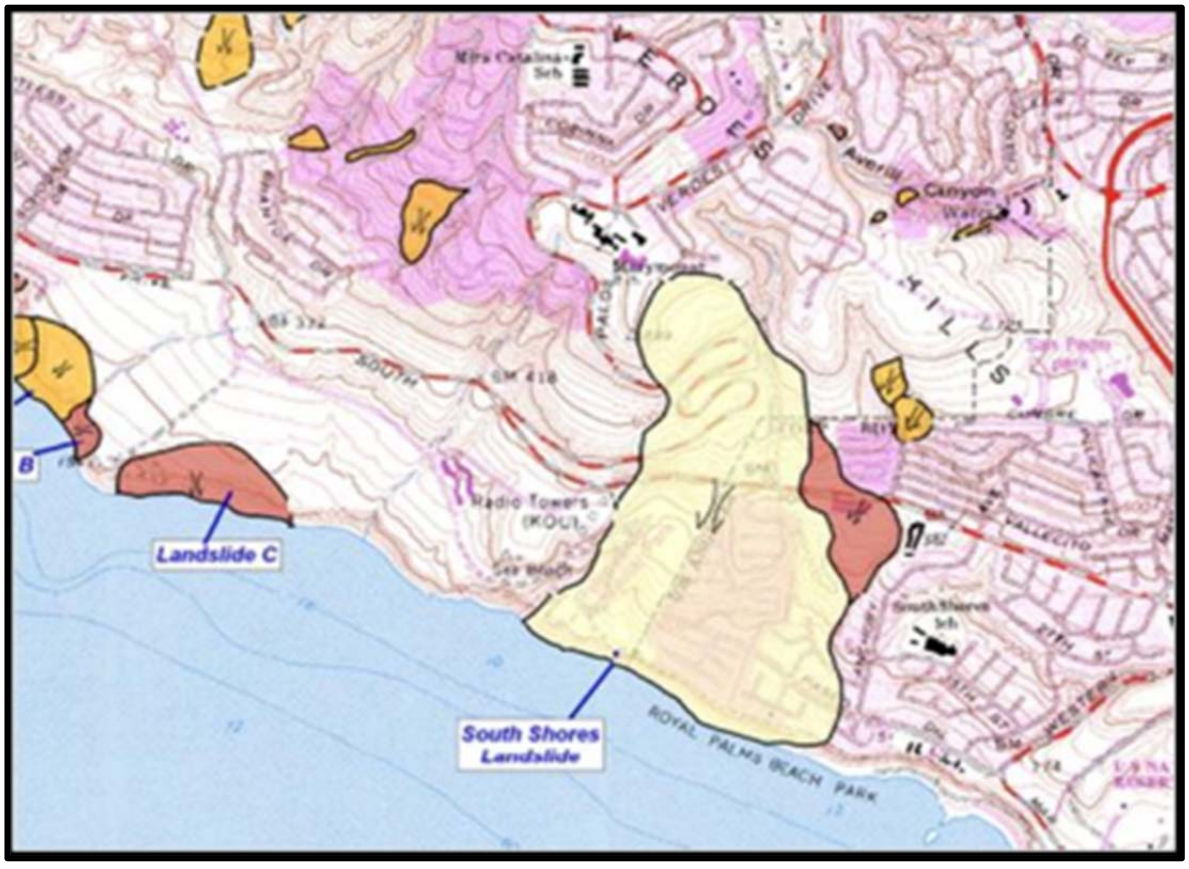
The U.S. Geological Survey has published a national strategy to reduce landslide losses that, if enacted, would provide guidance, partnering, and funding to states for landslide hazard identification and mitigation (Spiker and Gore, 2002). The National Research Council (NRC, 2004) has assessed the proposed strategy and supports the plan. Such a plan would greatly enhance landslide hazard mitigation and reduce future losses. The plan calls for increased research to develop a predictive understanding of landslide processes and triggering, and a landslide hazard assessment and mapping grant program similar to the national cooperative geologic mapping program, whereby states would receive financial assistance for such work. The plan also calls for more comprehensive and systematic loss assessment, public education and outreach, and landslide emergency preparedness, response, and recovery at the local level.

For specific mitigation ideas related to landslides, see "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" January 2013, prepared by FEMA, available on the FEMA website:
http://www.fema.gov/library/viewRecord.do?id=6938

Progress Summary 6.B: Landslide Hazard Mapping

Progress as of 2013: The California Geological Survey has released maps of zones of requiring investigation for seismically induced landslides under the Seismic Hazards Mapping Act since 1997. In addition, CGS has been producing maps of landslides since the 1970s. Hundreds of these landslide inventory maps, covering much of coastal California, have recently been made available through the CGS web page at http://www.quake.ca.gov/gmaps/WH/landslidemaps. Maps showing the locations of existing landslides in a community are useful for land use decision-making because they target areas to be avoided or remediated before construction can safely proceed. The maps indicate not only the location, but activity status and direction of slope movement. Because of their value for hazard mitigation projects, many communities have prepared such maps as part of the safety elements of their general plans or for Local Hazard Mitigation Plans. Advanced knowledge of slope instability can help to assure that proper consideration will be included in grading plans and that safe foundations will be constructed.

MAP 6.F: Palos Verdes Peninsula Area Landslide Hazard Map



Map 6.F is an example of a landslide inventory map showing boundaries of existing landslides in a portion of the Palos Verdes Peninsula of Southern California. The map shows the Portuguese Bend area and other areas of the Palos Verdes Peninsula. The major landslide covers former residential areas as well as traffic arteries in the area. Landslides are color-coded as Active or Historic Movement (brown), Dormant – Some Indication of Historic Movement (orange), and Dormant – Old, No Evidence of Historic Movement (yellow). Arrows show direction of landslide movement.

6.3 TSUNAMI HAZARDS

6.3.1 IDENTIFYING TSUNAMI HAZARDS

A tsunami is a wave triggered by any form of land displacement along the edge or bottom of an ocean or lake. This can be submarine landslides or submarine dip slip fault ruptures that result in seafloor uplift or down-drop. This mass movement translates to a tsunami or gravity wave within the overlying water. A good general description for understanding tsunamis can be found in Chen and Scawthorn (2003).

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

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

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

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

6.3.2 PROFILING TSUNAMI HAZARDS

Recent studies have documented historical tsunamis that have been recorded along coastal California. The California Seismic Safety Commission report, the Tsunami Threat to California Findings and Recommendations on Tsunami Hazards Risks, published in December 2005, indicates that over 80 tsunamis have been observed or recorded along the coast of California in the past 150 years. The report includes findings that tsunamis generated either locally or from events elsewhere in the Pacific Basin pose a significant threat to life and property in California, and that tsunamis present a substantial risk to the economy of the state and nation primarily through the impact on ports.

Over 80 tsunamis have been observed or recorded along the coast of California in the past 150 years. Since 1946, there have been seven tsunamis known to have caused damage to ports and harbors in California. In 1964, a tsunami caused by a M9.2 earthquake offshore from Alaska resulted in 12 deaths in California and destroyed portions of downtown Crescent City. More recently, a 2006 tsunami (originating in the Kurile Islands region) caused approximately $20 million in damage to Crescent City harbor. A 2010 tsunami (originating offshore from Chile) caused several million dollars in damage to ports and harbors in the state. A tsunami in 2011 (caused by a M9.0 earthquake offshore of Japan) killed one person at the mouth of the Klamath River and caused up to $100 million damage to 27 ports, harbors, and marinas throughout the

state. The most damage occurred in Crescent City, Santa Cruz and Moss Landing harbors and a federal disaster was declared in Del Norte, Santa Cruz, and Monterey Counties.

The magnitude 9.0 Tohoku Earthquake of March 11, 2011 generated a tsunami that caused damage around the Pacific basin. In California, the major damage occurred from the strong currents that were created as the waves surged in and out of enclosed areas such as ports and harbors. One person drowned in the event and several other people had to be rescued because they underestimated the hazard. Estimates as of early April are that damages are over $48 million statewide, with $12 to $16 million occurring at the Inner Basin of Crescent City Harbor and $25 million at Santa Cruz Harbor. Both Crescent City and Santa Cruz had small oil spills that resulted from sunk or damaged boats. Spills were quickly contained and clean-up efforts have been completed. (Source: http://www.coastal.ca.gov/energy/tsunami/CCC_Tohoku_Tsunami_Report.pdf)

Post Tsunami Damage to Crescent City Harbor, March 2011

The 2010 version of the Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS), codified as the 2010 California Code of Regulations Title 24, Part 2, California Building Code, Chapter 31F Marine Oil Terminals, became effective in 2011. It includes a study by Borrero et al. (2006) that provides maximum credible tsunami water levels and current speeds for marine oil terminals in the San Francisco Bay Area.

The work by Legg et al (2002) provides estimated wave height for coastal cities in Southern California. The portion of Northern California north of the Mendocino triple junction (roughly offshore due west of the town of Petrolia) falls within the Cascadia subduction zone, which has wave heights documented by the state mapping agencies.

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

6.3.3 ASSESSMENT OF STATE VULNERABILITY AND POTENTIAL LOSSES

Assessing vulnerability and potential loss due to tsunami hazards is a field that is in its infancy. Spurred by the catastrophic tsunami in Sumatra (Iwan et al., 2006), a recent spate of research has been initiated to evaluate relative loss as a function of the built environment and tsunami loading. At this point, there is

little in the way of quantitative methods for analyzing vulnerability and loss. Some of the issues that are relatively unknown include structural response to tsunami wave loading, tsunami wave-loading forces for design purposes, non-structural element response to wave loading, and dynamic effects of tsunami wave travel throughout a built environment.

Assessment of run-up heights is currently performed by tsunami modelers who have made significant improvements in their ability to properly model wave propagation with respect to complex sea floor topography and 3-D wave mechanics. To have probabilistic run-up heights, the triggering mechanism needs to be related to recurrence intervals such as with flood frequency or earthquake recurrence. The California Geological Survey (CGS) and Cal OES are producing maps that will utilize a probabilistic tsunami hazard analysis for California. These maps will identify potential tsunami hazard "zones of required investigation" under the Seismic Hazards Mapping Act and will assist state and local agencies in making land use planning decisions.

6.3.4 ASSESSMENT OF LOCAL VULNERABILITY AND POTENTIAL LOSSES

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans and Local Coastal Plans (LCPs) that help guide planning for coastal communities under the California Coastal Act. The Local Hazard Mitigation Plans reviewed identify tsunamis as a potential threat. A current evaluation is included in Annex 4, California Local Hazard Mitigation Plan Status Report.

Progress Summary 6.C: Tsunami Hazards

Progress as of 2013: The USGS has completed a vulnerability analysis based on the current state tsunami inundation maps. The study titled "Community Exposure to Tsunami Hazards in California" provides first responders, emergency planners and other stakeholders, with valuable new information about the people who live in, work in and visit each of the 20 counties, 94 incorporated cities and 83 unincorporated communities located in a tsunami inundation zone.

Community exposure to tsunamis in California varies considerably—some communities may experience great losses that reflect only a small part of their community and others may experience relatively small losses that devastate them. Among 94 incorporated communities and the remaining unincorporated areas of the 20 coastal counties, the communities of Alameda, Oakland, Long Beach, Los Angeles, Huntington Beach, and San Diego have the highest number of people and businesses in the tsunami-inundation zone. The communities of Belvedere, Alameda, Crescent City, Emeryville, Seal Beach, and Sausalito have the highest percentages of people and businesses in this zone. On the basis of a composite index, the cities of Alameda, Belvedere, Crescent City, Emeryville, Oakland, and Long Beach have the highest combinations of the number and percentage of people and businesses in tsunami-prone areas. To download the Community Exposure to Tsunami Hazards in California report visit the USGS website: http://pubs.usgs.gov/sir/2012/5222/

6.3.5 CURRENT TSUNAMI HAZARD MITIGATION EFFORTS

A report issued by the California Seismic Safety Commission in 2005 states that "tsunamis, generated either locally or from events elsewhere in the Pacific Basin, pose a significant threat to life and property in California" and points out that losses from tsunamis can be reduced in four ways: 1) engineering standards creating more damage-resistant buildings and port structures, 2) public education training Californians to recognize tsunami alerts and providing instruction on what to do, 3) warning systems alerting a population to a tsunami coming from a distant source, and 4) effective evacuation planning. The report recommends a series of actions to be taken to improve mitigation, preparedness, response, and recovery including:

- Improving public education about tsunami issues, including multi-lingual information
- Working with other coastal states to obtain an external expert review of the National Oceanic and Atmospheric Administration (NOAA) tsunami warning system criteria for issuing and canceling warnings
- Working with federal agencies to develop guidelines for structures to resist both strong ground motion and tsunami wave impact
- Supporting and providing matching funds for tsunami mitigation programs in coastal counties, including improvements to the communications and emergency response systems
- Supporting and providing matching funds for development of improved technologies and methodology to assess tsunami risk

Regions that are below the projected run-up height are delineated, and evacuation plans are essentially the only mitigation methods currently available. These have been implemented along the Cascadia subduction zone throughout Washington and Oregon, but most regions of coastal California have yet to adopt these preparations.

Federally directed mitigation programs are posted on the National Tsunami Hazard Mitigation website (http://nthmp-history.pmel.noaa.gov/). More information can be found at the NOAA tsunami website (http://www.tsunami.noaa.gov/). NOAA sponsors community-based tsunami preparedness programs with details described at the previous link. NOAA cooperates with California's State Tsunami Program through the National Tsunami Hazard Mitigation Program to fund these efforts.

The State Tsunami Program completed a new statewide set of tsunami inundation maps for use in evacuation planning. These maps, made with the assistance of the Tsunami Research Center at the University of Southern California, are available to the public through the CGS tsunami web page (www.tsunami.ca.gov) and Cal OES MyPlan and MyHazards web pages(http://myplan.calema.ca.gov/) (http://myhazards.calema.ca.gov/).

Progress Summary 6.D: New Tsunami Hazard Mapping

Progress as of 2013: Since the 2010 SHMP progress report, two significant teletsunamis (tsunamis originating from distant sources) occurred around the Pacific Ocean causing major damage along the immediate coast of other countries and moderate damage to ports and harbors in California. These teletsunamis helped to identify potential gaps in California's tsunami preparedness and mitigation activities. The two events, the February 27, 2010 Chile tsunami and the March 11, 2011 Japan tsunami - put the California coast into either a tsunami "Advisory" or "Warning" level of alert by the West Coast/Alaska Tsunami Warning Center. Because both teletsunamis arrived during low tide in California, the potential for inundation of dry land was greatly reduced during both events. However, both events created rapid water-level fluctuations and strong currents within harbors and along beaches, causing extensive damage in a number of harbors and challenging emergency managers in California's coastal jurisdictions.

Post-event survey teams and questionnaires were used to gather information about both physical effects and emergency response (Wilson and others, 2012). During the 2010 tsunami, a maximum tsunami amplitude of 1.2 m was observed at Pismo Beach, and over $3-million in damage to boats and docks occurred in nearly a dozen harbors, most significantly in Santa Cruz, Ventura, Mission Bay, and northern Shelter Island in San Diego Bay. During the 2011 tsunami, the maximum amplitude was measured at 2.47 m in Crescent City Harbor with over $50-million in damage to two dozen harbors. Those most significantly affected were Crescent City, Noyo River, Santa Cruz, Moss Landing, and southern Shelter Island. During both events, people on docks and near the ocean were at risk for injury with one fatality occurring during the 2011 tsunami at the mouth of the Klamath River. In addition, the significant sediment deposition and damage within the Crescent City and Santa Cruz harbors during the 2011 event caused long delays in recovery of those harbors because of regulatory and reconstruction issues.

California Tsunami Program

Based on the analysis of these recent events in Chile, Japan, and California, the California tsunami program is enhancing existing products and developing new products that will improve tsunami preparedness and mitigation. These products will help 1) the maritime community better understand tsunami hazards within their harbors and determine if and where boats should go offshore to be safe; 2) emergency managers develop evacuation plans for relatively small ''Warning'' level events where extensive evacuation is not required; and (3) land-use planners better understand the probabilities of tsunami hazard and the effects over the lifetime of construction and development.

Maritime communities in California were challenged and affected the most during the 2010 and 2011 tsunamis. Although millions of dollars were lost during these two events, the eye-witness accounts and video information collected after each event provided an excellent resource for improving tsunami hazard analysis in harbors and bays. Through a co-operative technical partnership developed between the state and FEMA, observed strong tsunami currents and damage are being used to validate/calibrate numerical tsunami model currents to produce in-harbor hazard maps and identify offshore safety zones for potential boat evacuation when a tsunami "Warning" is issued for a distant source event. The state tsunami program has developed educational information for boaters and harbor masters alike, including a new brochure for boaters with tsunami education information and advice on what to do and what not to do during a tsunami. Ultimately, harbor-specific guidance will be created to help maritime communities better prepare for, respond to, and recover from future tsunamis. Most of this mapping and guidance work with the maritime communities will be completed by 2015. Additional funding is being sought to help specific high-risk harbors and ports initiate mitigation measures to protect their facilities against tsunami hazards.

The state has also been involved in improving state and local emergency response activities. New tsunami inundation maps have been completed for Catalina Island, and new maps for the coastline between Gualala and Sea Ranch in Northern California are nearly completed. Information from the 2011 Japan event, a new tsunami deposit database showing the history of past events in California, and work underway in Oregon are being evaluated to determine if the existing tsunami hazard analysis for the Cascadia Subduction Zone is adequate. The State of California has also been in discussions with the State of Nevada to develop tsunami inundation maps for the Lake Tahoe region so that evacuation planning and tsunami sign placement can be done in an accurate and consistent manner. Real-time and post-tsunami field teams have also been expanded to capture additional detailed information that can be shared in a timelier manner during and after an event through a state-wide clearinghouse. These new products and related efforts will result in more accurate and efficient emergency response by coastal communities, potentially reducing the loss of lives and property during future tsunamis.

During the 2011 tsunami in California, the arrival of the significant tsunami activity which was only forecasted to be between 1m and 2.5m for areas within a "Warning" along the coast coincided with low tide conditions; therefore the tsunami, was not expected to inundate dry land. Considerable inconsistencies were noted in evacuation and response in various communities. Only a few communities in the state called full evacuations and, in most cases, no evacuations were initiated. Most emergency managers indicated that secondary evacuation zones for smaller warning-level events would have been useful, reducing the potential for under or over evacuation. As a result, scenario-specific, tsunami evacuation "playbook" maps and guidance are being produced detailing inundation from tsunamis of various size and source locations. In addition, a formula that incorporates forecasted tsunami amplitudes (wave heights), tidal conditions, storm activity, and site specific tsunami run-up potential into a "maximum predicted tsunami run-up height" is being developed to determine which evacuation scenario is most appropriate and conservative for use. These products, expected to be available by the end of 2013, will help coastal emergency managers prepare local response plans when minor distant source tsunamis or larger tsunamis from local and regional sources are generated.

Along with improvements to evacuation planning and maritime planning, the state tsunami program has made progress toward development of products for the land-use planning community. Because land-use planning decisions should not be based on the existing state-wide tsunami inundation maps as they represent "worst-case" scenarios, a probabilistic tsunami hazard analysis (PTHA) must be completed. Maps and associated products based on PTHA methods will be similar to other probabilistic flood and seismic hazard maps by representing standard risk levels (average return periods) for tsunami hazards which can be used not only in land use planning but possibly also in developing building design criteria, producing more consistent inundation maps for evacuation planning, and setting flood insurance rates. The initial phase of PTHA and land-use planning product development, which has been funded by the National Tsunami Hazard Mitigation Program (NTHMP), includes: 1) developing a "work group" of experts to evaluate existing PTHA methods; 2) determining the adequacy of the PTHA methods for land-use planning and other uses; 3) accepting and making improvements to one of the PTHA methods; 4) determining the appropriate risk levels for PTHA-based map production; and, 5) begin development of PTHA-based maps for at least 10 percent of the California coast. The process and products of this PTHA in California will also form the basis for the NTHMP to be implemented nation-wide. With this initial work being completed by the fall of 2013, additional partners and funding sources are being sought by the state tsunami program to develop these products for the entire state.

Multi-Hazards Demonstration Project: SAFRR

In addition to working with the NTHMP, NOAA, and FEMA, the State Tsunami Program has also partnered with the U.S. Geological Survey (USGS) to improve tsunami planning and preparedness in California. The USGS Science Application for Risk Reduction (SAFRR) project has developed a state-wide tsunami planning scenario that starts with a large-magnitude earthquake event off the eastern Aleutian Islands. The state and federal partnership through the SAFRR project has improved the understanding of scientific information, such as tsunami source mechanisms and tsunami deposit exploration, as well as engineering, environmental, and recovery assessments for a significant state-wide tsunami event. The results of SAFRR and tsunami vulnerability analysis project will be used by the state tsunami program to help coastal communities better envision the impacts from a large, state-wide tsunami.

In order to help guide, develop, and improve future tsunami preparedness and mitigation activities, the state tsunami program formed the California Tsunami Policy Work Group (CTPWG) in 2011. Comprised of members from federal, state, and local agencies as well as private organizations, the CTPWG works closely with the state tsunami program to understand the state of tsunami preparedness in California. The CTPWG is writing a report that will identify gaps and issues in current tsunami hazard mitigation, make recommendations that will help eliminate these impediments, and provide advice that will assist development and implementation of effective tsunami hazard products to improve community resiliency. This report should be available by fall 2013.

Other tsunami hazard mitigation activities of the California Tsunami Hazard Mitigation and Preparation Program (CTHMPP) include 1) developing products that help protect harbor infrastructures from tsunami hazards and identify offshore safe areas for ships/boats prior to the arrival of a distant tsunami; 2) guidelines for local emergency managers to use for reviewing geotechnical and utility-disruption hazards as they relate to evacuation from a local tsunami event; 3) assisting coastal communities to become TsunamiReady, a federal designation indicating that the community has fully prepared to respond to a tsunami emergency; 4) conducting tsunami workshops and exercises with local communities; and 5) providing communities with educational materials they can use for their outreach activities.

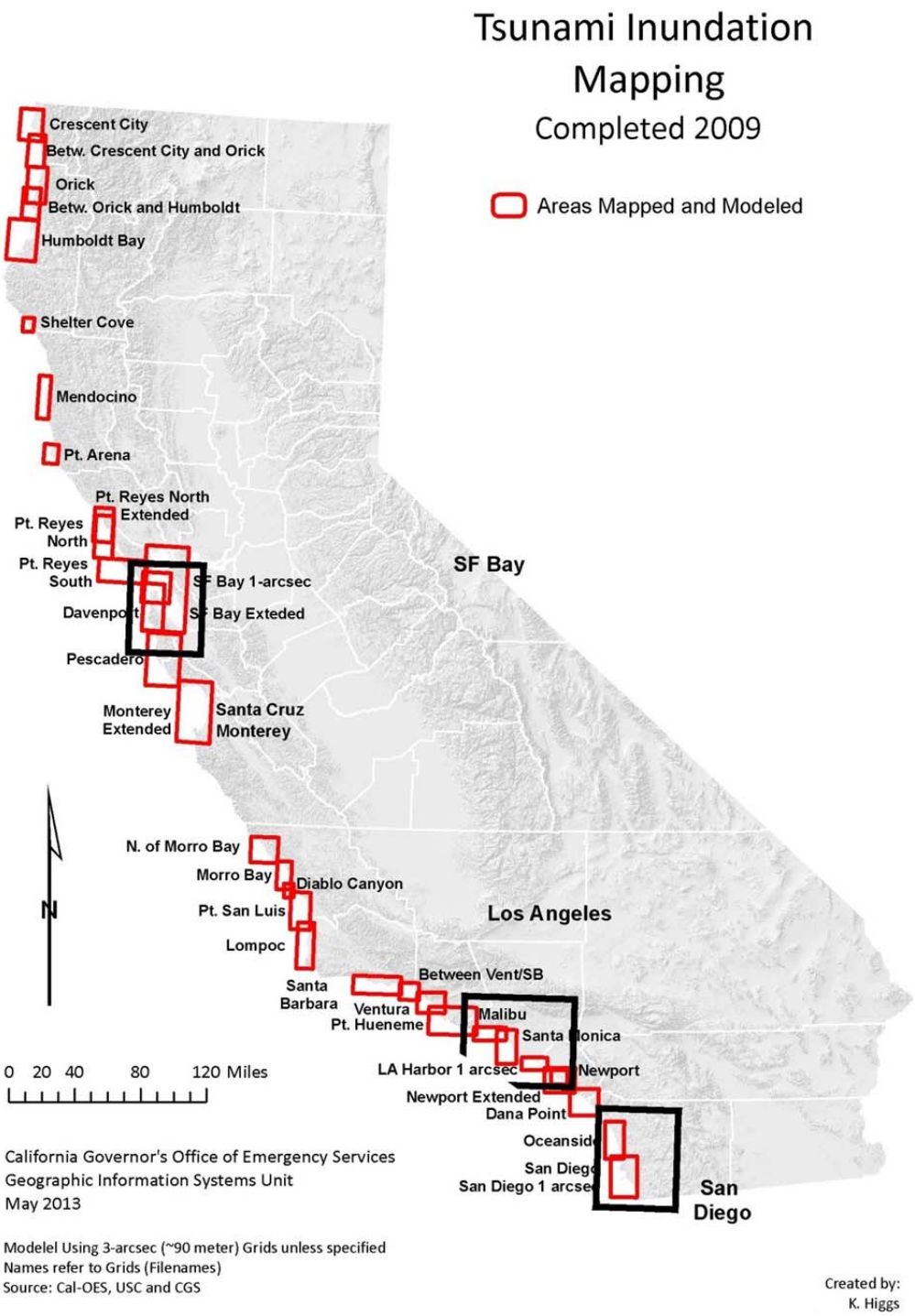
Municipalities are undertaking their own planning efforts specifically directed toward this hazard. For example, a Tsunami Safety Plan and a related brochure are being prepared for the Town of Samoa in Humboldt County with the assistance of the Redwood Coast Tsunami Working Group and NOAA (http://www.humboldt.edu/rctwg/). The State Tsunami Program is also assisting and helping to fund this work.

Tsunamis cannot be prevented, but early warning and evacuation can dramatically reduce their threat to human safety. Modern warning networks can sense tsunamis hundreds, or even thousands, of miles from their location of impact and issue warnings to potentially threatened communities. Such warning systems, coupled with well-designed evacuation plans, can remove people from harm's way. Federal and state programs to educate local emergency response agencies and the public and to develop safe evacuation routes with appropriate signage are currently under way.

Life and property loss from tsunamis and seiches can also be reduced by limiting development along low-lying coasts and designing structures to allow swift water to flow around, through or underneath without causing collapse.

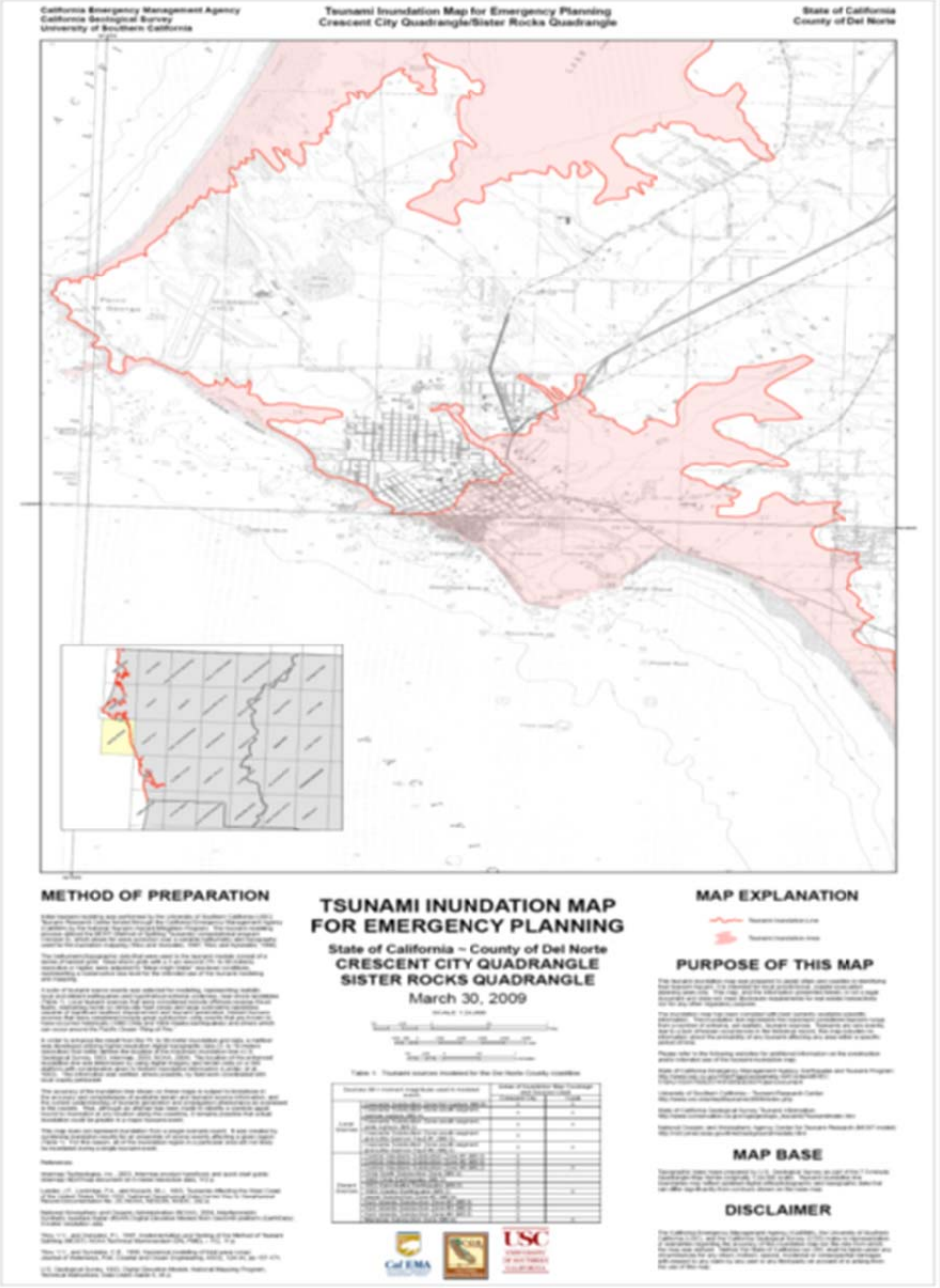
(Continued on next page)

MAP 6.G: Tsunami Inundation Mapping Completed, 2009



Map 6.G provides a generalized statewide index to local areas covered by California Geological Survey (CGS) tsunami modeling and mapping. CGS, in cooperation with Cal OES and the Tsunami Research Center at the University of Southern California, has undertaken modeling of tsunami hazards to produce statewide tsunami inundation maps. These local maps are developed for all populated areas at risk to tsunamis in California and represent a combination of the maximum considered tsunamis for each area.

MAP 6.H: Tsunami Inundation Map – Crescent City



Produced by the joint Cal OES-CGS tsunami modeling and mapping, Map 6.H shows within the pink boundary the potential run-up area for tsunami that might hit Crescent City, California, and surroundings. Crescent City experienced major tsunami devastation on March 28, 1964, following the Magnitude 8.6 Good Friday Earthquake that hit Anchorage, Alaska, the preceding day. Recent tsunamis have caused considerable damage to the Crescent City Harbor.

For more detailed information on areas within the future tsunami run-up areas, see:
http://www.consrv.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/DelNorte/Documents/Tsunami_Inundation_CrescentCitySisterRocks_Quads_DelNorte.pdf

For specific mitigation ideas related to tsunamis, see "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" January 2013, prepared by FEMA, available on the FEMA website: http://www.fema.gov/library/viewRecord.do?id=6938

6.3.6 OPPORTUNITIES FOR ENHANCED TSUNAMI MITIGATION

For enhanced mitigation, the run-up heights first need to be rendered in a probabilistic time frame similar to flood frequency or earthquake recurrence estimates. This would allow for a rational risk-based approach to hazard and mitigation decisions. Current research is focusing on addressing mitigation procedures other than evacuation with some initial results pending (see OSU Tsunami Research Center at: www.nees.oregonstate.edu). Eventually, building codes will incorporate some type of design requirements with respect to tsunami wave loading, but that is still years in the future.

The primary goal for coastal California is to identify which regions are within a projected run-up height and to prepare those communities accordingly. This would involve bringing California up to speed with practices currently implemented along the Cascadia subduction zone through the NOAA preparedness program.

Tsunami warnings or tsunami alerts are a key to evacuation. These warning are issued by the West Coast/Alaska Tsunami Warning Center (http://www.prh.noaa.gov/ptwc/) and local communities that are below the run-up height should have a communication avenue for broadcasting warnings.

6.4 CLIMATE-RELATED HAZARDS

This section assesses hazards that are related to climate and weather. NASA provides the following assessment of these terms:

> Weather is basically the way the atmosphere is behaving, mainly with respect to its effects upon life and human activities. The difference between weather and climate is that weather consists of the short-term (minutes to months) changes in the atmosphere. Most people think of weather in terms of temperature, humidity, precipitation, cloudiness, brightness, visibility, wind, and atmospheric pressure, as in high and low pressure. In most places, weather can change from minute-to-minute, hour-to-hour, day-to-day, and season-to-season. Climate, however, is the average of weather over time and space.[58]

Long-term changes in the climate, especially those driven by the accumulation of anthropogenic greenhouse gases in the atmosphere, are expected to change short-term weather patterns and thus change weather-related impacts, both short- and long-term. Most prominently, climate change is warming the average global temperatures, which will result in more frequent and intense extreme events related to changes in temperature and precipitation, such as heat waves, flooding.

In the SHMP, climate change is treated as a condition that will change and potentially exacerbate the impact of other hazards rather than being treated as a distinct hazard with unique impacts. For example, extreme heat and heat waves is an existing hazard that will be exacerbated by climate change. Impacts of climate change on the frequency, timing, and magnitude of flooding varies with the geography throughout the state. Areas that experience early run off from snow melt coupled with intensified rain or coastal areas experiencing sea level rise may be more greatly impacted by flooding. Hazards that have the potential to be affected by climate change are grouped in this subsection.

[58] http://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

With the exception of wildfires and inland flooding which are covered extensively in Chapter 5, the following section assesses many other climate change-related impacts. The discussion is limited to scientific assessments reviewed and validated by the appropriate state agency for the hazard and do not include the entirety of the peer-reviewed scientific literature.

6.4.1 AIR POLLUTION

Although as a single event air pollution is less significant than flood, fire, or earthquake, cumulatively it is much more hazardous to the health of large numbers of Californians. Air pollution is a continuing problem, with the largest concentration of pollution in the highest populated air basins: the San Francisco Bay Area, San Joaquin Valley, Sacramento Valley, San Diego, and the South Coast. Pollutants include smog, soot, and toxic air contaminants (TACs) (Toxic Beginnings—Cancer Risks to Children from California's Air Pollution, National Environmental Trust). However, toxic emissions in California are on the decline. Table 6.C shows the average quantities of emissions in tons per day since 1975. In 2000, average statewide emissions of nitrogen oxide (NOx) dropped to 77 percent of those in 1975, reactive organic gasses (ROG) dropped to 44 percent, and carbon monoxide (CO) dropped to 42 percent. Only Particulate Matter (PM10, less than or equal to 10 microns) has increased since 1975.

Table 6.C: Average Air Emissions in California, 1975-2020

Statewide Emissions (tons/day, annual average)										
	Pollutant									
	1975	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2015**	**2020**
NO_X	4,949	5,060	5,011	4,997	4,319	3,844	3,220	2,741	2,359	2,199
ROG	7,026	6,602	6,068	4,737	3,761	3,128	2,430	2,167	2,046	2,004
PM_{10}	1,992	2,026	2,131	2,316	2200	2,267	2,212	2,254	2,326	2,410
PM_{25}	896	874	884	934	862	877	864	879	903	933
CO	41,866	38,189	36,145	30,221	22,832	17,515	13,766	11,408	9,782	8,826

Source: www.arb.ca.gov/aqd/almanac/almanac06/chap306.htm

6.4.2 AVALANCHES

Identifying Avalanche Hazards

Avalanches occur in the steep mountainous areas of the state that receive significant amounts of snow. Avalanches are weather-related threats to communities, residents, and visitors to the high mountain areas of the state.

Profiling Avalanche Hazards

Avalanches have caused property damage and loss of life in California. For the period beginning in 1950 and continuing through 1997, there were 15 deaths reported as a result of avalanche. In all, 16 counties were affected by avalanche during that time. Significant events have damaged or destroyed ski resorts at Mt. Shasta and Lake Tahoe. Avalanches have also blocked and damaged roadways. Avalanches pose a threat in the Sierra Nevada on the eastern side of the state and the Cascade Range in the north.

The Department of Water Resources monitors snowfall amounts and water content but does not actively monitor avalanche probability or occurrences. It does, however, provide a website link to the Avalanche Center, a 501c(3) organization that posts information on avalanche conditions for the United States. The organization is a partnership between the United States Forest Service and the private sector and relies heavily on private contributions and volunteer support. There are three Avalanche Centers operating in California that provide up-to-date information on snow conditions and avalanche danger levels:

- Eastern Sierra Avalanche Center – Inyo National Forest in Mammoth Lakes

- Central Sierra Avalanche Center – Tahoe National Forest in Truckee
- Shasta Avalanche Center - Shasta-Trinity National Forest in Mt. Shasta

The information and the avalanche warnings that the centers provide are geared to the general public who engage in snow-related recreational activities.

6.4.3 COASTAL FLOODING, EROSION AND SEA LEVEL RISE

Identifying Coastal Flooding, Erosion and Sea Level Rise Hazards

As discussed earlier, the potential impacts of global warming and climate change include increased opportunities for severe weather and winter storms that may result in coastal flooding and erosion, as well as sea level rise. California's land mass includes more than 1,100 miles of coastline with varying geologic features including steep coastal bluffs, beaches, wetlands, bays, and deltas. It also supports varying levels of development and land use, including recreational, agricultural, industrial, commercial, and residential.

Profiling Coastal Flooding, Erosion and Sea Level Rise Hazards

Coastal erosion is a natural geomorphic process. In California, coastal erosion can be accelerated or exacerbated to the level of emergency or disaster through a combination of factors, including winter storms, tidal action, wind-generated high surf, wave action, and rising sea levels. Typically, the highest sea level readings along California's coastline occur during periods of heavy rain that coincide with high tides, causing coastal flooding, coastal bluff erosion, and landslides such as were experienced during the 1998 El Nino storms. Conversely, gradual sea level rise progressively worsens the impact of high tides and wind-driven waves associated with severe storms. Sea level rise coupled with increased frequency, severity, and duration of high tide and storm events related to climate change will result in more frequent and severe extreme events along the coast. These events could expose the coast to severe flooding and erosion, damage to coastal structures and real estate, and salinity intrusion into delta areas and coastal aquifers (Projecting Future Sea Level, A Report From the California Climate Change Center, 2006).

The continued rise in sea level will increase inundation of low coastal areas. Near-shore wave heights and wave energy will increase, intensifying the potential for storm damage, beach erosion, and bluff retreat. Ports and harbors will have reduced cargo transfer capability as ships ride higher along the dock. Wetlands can become inundated and degraded by salt water intrusion with resulting impacts related to land subsidence, loss of habitat for fish and wildlife, and loss of esthetic, recreational and commercial uses among others. Intact wetlands can serve as a buffer to flooding events by increasing flood capacity, restore ground water recharge and reduce the need for pumping, protect water quality and provide water supply reliability for the benefit of our communities.

Assessment of State and Local Vulnerability and Potential Loss

An early report prepared by California Coastal Commission staff in June 2001 identified a number of potential consequences from climate change-induced sea level rise, including impacts on ports and harbors, seawalls and other engineered structures, groundwater, wetlands, beaches, and coastal bluffs. In assessing overall economic impacts, the Coastal Commission projected areas of the coast where a long-term rise in sea level would be most severe and areas that would experience the greatest economic losses. The projections were based on estimates of coastal population growth to over 32 million by 2025 with an anticipated 20- to 60-percent increase in coastal economic growth, except for San Diego, which is anticipated to experience 60- to 90-percent growth.

Recently the State, in cooperation with Oregon and Washington, funded the National Research Council (NRC) to provide projections of sea level rise based on various emission scenarios. In March 2013,the Ocean Protection Council released updated sea level rise guidance, based upon these NRC projections, that

recommend using a sea level rise range from 0.3 to 4.69 feet (10 to 143 centimeters) north of Cape Mendocino and 1.38 to 5.48 feet (42 to 167 centimeters) south of Cape Mendocino by 2100 (see Table 6.D.). More information on the NRC report entitled: Sea Level Rise for the Coasts of California, Oregon, and Washington: Past Present and Future can be found at: http://nas-sites.org/americasclimatechoices/other-reports-on-climate-change/2012-2/

The Pacific Institute concludes that under medium to medium-high greenhouse gas emissions scenarios mean sea level rise will range from 1.0 to 1.4 meters (The Impacts of Sea Level Rise on the California Coast, Pacific Institute, May, 2009, p.2).

Table 6.D: Sea-Level Rise Projections using 2000 as the Baseline Time Period

	North of Cape Mendocino	South of Cape Mendocino
2000 - 2030	-4 to 23 cm (-0.13 to 0.75 ft)	4 to 30 cm (0.13 to 0.98 ft)
2000 – 2050	-3 to 48 cm (-0.1 to 1.57 ft)	12 to 61 cm (0.39 to 2.0 ft)
2000 – 2100	10 to 143 cm (0.3 to 4.69 ft)	42 to 17 cm (1.38 to 5.48 ft)

The differences in sea-level rise projections north and south of Cape Mendocino are due mainly to vertical land movement. North of Cape Mendocino, geologic forces are causing much of the land to uplift, resulting in a lower rise in sea level, relative to the land, than has been observed farther south.

The potential impacts of sea level rise are substantial. Areas vulnerable to inundation in 2100 currently have a population of about 475,000 and property values estimated at approximately $100 billion (Gleick, P. The Cost of Adaptation to Sea level Rise along the California Coast and in the San Francisco Bay. California Climate Change Center, October 2008, pp. 42-47). According to the Pacific Institute study, critical infrastructure now threatened by increased risk of inundation includes:

- 140 schools
- 34 police and fire stations
- 55 health care facilities
- 330 hazardous waste facilities and sites
- 3,500 miles of roads and highways and 280 miles of railways
- 30 coastal power plants, with a combined capacity of 10,000 megawatts
- 28 wastewater treatment plants
- San Francisco and Oakland International Airports

The study also estimates that $100 billion worth of property (in year 2000 dollars) is at risk from a 100-year flood event with a 55-inch sea level rise and no adaptation. Two-thirds of the vulnerable property is in the San Francisco Bay Area.

The Bay Conservation and Development Commission (BCDC) regulates the filling of San Francisco Bay and development within the first 100 feet of the waterfront. BCDC's recently released 2013-2016 Strategic Plan includes an objective to "Pioneer policies and actions that take advantage of, and reduce risks caused by, the changing Bay, including rising sea level." For an update on BCDC's sea level rise strategies, see Progress Summary 6.E. BCDC's Strategic Plan is available on the BCDC website: www.bcdc.ca.gov.

Current Coastal Flooding, Erosion and Sea Level Rise Hazard Mitigation Efforts

Mitigating the impacts of sea level rise requires action at all levels. A global effort is needed to reduce greenhouse gas emissions that are leading to climate change, melting of the polar ice caps, and glacial

melting. In addition, appropriate land use planning and regulation are needed at the federal, state, and local levels. The Federal Coastal Zone Management Act states that "Because global warming may result in a substantial sea level rise with serious adverse effects in the coastal zone, coastal states must anticipate and plan for such an occurrence.

Progress Summary 6.E: Adapting to Rising Sea Levels in San Francisco Bay

Progress as of 2013: In October 2011, the San Francisco Bay Conservation and Development Commission (BCDC) updated the San Francisco Bay Plan to better address the expected impacts of climate change in San Francisco Bay (www.bcdc.ca.gov/planning/climate_change/climate_change.shtml). Changes to BCDC's policies include a requirement for sea level rise risk assessments when planning shoreline areas or designing larger shoreline projects. Based on the risk assessment results, projects will need to mitigate for flooding expected by mid-century that would result in public safety risks. If the project is to remain in place longer than mid-century, a plan is required that will address end-of-century flood risks. Policies related to Bay fill, shoreline protection, and public accesses were also amended to ensure that risks from sea level rise are avoided or mitigated.

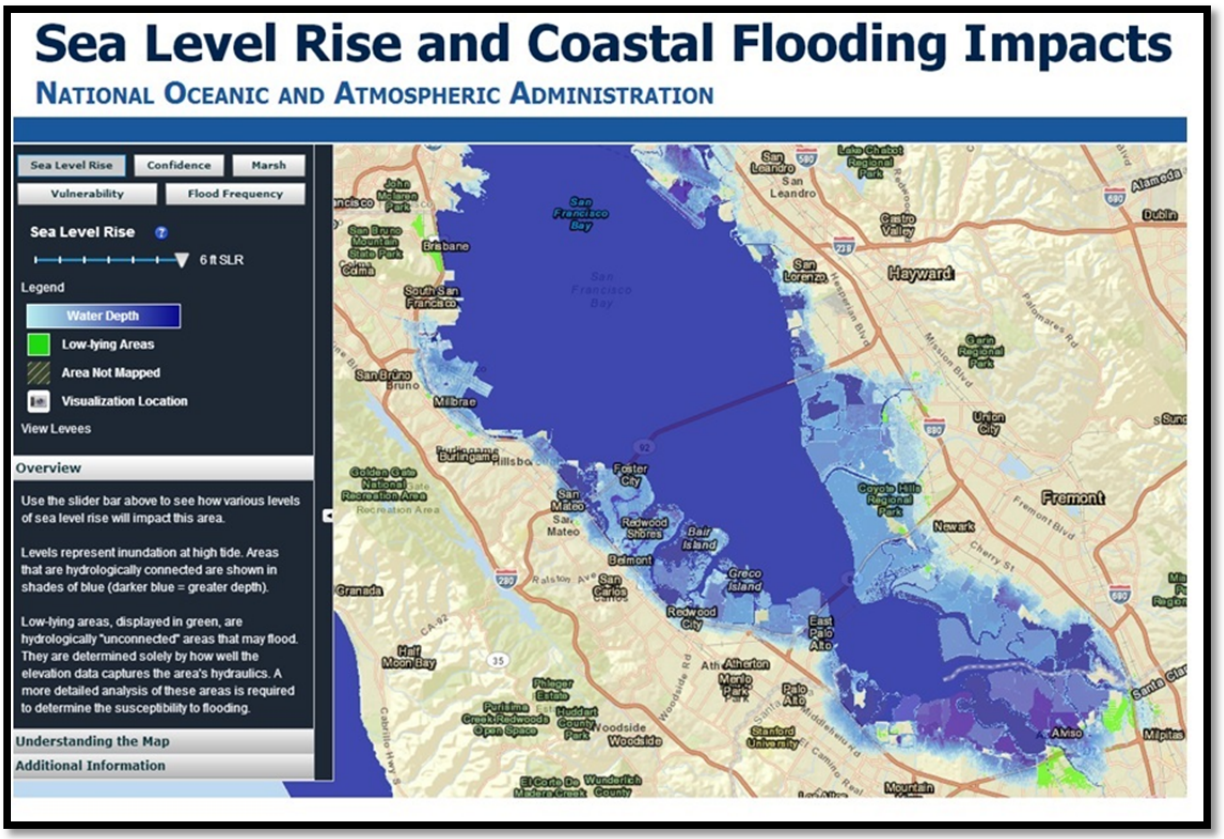
In addition to policies that address sea level rise on a case-by-case project basis, BCDC also adopted a new policy that aims to address sea level rise through the development of a regional strategy. BCDC, working with its Joint Policy Committee (JPC) partner the Association of Bay Area Governments (ABAG) is collaborating with regional, state, and federal agencies, local governments, and the general public to formulate a resilient shorelines strategy. This initiative will help the region better understand and mitigate future impacts associated with anticipated sea level rise and other coastal hazards such as storm events and seismic risk in high liquefaction areas.

BCDC has also been working with its state and federal partners to advance the understanding of sea level rise risk to the region. The National Oceanic and Atmospheric Administration Coastal Services Center (NOAA CSC) developed with input from BCDC an updated Sea Level Rise Viewer with maps and data for the entire west coast. The NOAA Sea Level Rise Viewer allows users to see at a glance the potential future flooded risk due to varying amounts of sea level rise (www.csc.noaa.gov/slr/viewer/). The viewer presents sea level rise maps for the Bay and the outer coast of California, and includes other information relative to risk mitigation including socioeconomic vulnerability and potential wetlands impacts. There are many other new tools that support climate adaptation planning, and NOAA CSC and its partners the Ecosystem Based Management Tools Network and NatureServe have published a guide that includes reviews and case studies of a number of multi-hazard risk assessment methods and tools http://natureserve.org/climatetoolsguide.

BCDC is continuing to work with regional, state and federal partners to develop and disseminate data, tools and information to help the region understand and mitigate future risks due to sea level rise and other climate impacts. These initiatives will increase the region's capacity to address climate change and include:

- Implementing the ocean and coastal resources component of the California Climate Adaptation Strategy with sister agencies in the California Natural Resources Agency
- Studying the resilience of Bay Area wetlands to climate change with the San Francisco Estuary Partnership
- Studying sediment transport in the Bay because an adequate supply of sediment is essential for wetlands to adapt to sea level rise (with the U.S. Geological Survey).
- Studying the projected migration of head of tide (HOT) on tributaries to San Francisco Bay as sea level rises to develop protocols for identifying the HOT zone and methods for assessing impacts of its migration (with the San Francisco Estuary Institute)
- Completing a technical update of the Baylands Goals to address climate change with the State Coastal Conservancy and several other agencies and organizations

MAP 6.I: Areas Potentially Vulnerable to Sea Level Rise using NOAA Coastal Services Center's Interactive Mapping Tool



Map 6.I indicates areas in the southern portion of San Francisco Bay Area that are vulnerable to a sea level rise using the National Oceanic and Atmospheric Administration's interactive mapping tools. Most of the bay front north, east, and south of San Francisco and Oakland, including both San Francisco and Oakland Airports, will require some form of adaptive action, such as sea walls, elevated and low-impact development, or managed retreat through acquisition and wetlands restoration.

Available Tools

For up-to-date detailed interactive mapping tools identifying sea level rise see:

- Cal Adapt climate change mapping tools at: http://cal-adapt.org/sealevel/
- NOAA Coastal Services Center web viewer at: http://www.csc.noaa.gov/digitalcoast/tools/slrviewer/
- State of California Geoportal at: http://portal.gis.ca.gov/geoportal/catalog/main/home.page

Progress Summary 6.F: State of California Sea-Level Rise Guidance Document

Progress as of 2013: In March 2013, the Coastal and Ocean Working Group of the California Climate Action Team (CO-CAT), with science support provided by the Ocean Protection Council's Science Advisory Team and the California Ocean Science Trust, published the State of California Sea-Level Rise Guidance Document. The Document provides the following recommendations (summarized):

1. Use the ranges of SLR presented in the June 2012 National Research Council report on Sea-Level Rise for the Coasts of California, Oregon, and Washington as a starting place and select SLR values based on agency and context-specific considerations of risk tolerance and adaptive capacity (see Table 6.D above).

2. Consider timeframes, adaptive capacity, and risk tolerance when selecting estimates of SLR.
3. Consider storms and other extreme events.
4. Coordinate with other state agencies when selecting values of SLR and, where appropriate and feasible, use the same projections of sea-level rise.
5. Future SLR projections should not be based on linear extrapolation of historic sea level observations.
6. Consider changing shorelines.
7. Consider predictions in tectonic activity.
8. Consider trends in relative local mean sea level.

Visit the Ocean Protection Council website to download the Sea Level Rise Guidance Document: http://www.opc.ca.gov/2013/04/update-to-the-sea-level-rise-guidance-document/

In California, development decisions affecting coastal areas are regulated at the state, regional, and local levels. The State Department of Parks and Recreation has jurisdiction over more than 300 miles of California coastline and implements a Coastal Erosion Policy to avoid construction of new structures or coastal facilities in areas subject to ocean wave erosion, sea cliff retreat, and unstable cliffs. The State Lands Commission (SLC) regulates the construction of marine oil terminals (Chapter 31F Marine Oil Terminals, Title 24 Part 2, California Building Code). SLC will regulate the construction of liquid natural gas (LNG) marine terminals through a building code in pre-draft stage and will oversee the construction of oil platforms on state lands. The California Coastal Commission mandates the local preparation of Local Coastal Programs (LCPs), which are required to implement state Coastal Act policies (subject to review and approval by the Coastal Commission). The Bay Conservation and Development Commission (BCDC) also prepares and implements plans that determine development along the San Francisco Bay.

There are a number of ways the California Coastal Commission currently addresses sea level rise in its planning and regulatory process. In accordance with the California Coastal Act, the commission reviews LCPs and their development standards regarding setbacks, site stability, and structural integrity, with a goal of ensuring that projects neither create nor contribute significantly to erosion that would require the construction of protective devices that significantly alter natural landforms along bluffs and cliffs. The Commission also undertakes direct review of some projects, usually through an appeal of a local agency decision.

While several state agencies are in the process of evaluating and responding to potential effects of sea level rise, three agencies have substantial focus on the issue. The California Coastal Commission and the San Francisco Bay Conservation and Development District (BCDC) are actively engaged in an ongoing evaluation of sea level rise and related hazards such as erosion and coastal flooding. Caltrans has responsibility for extensive transportation infrastructure potentially at risk and has been assessing the vulnerability of these transportation systems.

California Coastal Commission

The Coastal Commission is looking at the best available analysis of the effects of this magnitude of sea level rise and its implications for coastal erosion, which is contained in study done by Philip Williams and Associates, Ltd. for the Pacific Institute ("California Coastal Erosion Response to Sea Level Rise – Analysis and Mapping," Pacific Institute, 2008).

The Williams study is based on 2008 research published on sea level rise done by the Scripps Institute of Oceanography. The Scripps estimate anticipates a sea level rise in the range of 1 meter (39 inches) to 1.4 meters (55 inches) by 2100. This estimate projects a higher minimum expectation than does the Climate Action Team, but is consistent on the upper end of the range.

The rule of thumb for sea level rise is that 50 to 100 feet of beach will be lost for each foot rise in sea level. Thus, sea level rise on the magnitude projected (approximately 3 to 5 feet) indicates that California can expect to lose hundreds of feet of shoreline over the next century along its entire coastline.

However, as the Williams study points out, the actual effects will vary widely depending on local geologic and topographic factors. For example, Williams estimates that cliff erosion will average about 66 meters (71.5 feet), but that Del Norte County will see a 560-meter (606-foot) loss. For sand dunes, Williams estimates the average loss will be 170 meters (184 feet), with Humboldt County seeing losses closer to 600 meters (650 feet).

The total land loss anticipated for the state by the Williams study is as follows:

Year	Land Area Loss (low)	Land Area Loss (high)
2025	6,740 acres	6,780 acres
2050	10,870 acres	11,580 acres
2100	29,040 acres	24,700 acres

As noted in the Williams study, the implications for land use and infrastructure resulting from this land loss will be significant. Consequently, the Coastal Commission is now asking local governments to use these new assumptions when updating their Local Coastal Programs (LCPs). They are urging local agencies to undertake more active mitigation and resource protection efforts in conjunction with the LCPs. In addition to barriers and armoring, other examples of resource protection measures would include relocating and creating wetland areas to more inland locations.

In 2004, the legislature created the Oceans Protection Council (OPC) through the Oceans Protections Act of 2004. OPR has collaborated with the OPC on a technical advisory related to CEQA and Low Impact Development (LID) and Storm Water Design.

Caltrans

In February 2009, Caltrans prepared a report, "Vulnerability of Transportation Systems to Sea Level Rise: A Preliminary Assessment," which concluded that a 55-inch rise in sea level would have substantial impacts on various transportation systems. Impacts include flooding of tunnels and airport runways, washouts of coastal highways and rail lines, and submersion of dock and port facilities. These would have strategic security implications, as well as transportation and economic implications.

Marine transportation impacts include shipping into and out of the ports of Sacramento and Stockton, along with higher winter flows in the Sacramento River. Increased siltation from storm runoff would necessitate more frequent dredging of channels across California. Harbors could suffer wave damage, siltation, and other navigation and safety problems. Coastal airports, including the San Francisco, Oakland, and Santa Barbara airports, are vulnerable to flooding.

By 2100, a 55-inch sea level rise could put at risk about 350 miles of major state highways located along coastal, delta, and interior waterways. Freight transportation that involves ports, rail lines, local streets, highways, and pipelines will face major disruption potential. The effect of sea level rise could endanger an estimated 3,500 miles of roads and 280 miles of railways that would be vulnerable to a 100-year flood event in 2100.

In light of the analysis, Caltrans notes "how well the (transportation) system adapts to climate change and sea level rise is critical." At the same time, Caltrans notes the complexity involved in investment decisions and "the need for economic perspective in adaptation policy to ensure cost-effective and proportionate

responses and considerations of the…costs and benefits of adaptation" (CalTrans, Vulnerability of Transportation Systems to Sea Level Rise: A Preliminary Assessment, February 2009, p.7).

Clearly, sea level rise is commanding ever-greater attention on the part of the Coastal Commission, BCDC, and Caltrans. These state agencies will continue to lead the effort to work with regional and local governments and the private sector to understand, develop, and implement adaptation policies, strategies, and investments. Failure to implement adaptation and mitigation strategies, in light of current projections, could have a devastating effect on the state's population and economy.

Best Practices Highlight 6.C: The Adapting to Rising Tides Project: Collaborative Adaptation Planning on the Shoreline of Alameda County

The Adapting to Rising Tides (ART) project is a collaborative planning effort led by San Francisco Bay Conservation and Development Commission (BCDC) and the National Oceanic and Atmospheric Administration Coastal Services Center (NOAA CSC). The ART project is seeking to answer two key questions:
1) How will climate change impacts of sea level rise and storm events affect the future of Bay Area communities, infrastructure, ecosystems and economy?
2) What strategies can we pursue, both locally and regionally, to reduce and manage these risks?

The ART project has been working with an active and engaged group of local, county, regional, state and federal agency staff to evaluate the vulnerability and risk of a portion of the Alameda County shoreline from Emeryville to Union City. The first step in this process was an impacts assessment that identified local climate impacts associated with sea level rise and storm events, and characterized the existing conditions of community land use, transportation, utility and shoreline assets in the project area (the ART subregion). The impacts assessment set the stage for a comprehensive evaluation of vulnerability based on exposure and sensitivity to sea level rise and storm events, and the capacity to accommodate or adjust to these impacts. With input from the working group and other experts, the project also broadly evaluated the social equity, economic, environmental and governance consequences of sea level rise and storm event impacts.

Based on the assessment of vulnerability and risk, the ART project developed a suite of adaptation responses to mitigate the risk of future sea level rise and storm events by improving the resilience of community land use, transportation, utility, and shoreline assets at the subregional scale. With the working group the project is evaluating the subregional adaptation responses, which include a number of possible actions that can be taken together or individually by interested stakeholders to strategically address identified vulnerabilities. The adaptation response also included options for local, regional and state-wide implementation, including the processes, partners, and triggers for initiation.

In addition to developing adaptation responses at the subregional scale, the ART project is evaluating the issues of interrelated vulnerabilities and risks, including infrastructure interdependencies, that need to be addressed at scales smaller than the subregion. To advance this effort, the ART project is working with local and regional agencies to engage in neighborhood-level (focus-area) multi-hazard adaptation planning around the Oakland International Airport and Bay Farm Island. The project is also working with local parks and recreation asset managers to develop specific adaptation responses for select shoreline parks, and with the regional transportation planning agencies (Metropolitan Transportation Commission, California Department of Transportation and the Bay Area Rapid Transit [BART] district) to develop specific adaptation responses for three multi-modal transportation hubs. These efforts will help the region better understand the potential mitigation options to address cross-cutting, the multi-hazard risk that the shoreline will face in light of sea level rise, existing coastal hazards, and other future pressures.

Best Practices Highlight 6.D: Adaptation in Action: Managed Retreat at Surfer's Point

The City of Ventura was experiencing ongoing coastal erosion at Surfer's Point, a popular surf destination adjoining the Ventura County Fairgrounds parking lot. A coastal bike path near the site had already been undermined.

While the process was time-consuming and occasionally contentious, consensus on a managed retreat approach was reached by a working group made up of representatives from the City, the County of Ventura, the Ventura County Fairgrounds, the California Department of Parks and Recreation, the Surfrider Foundation, and other stakeholders in the region.

The managed retreat project included relocating the bike path and public parking lot more than 60 feet inland, removing existing rip rap; restoring the area to a more natural beach habitat, continuing to provide adequate parking for beach goers and the Fairgrounds, providing for ongoing beach renourishment, preserving public access to the area via Shoreline Drive, and advocating for the removal of the Matilija Dam to increase sand supplies to the beach (NOAA, 2007).

The managed retreat solution protects the relocated bike path and maintains the surf break for which the site is named. More information regarding the Climate Adaptation Planning Guide can be found at: http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html

Source: California Emergency Management Agency. 2012. California Adaptation Planning Guide: Identifying Adaptation Strategies.

Best Practices Highlight 6.E: Caltrans Incorporating Sea Level Rise into Corridor Planning

The University of California, Davis, in partnership with District 4, conducted the State Route 37 (SR 37) Stewardship Study to pilot test the use of more stewardship-based transportation corridor planning. SR 37 passes through the environmentally sensitive San Francisco Bay marshlands and is vulnerable to sea level rise.

The study, funded by the Transportation Research Board, was a first step in collaborative transportation and environmental planning and involved corridor stakeholders and resource agencies. The stakeholder group used the Sea Level Rise Guidance, among other tools and outreach strategies, to gather input on potential sea level rise impacts and explore a range of scenarios for adapting SR 37 to sea level rise.

The results of the study will help shape the long-range planning of SR 37 by informing the updates of the Transportation Concept Report. District 4 also will use this study as the foundation for future decision-making in potential follow-up studies, including a hydraulic study and a transit opportunities assessment.

Source: Cambridge Systematics. 2013. Addressing Climate Change Adaptation in Regional Transportation Plans: A Guide for California MPOs and RTPAs. Prepared for the California Department of Transportation.
Retrieved from:http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/FR3_CA_Climate_Change_Adaptation_Guide_2013-02-26_.pdf Page 78

For specific mitigation ideas related to sea level rise, see "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" January 2013, prepared by FEMA, available on the FEMA website: http://www.fema.gov/library/viewRecord.do?id=6938

6.4.4 DROUGHTS AND WATER SHORTAGES

Identifying Drought Hazards

Drought is a gradual phenomenon. Normally, one dry year does not constitute a drought in California, but rather serves as a reminder of the need to plan for droughts. California'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.

Drought can have secondary impacts. For example, drought is a major determinant of wildfire hazard, in that it creates greater propensity for fire starts and larger, more prolonged conflagrations fueled by excessively dry vegetation, along with reduced water supply for firefighting purposes. Drought is also an economic hazard. Significant economic impacts on California's agriculture industry can occur as a result of short- and long-term drought conditions; these include hardships to farmers, farm workers, packers, and shippers of agricultural products. In some cases, droughts can also cause significant increases in food prices to the consumer due to shortages. Drought can also result in lack of water and subsequent feed available to grazing livestock, potentially leading to risk of livestock death and resulting in losses to the state's agricultural economy.

Past experience with California droughts tells us that drought impacts are felt first by those most dependent on or affected by annual rainfall – agencies fighting forest fires, ranchers engaged in dryland grazing, rural residents relying on wells in low-yield rock formations, or small water systems lacking a reliable water source.

Profiling Drought Hazards

Drought has affected virtually every county in California at one time or another, causing more than $2.6 million in damages. Droughts exceeding three years are relatively rare in Northern California, the source of much of the state's water supply. The 1929-1934 drought established the criteria commonly used in designing storage capacity and yield for large Northern California reservoirs. The driest single year in California's measured hydrologic history is 1977.

California's last major statewide drought was 2007-2009. At a regional level, parts of Southern California experienced a series of consecutive dry years in the late 1990s/early 2000s, with water year 2002 setting records for the single driest precipitation year in cities such as Los Angeles and San Diego. The Colorado River Basin, an important source of water supply for Southern California, experienced five consecutive years of drought in water years 2000-2004.

Water year 2007 was unusually dry across much of California. Although one dry year does not constitute a drought, especially when that dry year follows a very wet 2006. The 2006-2007 water year was well below normal for the state, indicating another serious drought may be beginning.

The 1975-1977 Drought

From November 1975 through November 1977, California experienced one of its most severe droughts. Although people in many areas of the state are accustomed to very little precipitation during the growing season (April to October), they expect it in the winter. In 1976 and 1977, the winters brought only one-half and one-third of normal precipitation, respectively, leading to the state's fourth and first driest years on record. Most surface storage reservoirs were substantially drained in 1976, leading to widespread water shortages when 1977 turned out to be even drier.

The 1987-1992 Drought

From 1987 to 1992, California again experienced a serious drought due to low precipitation and run-off levels. The hardest-hit region was the central coast, roughly from San Jose to Ventura. For the central coast and central Sierra Nevada, 1987 to 1990 was the driest period on record. In 1988, 45 California counties experienced water shortages that adversely affected about 30 percent of the state's population, much of the dry-farmed agriculture, and over 40 percent of the irrigated agriculture. Fish and wildlife resources suffered, recreational use of lakes and rivers decreased, forestry losses and fires increased, and hydroelectric power production decreased.

In February 1991, DWR and Cal OES surveyed drought conditions in all 58 California counties and found five main problems:

- Extremely dry rangeland
- Irrigated agriculture with severe surface water shortages and falling groundwater levels
- Widespread rural areas where individual and community supplies were going dry
- Urban area water rationing at 25 to 50 percent of normal usage
- Environmental impacts

After four drought years and three winter months of meager precipitation, California's water prospects looked bleak at the start of 1991. Storage in major reservoirs had dropped to 54 percent of average, the lowest since 1977, a record dry year. Other supply systems were suffering more major shortages. The shortages led to stringent water rationing and severe cutbacks in agricultural production, including threats to survival of permanent crops such as trees and vines. Fish and wildlife resources were in critical shape as well. Not since the 1928-1934 drought had there been such a prolonged dry period. Water was so scarce that some suppliers doubted the State Water Project (SWP) and the Central Valley Project (CVP) would be able to provide minimum carryover storage as a hedge against yet another dry year. In February 1991, the Governor established the Drought Action Team. This team almost immediately created an emergency drought water bank to develop a supply for four critical needs:

- Municipal and industrial uses
- Agricultural uses
- Protection of fish and wildlife
- Carryover storage for 1992

The large-scale transfer program, which involved over 800,000 acre-feet of water, was implemented in less than 100 days with the help and commitment of the entire water community and established important links between state agencies, local water interests, and local governments for future programs (Department of Water Resources, "Preparing for California's Next Drought – Changes Since 1987-92," July 2000).

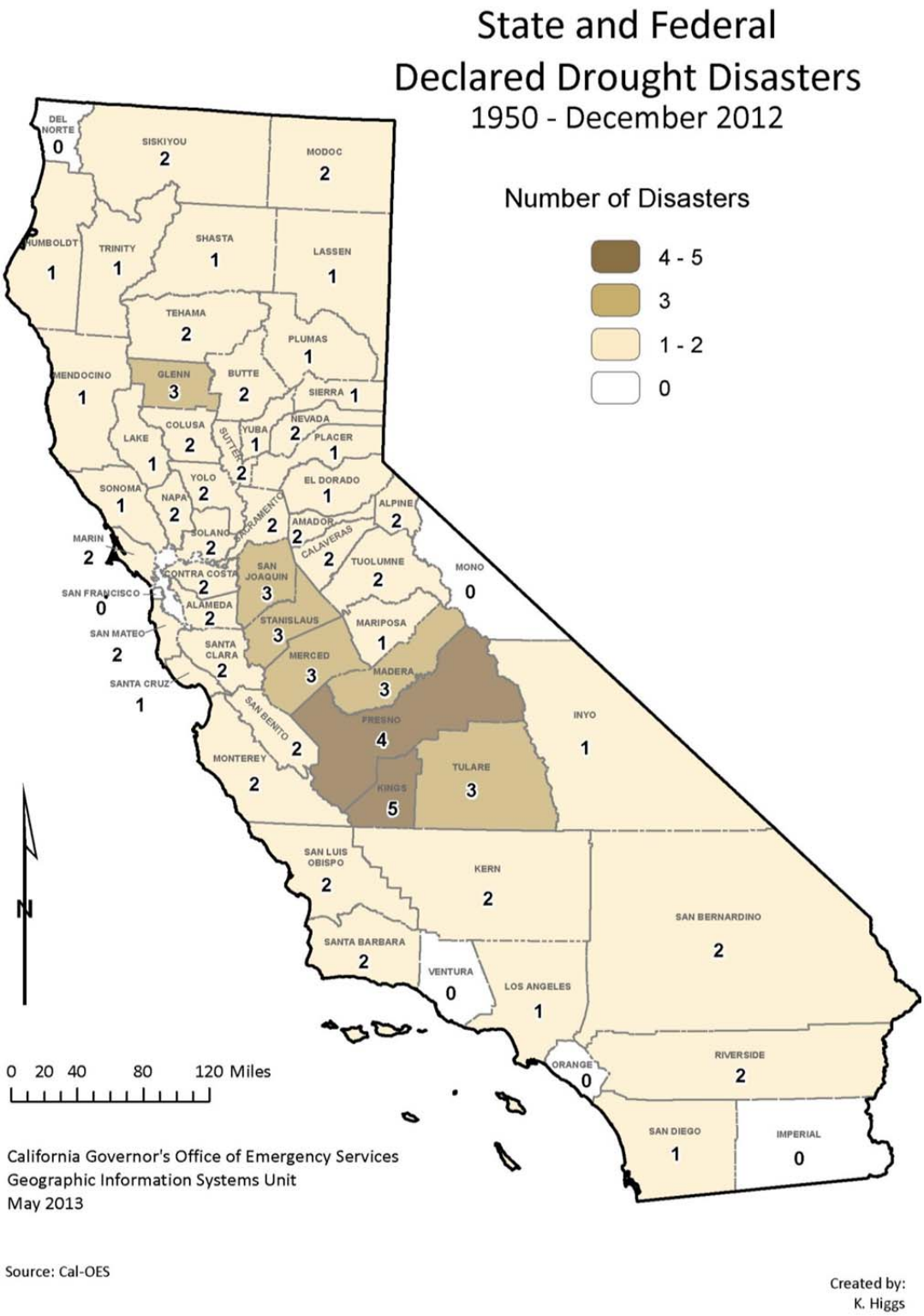
Table 6.E summarizes California droughts initially discussed in a July 2000 DWR report and brings the date forward to 2009. The 1976-1977 and 1987-1992 droughts were among the worst in California history.

Table 6.E: Drought Incidents, 1972 to 2009

Year	Number of Incidents	Jurisdictions Affected (Counties, Unless Otherwise Noted)	Crop Damage
1972	1	Glenn, San Benito, Santa Clara	$8 million
1976-1977	1	Alpine, Calaveras, Colusa, Fresno, Glenn, Madera, Merced, San Diego, San Joaquin, Solano, Stanislaus, Sutter, Tuolumne, Alameda, Butte, Contra Costa, Kings, Los Angeles, Riverside, San Luis Obispo, Tulare, Yolo, Amador, Monterey, Napa, Nevada, San Benito, San Bernardino, Tehama, San Mateo, Marin	$2.67 billion
1988	1	Madera County location emergency was ratified every two weeks through 1991.	N/A
1990	2	Santa Barbara(City and County)	0
1991	1	Alameda, Alpine, Colusa, Fresno, City of Orange Cove, Glenn, Kern, Kings, Lake, Madera, Marin, Mendocino, Monterey, Placer, Santa Barbara, City of Santa Barbara, Shasta, Siskiyou, Solano, Sonoma, Sutter, Tehama, Tulare, Tuolumne, and Yuba. Many of these emergencies continued through 1992.	USDA-nationwide: $995 million for 1990-1991 crop loss. Additional $775 million in emergency funds for 1990-92 crop losses.
2001	5	Del Norte, Modoc, Siskiyou, Inyo, Humboldt, Kern, Los Angeles, Ventura, Mono, Lassen, Plumas, San Bernardino, Santa Barbara, Sierra, Shasta, Trinity	N/A
2002	3	Alpine, Amador, Calaveras, Imperial, Modoc, Nevada, Orange, Placer, Riverside, San Bernardino, Sierra, Stanislaus	$12,100
2007	1	Kings, Riverside	(data pending)
2008	1	Fresno, Kern, Kings, Madera, Merced, Sacramento, San Joaquin, Stanislaus, Tulare	(data pending)
2009	1	Fresno	(data pending)

Sources: Cal OES Individual Assistance Section, 2001& 2002 SBA Declarations/USDA Designations database; Cal OES Origins and Development- A Chronology 1917- 1999

MAP 6.J: State and Federal Declared Drought Disasters, 1950-December 2012

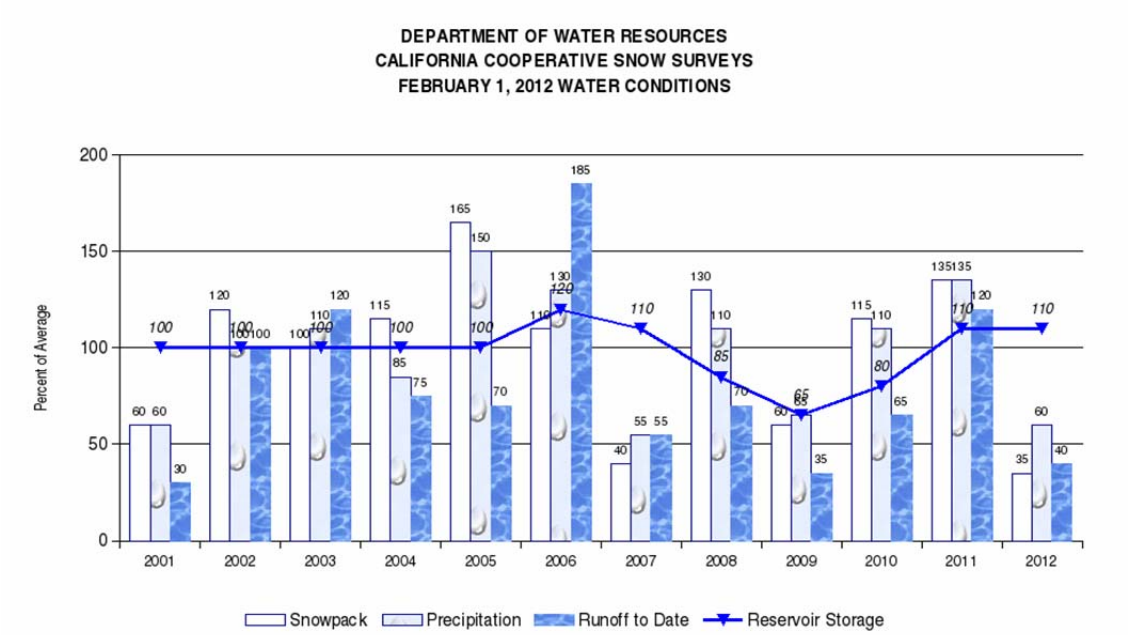


Map 6.J shows the pattern of drought-declared disasters in California over the past 62 years. Heaviest concentrations are in the Central Valley and inland areas.

Tracking Water Conditions

Chart 6.C illustrates several indicators commonly used to evaluate water conditions in California. The percent of average values are determined by measurements made in each of the ten major hydrologic regions. The chart describes water conditions in California between 1996 and 2007. The chart illustrates the cyclical nature of weather patterns in California. Snow pack and precipitation increased between 1996 and 1997, began decreasing in 1998, and began to show signs of recovery in 2002, increased in 2005, and decreased sharply in 2007.

Chart 6.C: Water Supply Conditions, 1996 to 2012



Source: DWR website

Climate Change and Drought

Climate scientists studying California find that drought conditions are likely to become more frequent and persistent over the 21st century due to climate change. The experiences of California during recent years underscore the need to examine more closely the state's water storage, distribution, management, conservation, and use policies.

The Climate Adaptation Strategy (CAS) stresses the need for public policy development addressing long-term climate change impacts on water supplies.[59] The CAS notes that climate change is likely to significantly diminish California's future water supply, stating that:

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

The regional implications of declining water supplies as a long-term public policy issue are recognized in a Southern California Association of Governments (SCAG) July 2009 publication of essays examining climate change topics. In one essay (Cayan, D. "Climate Change – What Should Southern California Prepare For?" in Climate Change and the Future of Southern California, SCAG, July 2009, p. 17), Dan Cayan observes:

[59] IPCC, Climate Change 2007: Impacts of Climate Change – Impacts, Adaptation and Vulnerability – Summary for Policymakers, April 2007

> In one form or another, many of Southern California's climate concerns radiate from efforts to secure an adequate fresh water supply…Of all the areas of North America, Southern California's annual receipt of precipitation is the most volatile – we only occasionally see a "normal" year, and in the last few we have swung from very wet in 2005 to very dry in 2007 and 2008….Southern California has special challenges because it is the most urban of the California water user regions and, regionwide, we import more than two-thirds of the water that we consume.

Assessment of State Vulnerability and Potential Losses

No definitive assessment of state vulnerability or potential long-term losses due to diminishing water supply is known to be available at this time. However, the CAS has opened the door to a series of discussions on this topic being undertaken through the Climate Vulnerability Assessment being prepared by the California Energy Commission.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

Current Drought Hazard Mitigation Efforts

Mitigation of drought impacts includes short- and long-term water conservation measures for urban areas as called for by the Governor's Emergency Proclamation S-13-08. There is ample literature on urban water conservation measures. Agricultural water conservation measures reducing crop damage and losses include but are not limited to (Natural Resource Conservation Service, Defending Against Drought, www.nrcs.usda.gov/feature/highlights/drought/html):

- Drought plan
- Water management
- Land management
- Crop management

Drought Contingency Plan

In response to the most recent drought, Governor Arnold Schwarzenegger issued Drought Proclamations and Executive Orders in 2008 and 2009 directing state agencies to take immediate actions to manage the crisis. DWR responded, with strong support from Cal OES and other agencies, by developing a Drought Contingency Plan (DCP). A public review draft was published in August 2010, addressing the possibility of dry conditions continuing beyond 2010.

The DCP contains strategies and actions that state agencies have taken or may take to prepare for, respond to, and recover from droughts. Its purpose is to minimize drought impacts by improving agency coordination and enhancing monitoring and early warning capabilities, water shortage impact assessments, and preparedness, response, and recovery programs. The DCP identifies an integrated, regional approach to addressing drought, drought action levels, and appropriate agency responses as drought conditions change. It calls for coordination and clearly defined roles and responsibilities of federal, state, and local agencies, and timely dissemination of information to decision-makers.

Five levels of drought response are identified. These range from Level 1, representing an Abnormally Dry period (calling for raising awareness), to Level 3, a Severe Drought (requiring mandatory conservation in some communities and emergency actions), to Level 5, an Exceptional Drought (water supplies may be cut off and maximum response). A Governor's emergency drought proclamation may be initiated at Level 3.

The DCP is intended to become part of the California Water Plan Update process, which occurs every five years. Some components of the DCP may be applied to water shortages that may occur in the absence of a drought. The complete DCP document may be found at: http://www.waterplan.water.ca.gov/docs/meeting_materials/drought/2010.08.10/CA_Drought_Contingency_Plan-Public_Review_Draft-081010.pdf

2009 California Water Plan

A comprehensive approach to addressing drought hazard mitigation over the long term is contained in the recently updated California Water Plan (2009), previously discussed in Section 5.2 of Chapter 5. It serves as the state's blueprint for integrated water management and sustainability. The updated California Water Plan:

- Details initiatives to ensure reliable water supplies and foundational actions for sustainable water use
- Provides an investment guide for the water community with an array of strategies to achieve multiple goals and benefits
- Integrates state government initiatives, objectives, and strategies
- Incorporates consideration of uncertainties, risks, and resource sustainability into water and flood planning for the future
- Describes resource management strategies to diversify regional water portfolios and increase regional self-sufficiency
- Outlines new analytical methods and tools to plan for population growth and development patterns, climate change, economic change, and other uncertainties
- Updates 12 regional reports

The full updated document and related regional reports are available to download at: http://www.waterplan.water.ca.gov/cwpu2009/index.cfm

For specific mitigation ideas related to drought, see "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" January 2013, prepared by FEMA, available on the FEMA website: http://www.fema.gov/library/viewRecord.do?id=693

6.4.5 ENERGY SHORTAGE AND ENERGY RESILIENCY

Identifying Energy Shortage Hazards

California accounts for approximately eight and a half percent (8.5%) of the total energy consumption in the United States. The vast majority of California's natural gas consumption is utilized by the residential sector (40%), while the commercial sector utilizes 37% of electricity use across the state. Gasoline makes up the largest statewide demand (54%) of liquid fuels which is a byproduct of Crude Oil. (*Source: CEC*)

The State of California gets its electric power from a number of sources. Most in-state electrical generation is derived from natural gas (45.3%). Even when combined with 'imports' from other regions, natural gas remains dominate at 35.6%. Renewables comprise 16.6% of in-state electrical generation and remain relatively the same (14.2%) when combined with imports. In-state electrical generation is 69% of the total (200,414 GWh versus 292,454 GWh) with the remaining being imported from the Southwest and Northwest. http://energyalmanac.ca.gov/electricity/index.html.

Hydro-generation provides approximately 20 percent of California's electric power, with the balance coming from fossil fuels, nuclear, and renewable sources. Rotating outages and/or blackouts such as those experienced in 2000 and 2001 can occur due to losses in transmission or generation and/or extremely severe temperatures that lead to heavy electric power consumption.

The 2000-2001 California electricity crisis brought to light many critical issues surrounding the state's power generation system, including post-deregulation market manipulation and California's dependency on out-of-state resources coupled with in-state transmission bottlenecks. Although the state has taken effective measures to mitigate market manipulation, built more transmission to reduce bottlenecks, and implemented effective energy conservation programs, California continues to experience both population growth and weather cycles that contribute to a heavy demand for power. Climate change may also increase California's vulnerability to energy shortage hazards. Predicted increases in heat waves as well as increasingly severe winter storms will put ever greater strain on California's electricity system.

Profiling Energy Shortage Hazards

On January 17, 2001, the California Independent System Operator (CAISO), the entity that coordinates statewide flow of electrical supply, declared a Stage 3 Emergency and notified the then Governor's Office of Emergency Services (OES) that PG&E was dropping firm load of 500 MW in Northern California (rolling black-outs). OES, in turn, issued an Electrical Emergency Message to all Emergency Services Agencies to prepare for rolling blackouts. This scenario was repeated the following day, January 18, 2001. On March 19, 2001, OES again issued an Electrical Emergency Message to Emergency Services Agencies that the CAIO declared a Stage 3 Emergency and would be conducting statewide rolling blackouts.

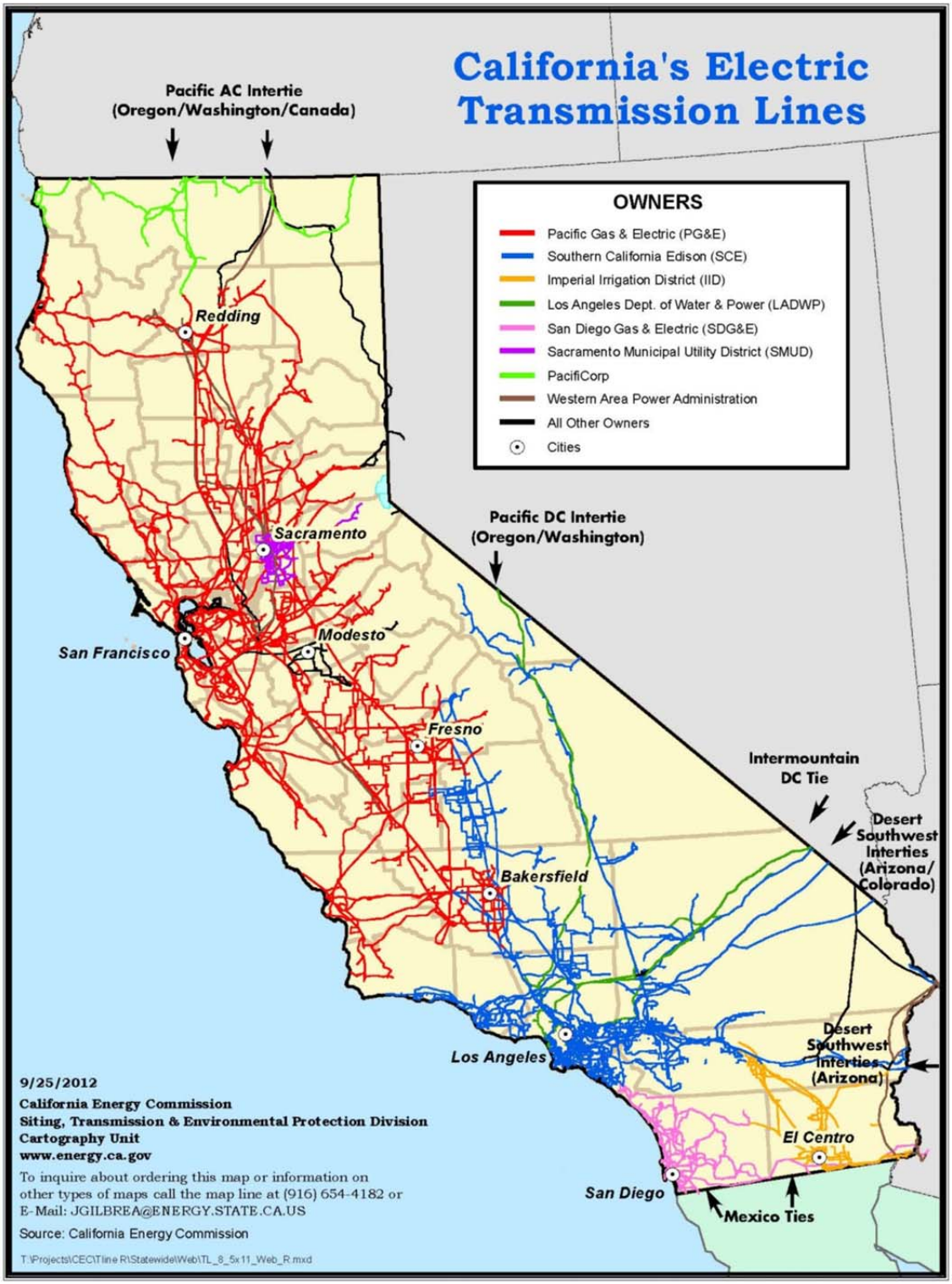
The July 2006 heat storm event affected the entire state as well as most of the West, producing record energy demand levels in California. The state was able to avoid rotating outages due to a combination of favorable factors that included no major transmission outages, lower than typical generator outages, significant customer response to pleas for energy conservation, high imports from the Pacific Northwest despite unusually high loads, outstanding cooperation among western control area operators, and prompt response to fires that potentially threatened major interties. However, the event brought to light the vulnerability of the electric distribution system, as over 3,500 distribution transformers failed, leaving over two million customers without power at various times over the ten-day event, many for several hours and a small minority for up to three days.

On the afternoon of September 8, 2011, an 11-minute system disturbance occurred in the Pacific Southwest, leading to cascading outages and leaving approximately 2.7 million customers without power. The outages affected parts of Arizona, Southern California, and Baja California, Mexico. All of the San Diego area lost power, with nearly one-and-a-half million customers losing power, some for up to 12 hours. The disturbance occurred near rush hour, on a business day, snarling traffic for hours. Schools and businesses closed, some flights and public transportation were disrupted, water and sewage pumping stations lost power, and beaches were closed due to sewage spills. Millions went without air conditioning on a hot day. (FERC/NERC Staff Report on the September 8, 2011 Blackout).

Secondary impacts of energy shortages are most often felt by vulnerable populations. For example, those who rely on electric power for life-saving medical equipment, such as respirators, are extremely vulnerable to power outages. Also, during periods of extreme heat emergencies, the elderly and the very young are more vulnerable to the loss of cooling systems requiring power sources.

Map 6.K on the following page illustrates the extent and complexity of California's electrical transmission system.

MAP 6.K: California's Electric Transmission Grid



The electric power industry does not have a universal agreement for classifying disruptions. Nevertheless, it is important to recognize that different types of outages are possible so that plans may be made to handle them effectively. Electric power disruptions can be generally grouped into two categories: intentional and unintentional.

There are four types of intentional disruptions:

1. *Planned*: Some disruptions are intentional and can be scheduled based maintenance or upgrading needs
2. *Unscheduled*: Some intentional disruptions must be done "on the spot." in response to an emergency
3. *Demand-Side Management*: Some customers (i.e., on the demand side) have entered into an agreement with their utility provider to curtail their demand for electricity during periods of peak system loads
4. *Load Shedding*: When the power system is under extreme stress due to heavy demand and/or failure of critical components, it is sometimes necessary to intentionally interrupt the service to selected customers to prevent the entire system from collapsing, resulting in rolling blackouts

Unintentional or unplanned disruptions are outages that come with essentially no advance notice. This type of disruption is the most problematic. The following are categories of unplanned disruptions:

- Accident by the utility, utility contractor, or others
- Malfunction or equipment failure
- Equipment overload (utility company or customer)
- Reduced capability (equipment that cannot operate within its design criteria)
- Tree contact other than from storms
- Vandalism or intentional damage
- Weather, including lightning, wind, earthquake, flood, and broken tree limbs taking down power lines
- Wildfire that damages transmission lines

The California Independent System Operator (CAISO) is tasked with managing the power distribution grid that supplies most of California, except in areas served by municipal utilities. CAISO uses a series of stage alerts to the media based on system conditions. The alerts are:

- Stage 1 - reserve margin falls below 7 percent
- Stage 2 - reserve margin falls below 5 percent
- Stage 3 - reserve margin falls below 1.5 percent

Rotating blackouts become a possibility when Stage 3 is reached.

With climate warming, 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 (typically measured in “cooling-degree days”) needed to cool homes and businesses both during heat waves and on a daily basis, during the daytime peak of the diurnal temperature cycle. During future heat waves, historically cooler coastal cities (e.g., San Francisco and Los Angeles) are projected to experience greater relative increases in temperature, such that areas that never before relied on air conditioning will experience new cooling demands (California Climate Change Center 2009).

Assessment of State Vulnerability and Potential Losses

The goal of the California Energy Commission (CEC)-sponsored California Local Energy Assurance Planning (CaLEAP) project is to assist local governments with generating plans to become more energy resilient. The project was initiated in recognition of California’s aging energy infrastructure, the increase in frequency,

duration and impact of energy disruptions and the fact that local governments have spent little time addressing the loss of energy and energy interdependencies. Energy assurance planning differs from planning for short term energy shortages in that it incorporates a more holistic approach to community energy resilience.

Progress Summary 6.G: California Energy Assurance Planning (CaLEAP)

Progress as of 2013: Objectives of energy assurance planning include ensuring that "key assets" are functional when needed, fostering critical public-private partnerships before incidents happen, gaining awareness of energy dependencies, and, identifying actions and projects to move toward increased energy resiliency. The emphasis of "key assets" is to ensure functionality of essential services, thus protecting safety and public health, and minimizing economic loss. Meeting this goal will help local governments prepare for, respond to, recover from and mitigate against potential emergencies that affect energy supplies.

Participation in the CaLEAP program and development of a local Energy Assurance Plan (EAP) is voluntary. The EAP may be a stand-alone plan or be integrated into other plans such as general plans and local hazard mitigation plans.

With funding from the U.S. Department of Energy (DOE), the CEC has developed a methodology and web-based implementation tool for use by local governments in developing their Energy Assurance Plans (EAPs). Currently the CEC is providing hands-on technical support to approximately 50 cities and counties throughout California. Through the planning process, local governments will build their energy expertise and awareness of impacts and interdependencies; identify deficiencies and vulnerabilities, and explore energy choices, including alternative resources that are reliable, safe, diverse, affordable and environmentally acceptable.

A State Energy Assurance Plan is currently being drafted by the CEC. The State EAP is intended to provide direction for the state, and local governments on aspects of energy supply and demand, energy trends, critical energy infrastructure vulnerabilities, energy dependencies and interdependencies, cooperative agreements with the private sector, coordination of agencies in respect to energy related regulations and enforcement, and overall state energy assurance policy. *Source: CEC/CaLEAP*

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

Current Energy Shortage Hazard Mitigation

State and local governments can take measures to improve their ability to cope with electric power disruptions in the longer term. These measures include building codes, zoning ordinances, climate action plans, energy assurance plans and growth and development projections.

Building codes are used to ensure that construction in a community meets minimum standards required for public health and safety and for quality workmanship. Building codes can also be used to increase a community's ability to deal with disruptions to the electric power infrastructure by requiring facilities to be adequately prepared for power disruptions. Modification of a building's use can significantly affect electrical service requirements, which may or may not be readily identified on building permits.

Local governments can use zoning change requests, permit applications, economic development plans, or other means to identify modification to rehabilitation projects. Communities that adopt building codes as part of their municipal codes, making compliance mandatory, frequently use several codes developed by

national organizations. While model codes provide basic guidance, municipalities often amend and modify them to meet specific local requirements.

Zoning ordinances stipulate the type of land use that is acceptable in various locations in a community. Zoning can significantly affect the electric power requirements of an area. For example, an area zoned "residential" will have a very different electricity load profile from an area zoned "commercial" or "industrial."

Zoning plays a role in determining the location of a site for electric power facilities, including power plants, transmission lines, and substations. The current trend of constructing many small and medium-scale "peaker" power plants has ignited zoning controversies. Many communities are now developing policies and zoning ordinances that will affect the location of these facilities. However, It is important for a community to understand that the location (or restrictions on the location through zoning) of electric power facilities within its boundaries may (or may not) directly affect the reliability of the power supply to that community. A community that is home to a peaker plant, for example, does not necessarily enjoy more reliable service. Likewise, not having a power plant does not imply decreased reliability. Electric power plants are built to provide power to the entire electric grid, not just to the area in which they are located. However, a distribution substation, which connects customers to the grid, will directly affect the reliability of electrical service in the area in which it is located.

All electric power companies develop projections of long-term demand as a starting point for planning the expansion of electric power generation, transmission, and distribution facilities. Projections are made for a range of planning horizons (from 1 to 20 years) and for a range of geographical resolutions (for the entire system to individual distribution substations and feeder lines). In general, the shorter the planning horizon and the larger the geographic resolution used, the more likely the demand forecast will be reasonably representative of the actual situation.

Energy Specific Strategies from the California Climate Adaptation Strategy

The 2009 California Climate Adaptation Strategy (CAS) included a list of energy specific strategies along with near term recommended actions for immediate implementation and longer term recommended actions that require state agency collaboration and support. These energy specific strategies are:

1. Increase energy efficiency efforts in climate vulnerable areas
2. Assess environmental impacts from climate change in siting and re-licensing of new energy facilities
3. Develop hydropower decision-support tools to better assess and manage climate change variability
4. Identify how state renewable energy goals could be impacted from future impacts

The 2013 CAS update is due out in December 2013. For more information regarding the CAS see Chapter 4, Section 4.5.2 or visit the California climate change portal website:
http://www.climatechange.ca.gov/adaptation/strategy/index.html

Anticipating Disruptions

Cal OES developed a document titled Electric Power Disruption: Toolkit for Local Government. The “Tool Kit” is a supplement to the Emergency Planning Guidance for Local Governments. It identifies disruptions, types of customers potentially affected, and the types of facilities and populations with critical electrical needs. This document is meant to be used in tandem with the June 2007 Contingency Plan for Excessive Heat Emergencies.

Opportunities for Enhanced Energy Shortage Hazard Mitigation

In addition to monitoring energy supply and planning for production, conservation is an important element of energy policy. Reducing the energy consumption and demand per capita can offset the growth in supply needed to keep pace with population growth and urban development.

California accounts for approximately 8.5 percent the total energy consumption in the United States. The vast majority of California's natural gas consumption is by the residential sector (40 percent), while the commercial sector accounts for 37 percent of electricity use across the state. Gasoline makes up the largest component (54 percent) of statewide demand for liquid fuels which are a byproduct of crude oil. (Source: CEC)

There are opportunities for energy conservation in all sectors. The emerging issue of global warming and climate change, coupled with the goal of decreasing national dependence on foreign oil supply, has spurred a renewed interest in developing low-cost efficient alternative energy sources. Stronger national and local policies and financial incentives are needed to support the development and production of alternative energy sources, such as solar and wind power, biodiesel, and other non-fossil fuels. AB 32 implementation tools, such as climate action plans, may provide cities with the support and incentives to significantly reduce energy consumption. Additionally, encouraging the development and implementation of green building techniques designed for energy efficiency and produced from renewable resources will have a cumulative effect on reducing energy consumption during the construction process and throughout the life of a structure or facility.

The Million Solar Roofs Initiative Small Grant Program for State and Local Partnerships sponsored by the U.S. Department of Energy (DOE) in 2004 is one example of incentives at the national level. The DOE initiative provided grant opportunities of up to $50,000 to state and local partnerships to reduce market barriers to the use of solar energy systems. In 2004, Governor Schwarzenegger introduced the Million Solar Roofs Initiative in California, which included $2.9 billion in incentives to homeowners and building owners who install solar electric systems. Passage of Senate Bill 1 in August 2006 further enhances the Governor's initiative by expanding the program to additional areas of the state and raising the limits on the amount of excess energy that can be sold back to energy suppliers. The goal of the solar roof program is to provide 3,000 megawatts of additional clean energy and reduce the output of greenhouse gases by 3 million tons by 2018. This is equivalent to the output of five modern electric power plants and taking one million cars off the road. Senate Bill 1 also requires that a developer of more than 50 new single-family homes offer the option of a solar energy system to all customers.

Assembly Bill 920 was passed by the legislature and signed into law by the Governor in the fall of 2009. AB 920 requires utilities to purchase surplus solar electricity generated by solar homeowners and businesses on an annual basis, provided further incentive for the purchase and use of solar panels. Senate Bill 32, signed by the Governor at the same time, requires utility companies to purchase solar electricity at a set rate over a 20-year period. It has the potential to encourage massive solar installations on large, unused spaces, such as parking lots and warehouses. This program has been used with much success in places like Germany.

Progress Summary 6.H: California Solar Initiative

Progress as of 2013: In January 2007, California began an unprecedented $3.3 billion effort to install 3,000 megawatts (MW) of new solar energy capacity over the next decade and transform the market for solar energy by reducing the cost of solar generating equipment. The California Public Utilities Commission (CPUC) portion of the solar effort is known as the California Solar Initiative (CSI) program. CSI, the country's largest solar program, has a $2.4 billion budget and a goal to install 1,940 MW of solar capacity by the end of 2016.

In 2011, California reached a major milestone by becoming the first state in the nation to install more than 1 gigawatt (1,000 MW) of customer-generated solar energy; a record 311 MW were installed in the investor-owned utility territories in 2011 alone. Currently more than 122,000 sites across the state host solar systems to serve on-site solar generation. The annual rate of new solar installations and the cumulative installed capacity both provide evidence that California is well along the path of achieving the goals set by Senate Bill (SB) 1 in 2006, the legislation that authorized the CSI program.

Residential solar system costs have decreased by 28 percent since 2007. CSI projects in low-income markets (areas with median incomes of less than $50,000) have increased by 364 percent since 2007. Approximately 1,500 low income homeowners, with help from the Single-Family Affordable Solar Homes (SASH) program, have installed solar panels to generate energy and improve their monthly cash flow. The Multi-family Affordable Solar Housing (MASH) program completed 181 projects as of April 30, 2012, with a capacity of 9.1 MW. Virtual Net Metering has allowed thousands of low income tenants to receive the direct benefits of solar as reductions in their monthly electric bills. CSI projects in middle income markets (areas with median incomes between $50,000 and $100,000) have increased by 445 percent since 2007 and comprise the majority of applications received in 2011.

In just over two years of operation, the CSI-Thermal Program, which provides rebates for solar water heating systems, has received 704 applications for $4.87 million in incentives.
Source: CPUC: www.cpuc.ca.gov/PUC/energy/Solar/2012CASolarLegReport.htm .

Of the energy used in the transportation sector, 65 percent of it is consumed by gasoline-powered vehicles. There are a number of measures that can be taken to reduce energy consumption for gasoline-powered vehicles, including the continued development of alternative energy vehicles and changing work commute patterns through telecommuting or land use policies that encourage mixed-use development. Development and production of alternative energy vehicles combined with a reduction in vehicle trips will result in both reduced reliance on fossil fuels and reduced carbon emissions to lessen the impacts of global warming and climate change.

Progress Summary 6.I: Clean Energy Progress Tracking

Progress as of 2013:
Energy Efficiency: Total energy savings from efficiency programs, codes and standards, and price and market effects have increased over time relative to conditions in 1975, and were estimated to reach over 65,000 GWh in 2012.

Statewide Energy Demand: Since the mid-1970s, per capita consumption has remained relatively constant in California but continues to grow in the U.S. overall. Californians consume 40 percent less electricity per person because of factors ranging from climate and household size to fuel and industry mixes and the state's aggressive energy policies.

Electric Vehicles: Governor Brown has signed an Executive Order laying the foundation to support 1.5 million zero-emission vehicles (ZEVs) by 2025 and published a ZEV Action Plan. As part of its work on electric vehicles, the Energy Commission forecasts ZEV sales and helps to set up a strategic electric vehicle charging network.

Reliance on Coal: In 2010, 10 percent of California's electricity came from coal and petroleum coke, mostly from power plants in other states. By 2020, California's use of electricity derived from coal and petroleum coke is expected to decline about 60 percent compared to the amount used in 2010.
Source: California Energy Commission:http://www.energy.ca.gov/renewables/tracking_progress/index.html

Progress Summary 6.J: The California Clean Energy Jobs Act

Progress as of 2013: The California Clean Energy Jobs Act (Proposition 39) was approved on November 6, 2012, by the voters of California. The initiative makes changes to corporate income taxes and provides for the annual transfer of funds from the General Fund to the Clean Energy Job Creation Fund for five fiscal years, beginning with the 2013–14 fiscal year.

The 2013–14 budget allocates $464 million of Proposition 39 revenue to school districts, charter schools, county offices of education (collectively referred to as local educational agencies [LEAs]), and community colleges to support energy efficiency projects. In the four years to follow, LEAs and community colleges will receive an estimated $550 million annually. Monies in the fund are available, upon appropriation by the Legislature, for purposes of funding eligible projects that create jobs in California while improving energy efficiency and expanding clean energy generation.

The California Department of Education (CDE) will be responsible for distributing funds to LEAs that serve grades K–12. These funds may be used by LEAs for energy efficiency and alternative energy projects, along with related improvements and repairs that contribute to reduced operating costs and improved health and safety conditions in public schools. Funds may also be used by LEAs for job training and workforce development in the energy efficiency and renewable energy industry sectors.

The CDE, in consultation with the California Energy Commission (CEC) and the California Public Utilities Commission (CPUC), developed the "Energy Efficiency K-12 Project Guidance" to assist LEAs in setting priorities for the use of funds and in planning and designing energy efficiency and workforce development projects that are cost-effective and create jobs, with total benefits that exceed project cost over time. The project must be consistent with the state's loading order. The loading order guides the state's energy policies and decisions according to the following priority order: 1) decrease electricity demand by increasing energy efficiency and reducing energy usage during periods of high demand or cost; 2) meet new energy supply needs with renewable resources; and 3) meet new energy generation needs with clean fossil-fuel generation.

California's 10,000 public schools spend an estimated $700 million per year on energy, which is equivalent to the amount spent cumulatively on books and supplies. Retrofit improvements to schools can often reduce a school's energy bill 20 to 30 percent, with a simple payback in the range of five to six years. If Proposition 39 funds can help achieve this, as much as $140 million to $200 million per year will be freed up from utility expenses to be deployed for other important school needs. For this reason, it is essential that LEAs invest the Proposition 39 funds wisely to obtain the expected project performance outcomes and reap long-term cash-flow gains for school operations.
Source: CEC

6.4.6 EXTREME HEAT

Identifying Extreme Heat Hazards

Table 6.F and Table 6.G show the Heat Index (HI) as a function of heat and relative humidity. The Heat Index describes how hot the heat-humidity combination makes the air feel. As relative humidity increases, the air seems warmer than it actually is because the body is less able to cool itself via evaporation of perspiration. As the Heat Index rises, so do health risks. Specifically:

- When the Heat Index is 90°F, heat exhaustion is possible with prolonged exposure and/or physical activity.
- When it is 90° to 105°F, heat exhaustion is probable with the possibility of sunstroke or heat cramps with prolonged exposure and/or physical activity.
- When it is 105° to 129°F, sunstroke, heat cramps or heat exhaustion is likely, and heatstroke is possible with prolonged exposure and/or physical activity.
- When it is 130°F and higher, heatstroke and sunstroke are extremely likely with continued exposure. Physical activity and prolonged exposure to the heat increase the risks.

Table 6.F: Air Temperature and Relative Humidity

	The Heat Index												
Air Temp (° F)	Relative Humidity												
	40	45	50	55	60	65	70	75	80	85	90	95	100
110 °	136	143	152										
105°	123	129	135	141	148								
100°	111	115	119	124	129	135	141	147					
95°	*101*	*104*	107	110	114	117	122	126	131	136	141		
90°	*92*	*94*	*96*	*98*	*100*	*103*	106	109	112	115	119	127	132
85°	84	85	86	88	89	*91*	*93*	*95*	*97*	*99*	*102*	*104*	107
80°	80	80	81	81	82	82	83	84	84	85	86	86	87
Exposure to full sunshine can increase Heat Index values by up to 15° F.													

Source: National Weather Service

The National Weather Service (NWS) initiates its Heat Index Program Alert procedures when the high temperature is expected to exceed 105° to 110° (depending on local climate) for at least two consecutive days.

Table 6.G: Possible Heat Disorders by Heat Index Level

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

Source: National Weather Service (http://www.weather.gov/)

Heat exhaustion occurs when the body is dehydrated resulting in an imbalance of electrolytes. Symptoms include headache, nausea, dizziness, cool and clammy skin, pale face, cramps, weakness, and profuse perspiration. First aid involves moving to a cooler spot and drinking water with a small amount of salt added (one teaspoon per quart). Without intervention, heat exhaustion can lead to collapse and heatstroke.

Heatstroke occurs when perspiration cannot occur and the body overheats. Symptoms include headache, nausea, face feeling flushed, hot and dry skin, no perspiration, body temperature over 101°F, chills, and rapid pulse. First aid involves cooling the person immediately; moving to shade or indoors; wrapping the person in a cool, wet sheet; and getting medical assistance. Without intervention, heatstroke can lead to confusion, coma, and death.

Heat emergencies are often slow to develop. It could take a number of days of oppressive heat for a heat wave to have a significant or quantifiable impact. Heat waves do not strike victims immediately, but rather their cumulative effects slowly take the lives of vulnerable populations.

Profiling Extreme Heat Hazards

Heat waves do not cause damage or elicit the immediate response that floods, fires, earthquakes, and other disasters do. They have, however, claimed many lives in comparison with other disasters. For example, the 1989 Loma Prieta Earthquake resulted in 63 deaths while the 1992 Northridge Earthquake was responsible for the loss of 55 lives. The catastrophic 2003 Southern California Firestorms resulted in 24 deaths. However, the worst single heat wave event in California occurred in Southern California in 1955, when an eight-day heat wave is said to have resulted in 946 deaths. The July 2006 heat wave in California caused the deaths of about 140 people over a 13-day period. The Spatial Hazard Events and Loss Data for the United States (SHELDUS), estimates that approximately 47 heat events occurred in California between the years 1960 and 2008. Adjusted to 2008 dollars, SHELDUS reports that severe heat events in California caused roughly $1.8 million in property damage and $531.7 million in crop damage.

The California Climate Adaptation Strategy (CAS), citing a California Energy Commission study, states that "over the past 15 years, heat waves have claimed more lives in California than all other declared disaster events combined."[60] Despite this history, however, not a single heat emergency was formally proclaimed at the state level or declared as a federal disaster between 1960 and 2008. Though no formal explanation exists for this seeming contradiction, scholars have written about the exclusion of heat events as declared disasters. For example, Eric Klinenberg, author of an account of a heat wave which killed 739 people in the City of Chicago in July 1995, suggests that the hidden nature of social vulnerability combined with the inconspicuous nature of heat events (unlike earthquakes, floods, wildfires, tornados, etc.) prevent them from being declared as legitimate disasters.[61] Further, although heat events can have a devastating effect on agriculture, heat-caused property damage over the last 48 years has been relatively small.

Treating Heat as a "Legitimate Disaster"

These facts raise several issues. First, since the primary goal of the SHMP is to significantly reduce the loss of life and injuries in the state of California, heat is considered a legitimate disaster type. Though heat does not cause much economic damage or damage to the built environment, the number of people it has killed underscores the importance of mitigating its impacts. Second, heat events highlight the importance of thoughtful social vulnerability analyses. While changes to the built environment can greatly alter vulnerability to different hazards, social vulnerability and resiliency are especially important during heat events. For example, socially isolated elderly persons are especially vulnerable. Any mitigation efforts

[60] California Natural Resources Agency, California Climate Adaptation Strategy, December 2009, p. 32; Messner, Steven, Sandra C. Miranda, Karen Green, Charles Phillips, Joseph Dudley, Dan Cayan, Emily Young. Climate Change Related Impacts in the San Diego Region by 2050. PIER Research Report, CEC-500-2009-027-D, Sacramento, CA: California Energy Commission. 2009.
[61] Heat Wave: A Social Autopsy of Disaster in Chicago, The University of Chicago, 2002

aimed at reducing heat losses will focus on ways to reduce social isolation as well as changes to the built environment. Third, heat events illustrate how seemingly unrelated phenomena combine to create disaster. For example, the increased use of air conditioners during heat waves can lead to power outages, which makes the events even more deadly. Upgrading water and power infrastructure, then, is a form of heat disaster mitigation.

Situational and physical characteristics help to identify vulnerable populations that may not comfortably or safely access and use disaster resources. Specifically, when discussing heat-related emergency preparedness, the following groups could be considered vulnerable or at greater risk in a heat emergency:

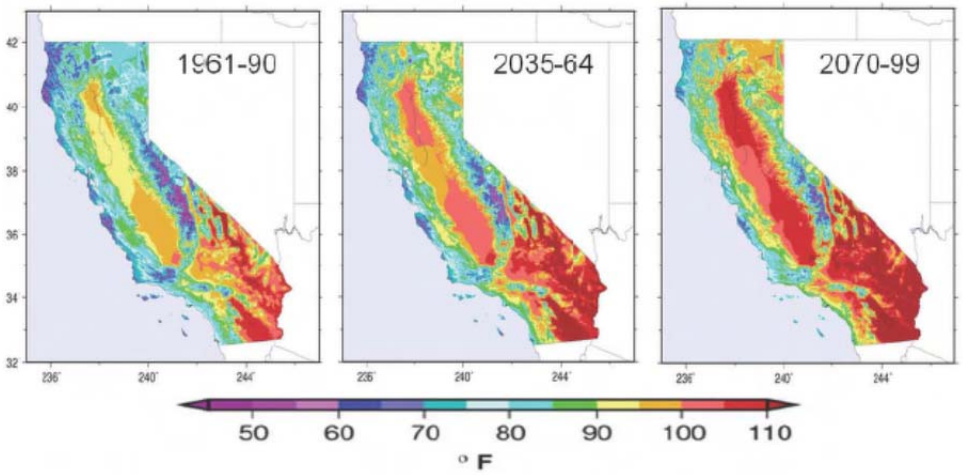
- People with developmental/intellectual disabilities - refers to a severe and chronic disability that is attributable to a mental or physical impairment that begins before an individual reaches adulthood. These disabilities include cerebral palsy, epilepsy, mobility and autism.
- Blind/low vision
- Deaf/Hard of hearing
- Mobility
- Injuries: from auto accidents, falls, sports, and or war. These injuries can cause damage to the brain, spinal cord, hearing, sight and mobility
- Chronic Conditions: Diabetes, Arthritis, dialysis, asthma and epilepsy
- Older adults: Have age-related limitations. (move slower, sight and sound limitations, etc)
- Children: Challenges include dependency not only for care, but decision-making, processing information and trauma differently than adults, they may be unable to articulate their needs, may decompensate faster than adults, and are generally more susceptible to thirst, hunger, temperature, etc than adults

Animals, including domestic pets, livestock, and poultry are also susceptible to extreme heat. For example, dogs and cats are in danger of heat stroke in temperatures of 110°F. The heat wave of 2006 resulted in 15 reported pet deaths and more than 25,000 cattle, and 700,000 fowl heat-related deaths. Heat wave impacts to livestock can lead to financial losses in California's agricultural economy.

Climate Change and Extreme Heat

According to the CAS, California is getting warmer, leading to increasing frequency, intensity, and duration of heat waves, and increased mortality. Map 6.L illustrates the statewide temperature increase trend.

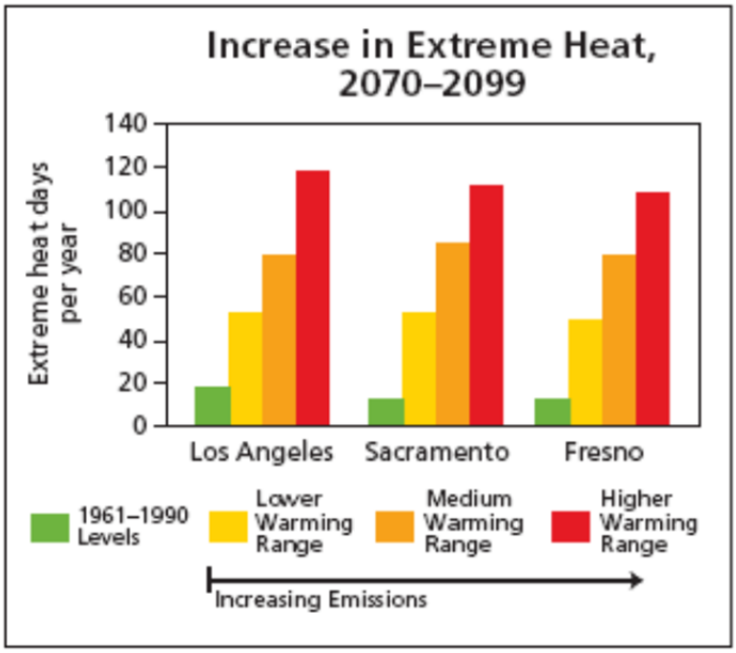
MAP 6.L: California Historical and Projected Temperature, 1961-2099



Source: Dan Cayan; California Climate Adaptation Strategy

As temperatures rise, Californians will face greater risk of death from dehydration, heat stroke/exhaustion, heart attack, stroke, and respiratory distress caused by extreme heat. By mid-century, extreme heat events in urban centers could cause two to three times more heat-related deaths than occur today.[62] By 2100, hotter temperatures are expected throughout the state, with an increase of 3 to 5.5°F under the lower emissions scenario and 8 to 10.5°F under the higher emissions scenario. If temperatures rise to the higher warming range, there could be up to 100 more days per year with temperatures above 90°F in Los Angeles and above 95°F in Sacramento (see Chart 6.D).

Chart 6.D: Increase in Extreme Heat, 2070-2099



Assessment of State Vulnerability and Potential Loss to Extreme Heat Hazards

No current assessment of state vulnerability or potential extreme heat hazard losses is known to be available at this time. However, related California Energy Commission studies are under way.

Assessment of Local Vulnerability and Potential Loss to Extreme Heat Hazards

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

[62] California Climate Change Center 2006, 2009

Current Extreme Heat Hazard Mitigation Efforts

Progress Summary 6.K: State Climate and Heat Guidance

Progress as of 2013: An important companion to this section is the state's latest climate change and heat guidance "Preparing California for Extreme Heat: Guidance and Recommendations" produced by the Heat Adaptation Work Group of the Climate Action Team's Public Health Workgroup, and coordinated by the California Department of Public Health and Cal/EPA. This document provides an overview of climate change projections for increasing temperature and extreme heat events through 2100, the health risks associated with these changes, and presents recommendations to guide the state's actions to reduce human health risks in the face of a warming climate in California and promote more heat resilient communities. To download the Preparing California for Extreme Heat: Guidance and Recommendations document please visit: http://www.climatechange.ca.gov/climate_action_team/reports/Preparing_California_for_Extreme_Heat.pdf

Cal OES has prepared a revision of the Contingency Plan for Excessive Heat Emergencies dated April 2010, as a supporting document to the State Emergency Plan. Although primarily designed to guide preparedness and response activities, it also identifies mitigation actions to prevent life loss, including:

- Identifying the location of vulnerable populations
- Establishing cooling centers
- Issuing advisories and warnings
- Conducting pre-season public information campaigns
- Promoting and expanding urban greening and the use of green infrastructure as part of cooling strategies in public and private spaces

Details regarding the Contingency Plan for Excessive Heat Emergencies are available at:
http://www.calema.ca.gov/PlanningandPreparedness/Pages/Documents%20and%20Publications.aspx
The California Adaptation Planning Guide: Identifying Adaptation Strategies (APG) document is a climate change document which presents potential adaptation strategies, including some strategies addressing heat events, which communities can use to meet adaptation needs. The APG can be found at
http://resources.ca.gov/climate_adaptation/local_government/adaptation_planning_guide.html
For specific mitigation ideas related to extreme temperatures, see "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" January 2013, prepared by FEMA, available on the FEMA website: http://www.fema.gov/library/viewRecord.do?id=6938

Opportunities for Enhanced Extreme Heat Hazard Mitigation

Additional opportunities to prevent or mitigate the impacts of extreme heat exist in the form of the ongoing climate change science studies sponsored by the California Energy Commission.

Progress Summary 6.L: Urban Heat Island Effect Research

Progress as of 2013: The Governor's Office of Planning and Research is joining with Cal/EPA and several other State agencies on a new research project about the Urban Heat Island Effect. A major goal of this project is to develop a method to quantify the average temperature increase in California communities due to this effect.

Currently no tool exists to quantify the extent and severity of an urban heat island for California. The research project intends to produce a tool that can be mapped at the census tract level or smaller, and that enables state and local agencies to identify the areas that are most affected and quantify the benefits of heat island reduction measures. One of the motivations for this project is to provide another indicator of climate change vulnerability for the CalEnviroScreen, Cal/EPA's tool to identify disadvantaged communities for potential funding associated with greenhouse gas reduction revenues in California.

Best Practices Highlight 6.F: Kern County Cooling Centers

Kern County, located in the southern Central Valley, already experiences extreme heat events and the frequency of these events is projected to increase due to climate change. For community members who do not have access to a setting with temperature control (e.g. air conditioning), cooling centers have been established to provide somewhere to escape the heat. The opening of these centers is tied to a set of temperature triggers that vary by location.

The temperature triggers for opening the cooling centers, based on the National Weather Service forecast as of the previous day, are as follows:

- San Joaquin Valley / Kern River Valley Centers: 105 degrees
- Mountain Center(s): 95 degrees
- Desert Centers: 108 degrees

Cooling centers include a wide range of community facilities including senior centers, parks and recreation facilities, community centers, police departments, and veteran's centers. When they have been made available, announcements are made via TV, radio, and the Internet. In addition, transportation is available for community members that do not have a way to travel to one of the centers.

Source: Reported in the California Climate Adaptation Planning Guide; case from
http://www.kerncountyfire.org/index.php?option=com_content&view=article&id=59&Itemid=66
http://www.co.kern.ca.us/pio/coolingcenters.asp

6.4.7 FREEZE

Identifying Freeze Hazards

Sustained temperatures below freezing in California's generally mild weather regions can cause life loss and health risks to vulnerable populations. Although infrequent, freezes can severely affect California agriculture. Freezing temperatures occurring during winter and spring growing seasons can cause extensive crop damage.

Secondary impacts of freeze disasters can include major economic impacts on farmers, farm workers, packers, and shippers of agricultural products. Freezes can also cause significant increases in food prices to the consumer due to shortages.

Freezing spells are likely to become less frequent in California as climate temperatures increase; if emissions follow higher pathways, freezing events could occur only once per decade in a sizable portion of the state by the second half of the 21st century. While fewer freezing spells would decrease cold-related health effects, too few freezes could lead to increased incidence of disease as vectors and pathogens do not die off (CNRA 2009).

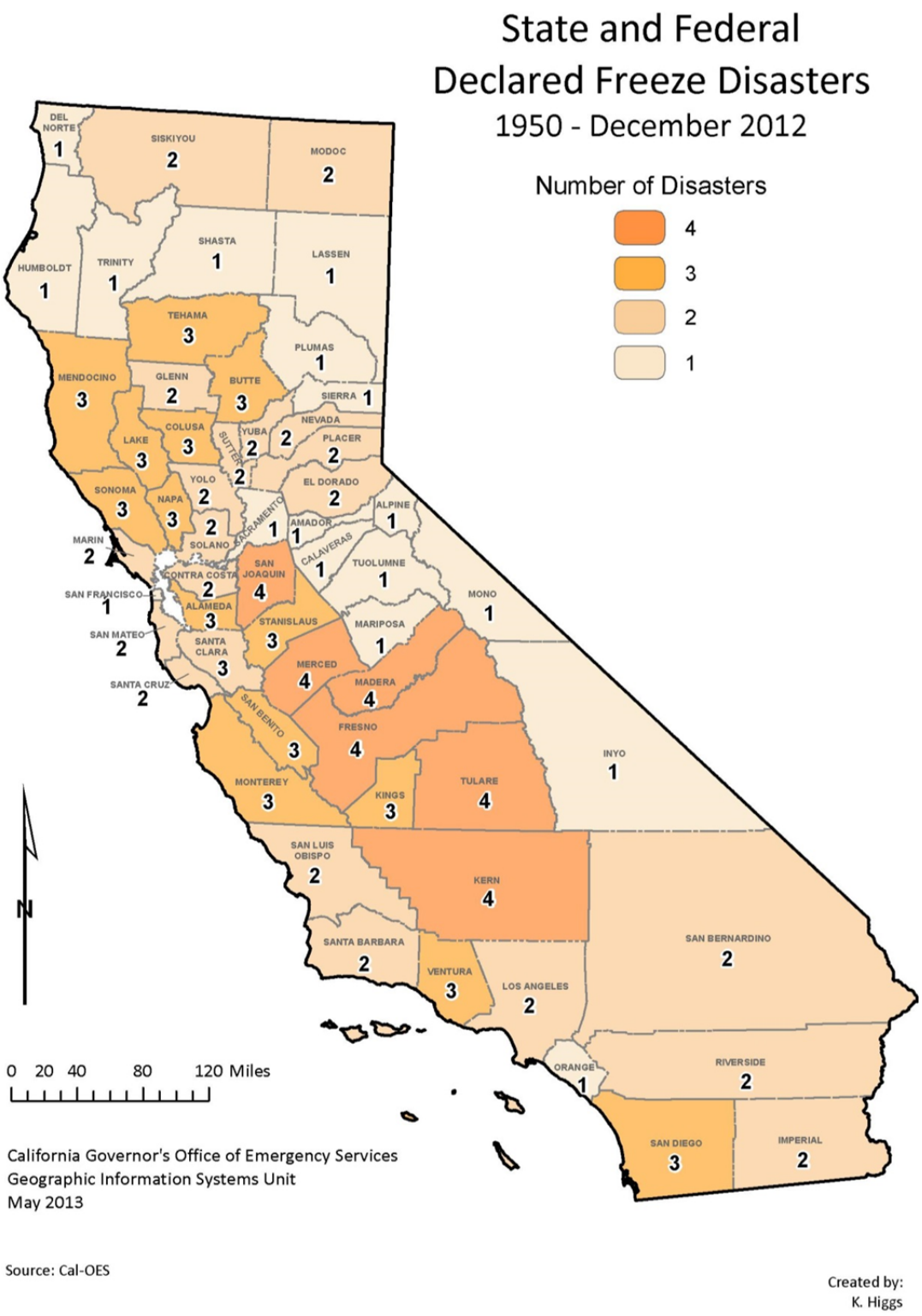
Assessment of State Vulnerability and Potential Losses

No known current assessment of state vulnerability or potential losses is available at this time.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

MAP 6.M: State and Federal Declared Freeze Disasters, 1950-December 2012



Map 6.M shows the pattern of declared freeze disasters in California since 1950. Greatest concentrations are in the Central Valley, followed by areas north and south of the San Francisco Bay Area and portions of Southern California. Table 6.H lists freeze disasters that have occurred in the state since 1950.

Table 6.H: Freeze Disasters, 1950 to Present

Year	Number of Incidents	Counties Affected	Crop Damage
1969	1	San Diego	$10 million
1972	2	Colusa, El Dorado, Fresno, Kern, Kings, Lake, Madera, Merced, Modoc, Nevada, Placer, San Benito, San Joaquin, Santa Clara, Stanislaus, Siskiyou, Tehama, Tulare	$113.5 million
1973	1	Alameda, Contra Costa	$8-$10 million
1990	1	Alameda, Butte, Colusa, Fresno, Glenn, Imperial, Kern, Los Angeles, Madera, Marin, Merced, Mendocino, Monterey, Napa, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tulare, Ventura, Yolo, Yuba	$852.4 million
1998-99	1	Fresno, Kern, Kings, Madera, Merced, Monterey, Tulare, Ventura	N/A
2001	3	Butte, Colusa, Fresno, Glenn, Madera, Mariposa, Merced, Plumas, Sutter, Tehama, Tuolumne, Yuba	N/A
2002	5	Butte, Colusa, Glenn, Lake, Marin, Mendocino, Napa, Orange, Riverside, Sacramento, Shasta, Sonoma, Tehama, Trinity	N/A
2007	1	Alameda, Amador, Calaveras, El Dorado, Fresno, Glenn, Imperial, Kern, Kings, Lake, Los Angeles, Madera, Marin, Mendocino, Merced, Monterey, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Solano, Stanislaus, Tulare, Ventura, Yolo, Yuba	$1.3 billion

Sources: Cal OES Individual Assistance Section, 2001 & 2002 SBA Declarations/ USDA Designations database; Cal OES Origins and Development - A Chronology 1917-1999

Current Freeze Hazard Mitigation Efforts

Freeze damage is another economic hazard. Mitigation measures for frost include:

- Warning systems
- Selective planting
- Crop insurance
- Frost-fighting equipment
- Biological ice nucleation[63]

For specific mitigation ideas related to extreme temperatures, see "Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards" January 2013, prepared by FEMA, available on the FEMA website: http://www.fema.gov/library/viewRecord.do?id=6938

Opportunities for Enhanced Freeze Hazard Mitigation

There are no additional opportunities identified at this time to prevent or mitigate the impacts of freeze hazards.

[63] FEMA Region IX Mitigation Division, Mitigation Strategy Report, FEMA-DR-1267-Ca, The California Freeze of 1998.

6.4.8 INSECT PESTS AND DISEASES

Climate Change and Pests and Diseases

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. For example, the pink bollworm, a common pest of cotton crops, is currently a problem only in southern desert valleys because it cannot survive winter frosts elsewhere in the state. However, if winter temperatures rise 3 to 4.5°F, the pink bollworm's range would likely expand northward, which could lead to substantial economic and ecological consequences for the state.

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 lifecycles 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 (California Climate Change Center 2006).

Possible future strategies to address climate change influences on insect pests and diseases might include:

- Inventory and monitor invasive species that threaten crops
- Downscale climate change data to allow informed decisions on biodiversity planning by farmers and rural communities
- Strengthen the dissemination of knowledge, appropriate technologies and tools to improve management practices related to agricultural biodiversity and ecosystem services

The above strategies were derived from Food and Agriculture Organization of the United Nations, Climate Change for Food and Agriculture, Technical Background Document from the Expert Consultation, 2008, available at: ftp://ftp.fao.org/docrep/fao/meeting/013/ai784e.pdf

Invasive Species Council of California

The Invasive Species Council of California (ISCC) was established in 2009 to provide leadership and authority in state government regarding invasive species with its primary goal being to guide efforts to keep invasive species out of the state and to eradicate incipient populations of undesirable species. ISCC is an inter-agency council chaired by the Secretary of the California Department of Food and Agriculture with members from the California Natural Resources Agency, the California Environmental Protection Agency, the California Business, Transportation and Housing Agency, the California Health and Human Services Agency and Cal OES. The ISCC has appointed a California Invasive Species Advisory Committee (CISAC) primarily tasked with making recommendations to develop and prioritize an Invasive Species Action Plan. For more information regarding the ISCC and the CISAC, please visit: http://www.iscc.ca.gov/

6.4.9 SEVERE WEATHER AND STORMS

As pointed out in the discussion of global warming earlier in this chapter as well as in Chapter 4, more extreme weather and severe storms are expected among the future natural hazards challenges in California due to climate change. Increases in severe weather, winter storms, flooding, temperature extremes, and other meteorological effects are anticipated.

Similarly, a key theme in the California Climate Adaptation Strategy (CAS) is the likelihood of more extreme weather-related events requiring planning for adaptation. Because the science is so new, however, little is yet known about certain possible weather effects of climate change. For example, among potential weather-related effects not dealt with in depth in the CAS is the possibility of increasing numbers and intensities of windstorms, a variable having substantial local impacts and affecting future building code provisions, landscape design and maintenance, and power line and pole design, among other things.

Therefore, although this subsection focuses primarily on tornadoes and to a lesser degree on hurricanes, it is intended to serve as a placeholder for future assessment of other weather-related hazards representing a broader variety of manifestations in this classification of extreme weather.

Identifying Hurricane Hazards

California is at very low risk of hurricanes, although it is possible for one to threaten the Southern California coast. (www.weather.com/encyclopedia/tropical/climo.html)

No hurricanes have hit California in recorded history because tropical storm winds generally blow from east to west. California is affected by heavy rain resulting from tropical winds that blow north from Mexico and become colder by the time they hit California (The USA TODAY Weather Book by Jack Williams).

In the future, monitoring is needed to determine whether present patterns of movement of such storms continue or are modified by the warming of waters off the Pacific Coast due to climate change.

Identifying Tornado Hazards

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.

Wind speeds in tornadoes range from values below that of hurricane speeds to more than 300 miles per hour. Unlike hurricanes, which produce wind speeds of similar values over relatively widespread areas (when compared to tornadoes), the maximum winds in tornadoes are often confined to extremely small areas and vary substantially over very short distances, even within the funnel itself.

Tornados are measured by the Fujita Tornado Scale (F0-F12) which classifies tornadoes by intensity categories, based on the maximum winds occurring within the funnel. Table 6.I describes the Fujita Tornado Scale.

Table 6.I: Fujita Tornado Scale

Category	Wind Speed	Description
F0	40-72 miles per hour	Gale Tornado. Light Damage: Some damage to chimneys; breaks twigs and branches off trees; pushes over shallow-rooted trees; damages signboards; some windows broken; hurricane wind speed begins at 73 miles per hour.
F1	73-112 miles per hour	Moderate Tornado. Moderate Damage: Peels surfaces off roofs; mobile homes pushed off foundations or overturned; outbuildings demolished; moving autos pushed off the roads; trees snapped or broken.
F2	113-157 miles per hour	Significant Tornado. Considerable Damage: Roofs torn off frame houses; mobile homes demolished; frame houses with weak foundations lifted and moved; boxcars pushed over; large trees snapped or uprooted; light-object missiles generated.
F3	158-206 miles per hour	Severe Tornado. Severe Damage: Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forests uprooted; heavy cars lifted off the ground and thrown; weak pavement blown off roads.
F4	207-260 miles per hour	Devastating Tornado. Devastating Damage: Well-constructed homes leveled; structures with weak foundations blown off some distance; cars thrown and disintegrated; large missiles generated; trees in forest uprooted and carried some distance away.

F5	261-318 miles per hour	Incredible Tornado. Incredible Damage: Strong frame houses lifted off foundations and carried considerable distance to disintegrate; automobile-sized missiles fly through the air in excess of 300 feet (100 meters); trees debarked; incredible phenomena will occur.
F6-12	Greater than 319 miles per hour	The maximum wind speeds of tornadoes are not expected to reach the F6 wind speeds.

Profiling Tornado Hazards

As shown in Table 6.J, between 1950 and 2006, 316 tornadoes occurred in California, resulting in 87 injuries, and totaling more than $103.5 million in property damage, as well as $267,000 in reported crop damage. No known deaths occurred as a result of California tornadoes, however, and the state has never proclaimed a state of emergency or had a federal disaster declared as the result of a tornado event. Of the 316 tornadoes occurring in California between 1950 and 2006, only 2 reached F3; 22 were F2, 84 were F1, and the remaining 208 were at F0. Based on the number of events within the recorded period, in the 56 years between 1950 and 2006, the average recurrence interval of an F0 tornado was about 3.7 per year; the interval for an F1 tornado was about 1.5 per year, the interval for an F2 tornado was approximately once every two years, and the interval for an F3 tornado was once every 28 years. However, both F3 tornadoes occurred within a five-year period (1973-1978).The biggest risks of tornadoes in California include light to moderate damage to homes, destruction of mobile homes, and injuries caused by light object projectiles.

Table 6.J: Tornado Losses, 1950-2006

Magnitude	Number	Injuries	Property Damage	Crop Damage
F0	208	8	$38 million	$212,000
F1	84	26	$18 million	$55,000
F2	22	47	$45 million	N/A
F3	2	6	$2.5 million	N/A

Source: The Tornado Project (www.tornadoproject.com), NOAA national climate data center

Assessment of State Vulnerability and Potential Losses

No known current assessment of state vulnerability or potential losses due to tornado hazards is available at this time.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

Current Tornado Hazard Mitigation Efforts

Tornado mitigation is achieved through the enforcement of wind engineering design and construction codes and standards. Tornado watch and warning announcements are issued to local emergency management agencies and to the media through the Emergency Disaster Information System (EDIS), based on information provided by National Oceanic and Atmospheric Administration (NOAA) and the National Weather Service. For specific mitigation ideas related to severe winter weather, see “Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards” January 2013, prepared by FEMA, available on the FEMA website: http://www.fema.gov/library/viewRecord.do?id=6938

Opportunities for Enhanced Tornado Hazard Mitigation

There are no additional opportunities identified at this time to prevent or mitigate the impacts of tornado hazards.

6.5 VOLCANOES

"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

Many of California's young volcanoes pose a threat to people and property. Volcanic eruptions occur in the State about as frequently as the largest San Andreas Fault Zone earthquakes; at least ten eruptions have occurred in California in the last 1,000 years. A new effort to identify, prepare for, and mitigate volcanic hazards within California is underway. Cal OES, in partnership with the United States Geological Survey (USGS) and California Geological Survey (CGS), is developing its first "State of California Volcanic Hazards Identification, Risk Analysis, and Concept of Operations Annex to the State Emergency Plan." In addition, in 2013 Cal OES, in partnership with NOAA, the port of Aviation" which addresses air operations issues related to volcanic ash.

6.5.1 IDENTIFYING VOLCANO HAZARDS

A national report on volcanic threat published by the USGS in 2005 lists eight young and potentially hazardous volcanic areas in California (http://pubs.usgs.gov/of/2005/1164/). Volcanic threat rankings for U.S. volcanoes were derived from a combination of factors including age of the volcano, potential hazards (the destructive natural phenomena produced by a volcano), exposure (people and property at risk from the hazards), and current level of monitoring (real-time sensors in place to detect volcanic unrest).

As shown in Map 6.N below, California's high-to-moderate threat volcanoes include Medicine Lake Volcano (Siskiyou, Modoc, and Shasta counties), Mt. Shasta (Siskiyou County), Lassen Volcanic Center (Shasta, Tehama, Lassen, and Plumas counties), Clear Lake Volcanic Field (Sonoma County), Long Valley Caldera/Mono-Inyo Craters (Mono County), Ubehebe Craters (Inyo County), Coso Volcanic Field (Inyo County) and Salton Buttes (Imperial County). Seven other young volcanoes in California with lower threat ranking are identified in the 2005 report, including Brushy Butte, Twin Buttes, Tumble Buttes, and Silver Lake Volcanic Field (Shasta County); Eagle Lake Volcanic Field (Lassen County); Golden Trout Creek Volcanic Field (Tulare County); and Lavic Lake Volcanic Field (San Bernardino County). In addition, close proximity to a number of active or potentially active volcanoes in nearby states of Nevada, Oregon, and Arizona and across the border in Mexico could cause volcanic ash fall hazards within California, depending on atmospheric conditions and eruption magnitude.

6.5.2 PROFILING VOLCANO HAZARDS

USGS hazard zonation maps based on known past behavior of California's high threat volcanoes provide basic information for statewide volcanic hazard mitigation. USGS hazard zone maps are dynamic documents; as research progresses, gaps are filled in and the maps are updated. Most recently published are assessments for Lassen Volcanic Center (http://pubs.usgs.gov/sir/2012/5176/a/) and Medicine Lake volcano (http://pubs.usgs.gov/sir/2007/5174/a/), but not all high to moderate threat volcanic areas in California have modern assessments; Clear Lake Volcanic Field, Mt Shasta, and the Long Valley Caldera/Mono-Inyo Craters region are priority targets for new USGS assessments. In the interim, the statewide perspective on volcanic hazards was adapted by USGS and CGS experts from USGS Bulletin 1847 Potential Hazards from Future Volcanic Eruptions in California. For more information visit: (http://pubs.usgs.gov/bul/1847/b1847_text.pdf).

Types of Hazards

Hazards types, general characteristics, and potential impact are listed in Table 6.K.

MAP 6.N: Potentially Hazardous Volcanoes of California

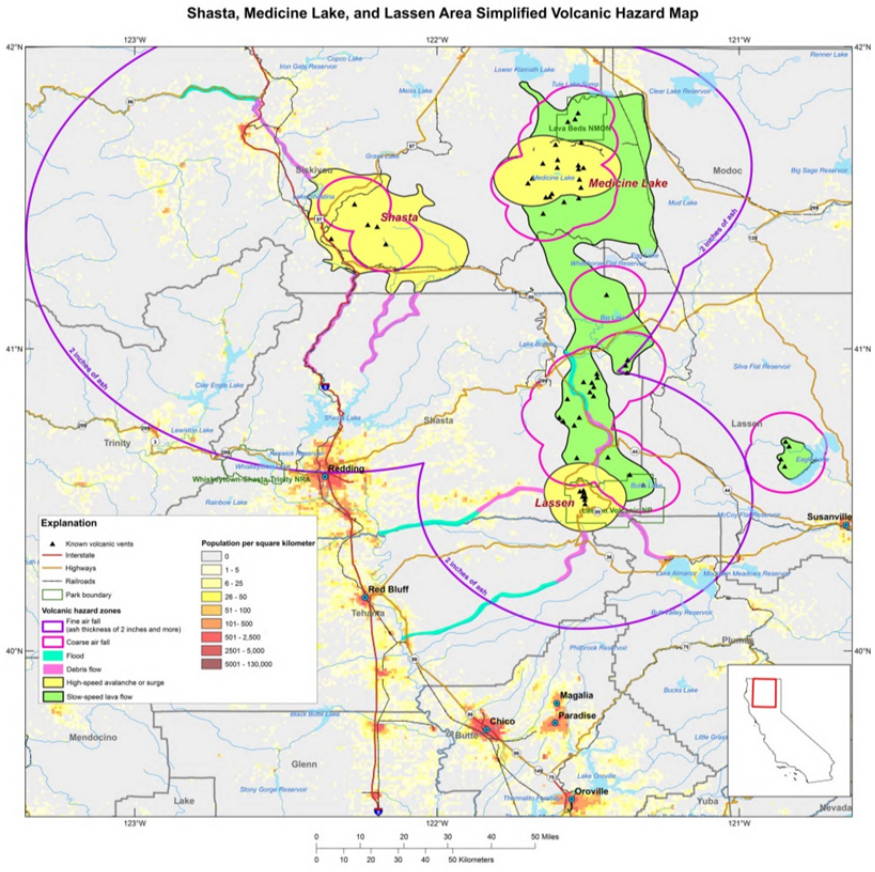
Map 6.N depicts California's young, most hazardous volcanoes. Lower threat volcanoes are not shown (see http://volcanoes.usgs.gov/observatories/calvo/).

Table 6.K: Classification of Types, Characteristics, and Potential Impacts of Volcanic Hazards in California

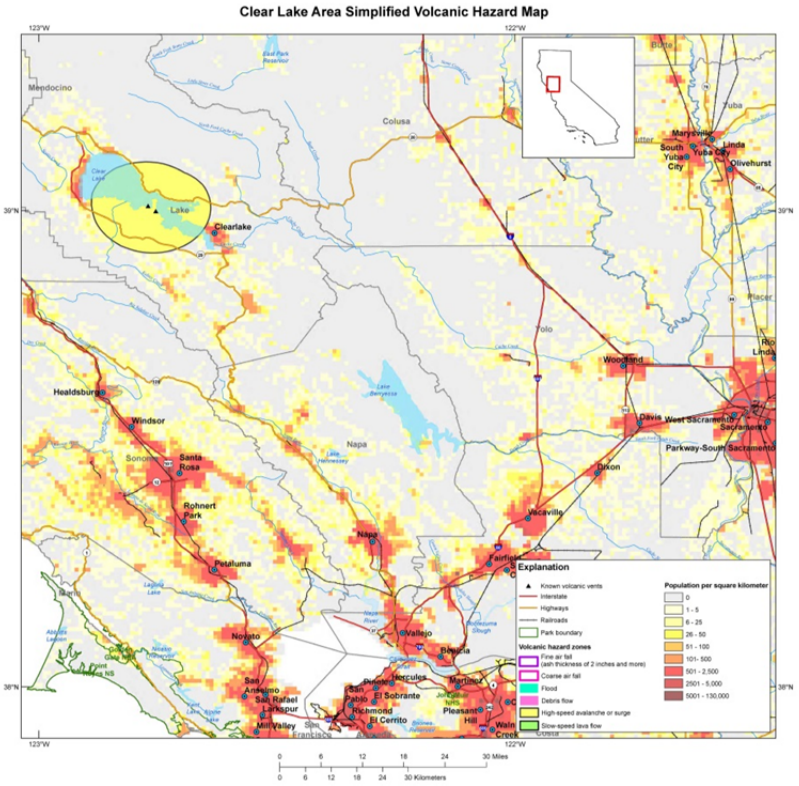
Hazard Profile	Characteristics	Impact
High speed lava avalanches or surges produced by high-energy explosive eruptions or steam blasts (pyroclastic flow)	Sudden eruption of hot (400-1300°F), gas-pressurized flows of ash and lava fragments that rush outward from the volcano with great force at ground speeds greater than 50 miles per hour (mph). Flows typically follow valleys but can overtop ridges and travel 30 miles or more from the volcano.	These high-speed 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.
Slow speed lava flows produced by a low-energy, effusive eruptions	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 thick mounds (lava dome), or move across the landscape for many kilometers as fluid 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.
Volcanically produced **debris flows** (lahars)	Slurry-like floods of volcanic ash, rock, and water that look like wet concrete. Debris flows gain momentum during travel by eroding and entraining soil and loose rock debris from channels. Large debris flows may carry boulders 30 feet across and travel through valleys and stream channels at speeds of 20 to 40 mph. Debris flows can be hot, with temperatures close to boiling. They occur during an eruption due to melting snow or ice, or after an eruption due to re-mobilization of loose volcanic deposits during intense rainfall.	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.
Volcanically produced **flood**s	Floods of surface water produced by sudden melting of snow/ice, and/or diversion of water by blocked drainages or breached embankments.	Impacts are similar those of non-volcanic floods, but the onset is usually sudden.
Fine ash fall from high-energy explosive eruptions	Fine fragments of lava, sand size and smaller, deposited from drifting ash clouds. Impact zone may be many tens to a few hundreds of miles from the volcano.	Although generally non-lethal, fine ash fall is the most widespread and disruptive volcanic hazard. People exposed to fine ash commonly experience various eye, nose, and throat symptoms. Short-term exposures are not known to pose a significant health hazard. Long-term health effects have not been demonstrated conclusively. Ash deposited downwind of the volcano covers everything like a snowfall, but also infiltrates cracks and openings in machinery, buildings, and electronics. Falling ash can obscure sunlight, reducing visibility to zero. When

Hazard Profile	Characteristics	Impact
		wet, it can make paved surfaces slippery and impassable. Fine ash is abrasive, damaging surfaces and moving parts of machinery, vehicles, and aircraft. Life-threatening and costly damage can occur to aircraft that fly through fine ash clouds. Newly fallen volcanic 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, waste water systems to clog, and power systems to shut down. In agricultural areas, fine ash can damage crops, and sicken livestock. Re-suspension of ash by human activity and wind cause continuing disruption to daily life.
Coarse air fall from low-energy effusive eruptions (scoria, tephra, pyroclast, pumice)	Ballistic ejection of coarse, hot fragments of lava from the volcanic vent. Impact zones are usually constrained to the flanks of the volcano. Fragments are 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 fragments or burnt by their high heat. Wildfires may be ignited.

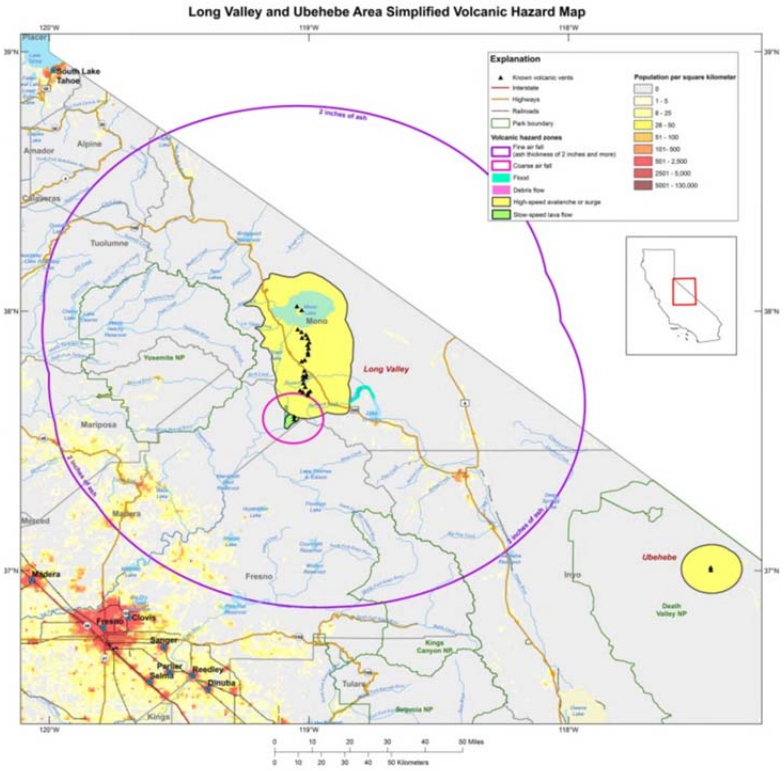
MAP 6.O: Shasta Area Volcanic Hazard Zonation Map



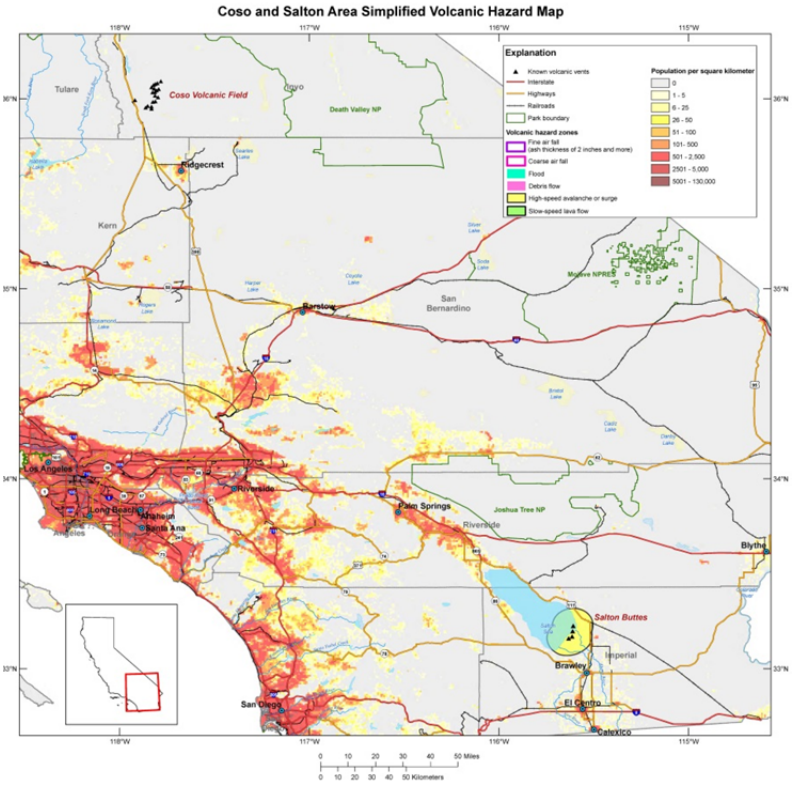
MAP 6.P: Clearlake Area Volcanic Hazard Zonation Map

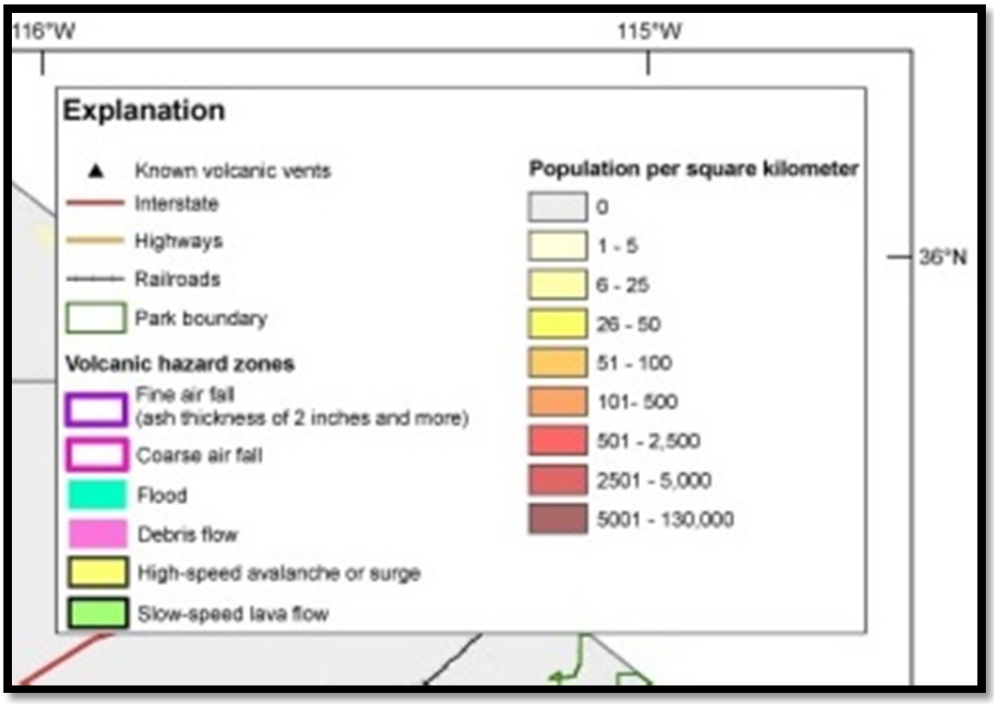


MAP 6.Q: Mono Area Volcanic Hazard Zonation Map



MAP 6.R: Salton Area Volcanic Hazard Zonation Map





(Online or download viewers can zoom in for a closer view of the information on these maps.) Following the volcano hazard zonation maps is a zoomed in version of the legend used in each of the four maps.

Map 6.O, Map 6.P, Map 6.Q and Map 6.R define zones of potential lava flow, ash fall, debris flow and flood hazards for the Shasta, Clearlake, Mono and Salton volcanoes, respectively.

Past Eruptions and Ongoing Volcanic Unrest

Future volcanic eruptions in California are inevitable. Geophysical and geochemical monitoring conducted by the USGS reveal the presence of magma (molten rock) beneath seven of the eight California volcanoes ranked as moderate to high threat. Low-levels of volcanic seismicity, emissions of noxious volcanic gas, and/or ground deformation characterize the present status of Medicine Lake, Mt. Shasta, Lassen Volcanic Center, Clear Lake Volcanic Field, Long Valley Caldera/Mono-Inyo Craters, and Salton Buttes. From studies at high to moderate threat volcanoes, the USGS estimates the likelihood of renewed volcanism in California is about 1 in 200 to 1 in 3,600 in any given year. The most recent eruption occurred at Lassen Peak, in Lassen Volcanic National Park.

Analysis of population density within hazard zones for each volcanic area has been completed. Although many hazard areas have low residential population, they may have significant population influx for vacation and recreational use.

The photo below captures an image of a large volcanic ash column from the May 22, 1915 eruption of Lassen Peak as seen from the town of Red Bluff, located 40 miles west of the volcano. The column reached heights of 30,000 feet.

1915 Eruption of Lassen Peak as seen from Red Bluff

Photo by R.E. Stinson courtesy of the National Park Service

Volcanic Activity Past, Present and Future: The Lassen Peak Example

Volcanic History: Lassen Volcanic Center (LVC) lies in Lassen Volcanic National Park 55 miles east of Redding. The park draws over 350,000 visitors each year with its spectacular volcanic landscapes.

LVC has been relatively quiet for the last 25,000 years with three notable exceptions: the Chaos Crags eruption (1,100 years ago), the eruption of Cinder Cone (345 years ago), and the Lassen Peak eruption (1914 to 1917 C.E.). The Lassen Peak eruption consisted mostly of sporadic steam blasts. In May 1915, partially molten rock oozing from the vent began building a precarious lava dome. The dome collapsed on May 19, sending an avalanche of hot rock down the north flank of the volcano. Three days later, a vertical column of fine ash exploded from the vent reaching altitudes of 30,000 feet. The ash column spawned a high-speed avalanche of hot gas and rock. Fine ash from the top of the column drifted downwind 200 miles to the east, as far as Winnemucca, Nevada. On both days, melting snow fueled mudflows, flooding drainages 20 to 30 miles away. The older Chaos Crags eruption was similar in style but considerably larger in magnitude.

Presently, LVC hosts a vigorous geothermal system, numerous hot springs, steam vents, and boiling mud pots. Volcanic earthquakes are common, although most are too small to be felt. Non-volcanic earthquakes along regional faults also occur; earthquake swarms in 1936, 1945-1947, and 1950 included several events above magnitude 4.0, with the two largest registering 5.0 and 5.5. Ground surveys show the volcano is gradually subsiding at the appreciable rate of 7 to 10 millimeters per year.

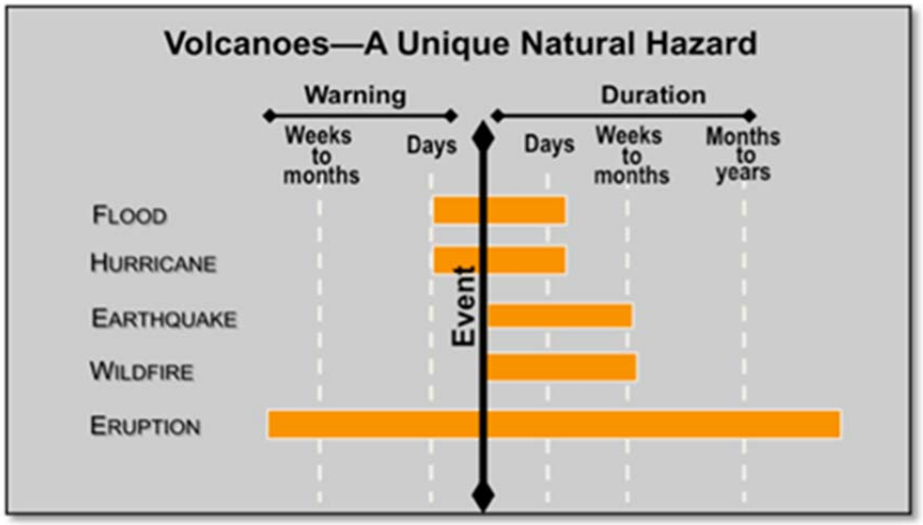
Volcano Monitoring: A continuous volcano monitoring network comprised of six seismometers and seven continuously recording GPS receivers is located within 10 miles of Lassen Peak. The sensors transmit earthquake and ground deformation data in real-time to computers at the USGS California Volcano Observatory for interpretation. Volcano surveillance also includes ongoing geochemical and thermal surveys of volcanic gas vents and hot springs.

Likelihood of a Future Eruption: Volcanic activity over the past 100,000 years suggests that within any given year there exists about a 1 in 1,000 chance of an eruption occurring at LVC.
(see http://pubs.usgs.gov/sir/2012/5176/a/)

Most Likely Scenario: Heightened seismicity and ground deformation will probably precede the next eruption. Most likely to occur is an effusive eruption with incandescent lava fountains rising tens to hundreds of feet in the air. A mound of coarse air fall (volcanic cinder) would gradually build around the vent and slow-moving lava flows could affect areas a few miles away. Future explosive eruptions, similar to Lassen Peak or the larger Chaos Crags, are also possible.

Unlike most other natural disasters, volcanic eruptions are usually preceded by weeks to months of precursory unrest (see Chart 6.E), which manifests as ground deformation, earthquake swarms, and gas emissions. By monitoring the signals of unrest, scientists can make accurate eruption forecasts. As shown in Chart 6.E, volcanic eruptions typically last longer than other types of natural hazard events. This longer duration can tax emergency response and recovery efforts.

Chart 6.E: Schematic Representation of Natural Disaster Timelines, Emphasizing the Unique Build-Up and Duration Times of Volcanic Disasters



6.5.3 ASSESSMENT OF STATE VULNERABILITY AND POTENTIAL LOSSES

A comprehensive assessment of state vulnerability and potential losses is underway as part of the "State of California Volcanic Hazards Identification, Risk Analysis, and Concept of Operations Annex to the State Emergency Plan." The plan will consider vulnerability with respect to: agriculture and forestry, communications, hospitals and urgent care facilities, population and recreational use, transportation, utilities, water resources, and wildlife. The information will provide the framework needed for local governments to conduct community-based volcanic vulnerability assessments and to develop mitigation and response plans.

Table 6.L shows a partial listing of vulnerable populations, resources, and assets located within the volcanic hazard zones presented in Map 6.O, Map 6.P, Map 6.Q and Map 6.R.

Table 6.L: Vulnerability in Volcano Hazard Zones

Type	Estimated Population/Vulnerable Resources
Ambient Population	200,000 average per 24 hours
Transient Population (Recreation Usage/Highway Traffic)	National Park Service: 6,900,000 visitors per year (includes Lassen Volcanic National Park, Yosemite National Park, Lava Beds National Monument, Devils Postpile National Monument, Kings Canyon National Park, Death Valley National Park, and Whiskeytown National Recreation Area) Interstate 5: 38,000 average daily traffic (ADT) at junction with Route 299 Route 299: 8,600 ADT at Burney Route 20: 11,700 ADT at Lucerne Route 29: 10,800 ADT at Kelseyville Route 395: 6,500 ADT at Mono-Inyo county line Route 108: 1,650 ADT at USMC Camp Cloudburst Route 111: 5,200 ADT at Calipatria
Major Resources/Assets	Reservoirs and Rivers: Lake Shasta, Trinity Lake, Clear Lake, Lake Almanor; the Klamath, Salmon, Trinity, Sacramento, Pit, Owens,

Type	Estimated Population/Vulnerable Resources
	Tuolumne, Merced, San Joaquin, and Kings rivers. Power Transmission: power lines, including Pacific AC Intertie OR/WA/Canada and Pacific DC Intertie OR/WA, and transmission substations, including PacifCorp, Pacific Gas & Electric, Southern California Electric, and Imperial Irrigation District. Natural Gas: Pipelines including Pacific Gas & Electric and Southern California Gas.

Sources:
UT- Battelle Oak Ridge National Lab LandScan 2010 (http://www.ornl.gov/sci/landscan/index.shtml)
NPS 2012 visitation database (http://irma.nps.gov)
CalTrans 2011 Average Daily Traffic (ADT) counts database (http://traffic-counts.dot.ca.gov
California Energy Commission (http://www.energy.ca.gov/maps/ .

6.5.4 ASSESSMENT OF LOCAL VULNERABILITY AND POTENTIAL LOSSES

Assessment of local vulnerability will not be included in the "State of California Volcanic Hazards Identification, Risk Analysis, and Concept of Operations Annex to the State Emergency Plan". It is anticipated that the information provided in this new statewide plan will help local governments with their assessments, however. At this time, the 2013 SHMP team is not aware of any vulnerability or loss estimates completed at the local level.

Current GIS analysis of land use data indicates that the following state agencies and local jurisdictions have land holdings within one or more volcano hazard areas: California Department of Fish and Wildlife (CDFW), California Department of Forestry and Fire Protection (CAL FIRE), California Department of Parks and Recreation , State Lands Commission and the counties of: *Alpine, Fresno, Imperial, Inyo, Lake, Lassen, Madera, Mariposa, Modoc, Mono, Plumas, Shasta, Siskiyou, Sonoma, Tehama, Trinity and Tuolumne.*

Information related to community vulnerability and loss assessments may also be found in Local Hazard Mitigation Plans.

6.5.5 CURRENT VOLCANO HAZARD MITIGATION EFFORTS

Establishment of robust volcano monitoring networks and effective warning schemes are essential mitigation measures. The USGS monitors hazardous volcanoes and responds to volcanic crises under Congressional mandate (Public Law 93-288), which requires the USGS to issue "timely warnings" of potential volcanic hazards to responsible emergency management authorities and to the populace affected.

The USGS California Volcano Observatory, or CalVO, headquartered in Menlo Park, California obtains and interprets data from real-time monitoring sensors (seismometers, continuously recording GPS receivers, tiltmeters, and/or strain meters) installed on California's high-to-moderate threat volcanoes, although network coverage is minimal at some locations (See monitoring capabilities and data at http://volcanoes.usgs.gov/observatories/calvo/). The sensor networks automatically and continually relay data to CalVO for scientific interpretation. Information is communicated to emergency response agencies and the public using alert level schemes for ground-based and airborne hazards (Tables 6.M and 6.N).

Table 6.M: Ground-Based Volcanic Hazard Alert Levels

Volcano Alert Levels Used by USGS Volcano Observatories

Alert Levels are intended to inform people on the ground about a volcano's status and are issued in conjunction with the Aviation Color Code. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption and about potential or current hazards and likely outcomes.

Term	Description
NORMAL	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
ADVISORY	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
WATCH	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway but poses limited hazards.
WARNING	Hazardous eruption is imminent, underway, or suspected.

Table 6.N: Airborne Volcanic Hazards Alert Levels

Aviation Color Code Used by USGS Volcano Observatories

Color codes, which are in accordance with recommended International Civil Aviation Organization (ICAO) procedures, are intended to inform the aviation sector about a volcano's status and are issued in conjunction with an Alert Level. Notifications are issued for both increasing and decreasing volcanic activity and are accompanied by text with details (as known) about the nature of the unrest or eruption, especially in regard to ash-plume information and likely outcomes.

Color	Description
GREEN	Volcano is in typical background, noneruptive state or, *after a change from a higher level,* volcanic activity has ceased and volcano has returned to noneruptive background state.
YELLOW	Volcano is exhibiting signs of elevated unrest above known background level or, *after a change from a higher level,* volcanic activity has decreased significantly but continues to be closely monitored for possible renewed increase.
ORANGE	Volcano is exhibiting heightened or escalating unrest with increased potential of eruption, timeframe uncertain, **OR** eruption is underway with no or minor volcanic-ash emissions [ash-plume height specified, if possible].
RED	Eruption is imminent with significant emission of volcanic ash into the atmosphere likely **OR** eruption is underway or suspected with significant emission of volcanic ash into the atmosphere [ash-plume height specified, if possible].

A no-cost, email-based Volcano Notification Service (VNS) is available to agencies, businesses, and the public by registering online at http://volcanoes.usgs.gov/vns/help.php. VNS sends monthly volcano status updates to subscribers and other posts as warranted, including notification of alert level changes, details of volcanic unrest, and eruption information.

6.5.6 OPPORTUNITIES FOR ENHANCED VOLCANO HAZARD MITIGATION

At its most immediate, volcanic hazard mitigation requires effective volcano monitoring and communication protocols, but long-term mitigation requires wise land-use decisions that take into account proximity to high threat volcanoes. Up-to-date, scientifically sound hazard zone maps are integral to wise long-term decision-making. Identifying existing infrastructure, operations, resources, cultural assets, and populations within designated volcanic hazard zones is a critical first step in mitigation. Establishing robust communication protocols for obtaining volcano alert notifications and status reports from the USGS California Volcano Observatory are key to situational awareness. Fortunately, volcanoes usually exhibit many weeks to many months of precursory unrest providing informed and well-prepared communities sufficient time to respond effectively.

6.6 OTHER HAZARDS

6.6.1 AGRICULTURE PESTS AND DISEASES

Identifying Insect Pests Hazards

California agriculture is at risk from pests and diseases that, under the right circumstances, can cause severe economic, environmental, or physical harm. Table 6.O identifies pests and diseases of concern.

Table 6.O: California Agriculture Pests and Diseases

Dangerous to	Pests and Diseases
Plants and Crops	Asian citrus pysillid/ Huanglong Bing (HLB) disease, Asian longhorn beetle, Caribbean fruit fly, glassy-winged sharp shooter/Pierce's Disease, European Grapevine Moth, guava fruit fly, gypsy moth, Japanese beetle, Mediterranean fruit fly, melon fruit fly, Mexican fruit fly, olive fruit fly, oriental fruit fly, bark beetle
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 Spongeform Encephalopathy, zoonotic animal viruses

Source: http://www.cdfa.ca.gov/PHPPS/pdep/target_pests.html
Source: http://www.cdfa.ca.gov/ahfss/Animal_Health/pdfs/CA_Reportable_Disease_List_Poster.pdf

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. They can also cause significant increases in food prices for consumers due to shortages. In addition, insect pests and diseases such as 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.

Profiling Pest and Disease Hazards

Asian Citrus Psyllid

The Asian citrus psyllid (ACP) is a pest that acts as a carrier or vector spreading "Huanglongbing" (HLB), 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 ACP damages citrus by withdrawing large amounts of sap from the plant and producing copious amounts of honeydew. The honeydew coats the leaves of the tree, encouraging sooty mold to grow. However, the most serious damage caused by ACP is due to its ability to effectively introduce a harmful bacterium that causes Huanglongbing (HLB) disease. HLB is the most devastating disease of citrus in the world. HLB renders the fruit of the infected tree unusable. In a recent study in Florida, the presence of HLB increased citrus production costs by 40 percent (Irey et al. 2008). It is estimated that over the last five years in Florida, HLB has caused the loss of over 6600 jobs, over $1.3 billion in lost revenue to the citrus industry, and the loss of over $3.6 billion in total economic activity (Hodges and Spreen 2012).

California is currently actively eradicating the ACP, and has identified only one plant infected with HLB.

Foot and Mouth Disease

Foot and Mouth Disease (FMD) is a debilitating disease affecting all cloven–hoofed animals, including cattle, pigs, and sheep. Clinical signs commonly seen in cattle are drooling, lip smacking, and lameness, caused by blisters (vesicles) on the tongue, dental pad and feet. Sheep and pigs have similar, but often less pronounced, clinical signs.

Many nations in the world are either endemic for various strains of FMD virus or currently dealing with FMD outbreaks. As of July 12, 2012, countries that have recently dealt with outbreaks but now declared resolved by the World Organization for Animal Health (OIE) include: Israel (April 3, 2012), Paraguay (January 9, 2012), Zambia (April 2, 2012) and Russia (April 11, 2012). Countries that are identified as having continuing FMD infection include: Angola, Botswana, People's Republic of China, Chinese Taipei, Egypt, Kazakhstan, Libya, Mozambique, Namibia, and South Africa. The Republic of Korea (South Korea) was identified as FMD infected in 2011 with a last reported case occurring on April 21,2011 and no additional infection since that time indicating resolution. Vietnam and the Palestine Autonomous Territories have been identified as endemic with periodic reporting. Note there are other countries where FMD is endemic, but they are not currently being tracked via OIE's "Immediate Notification and Follow-ups" reports.

Globally, the FMD virus situation changes quickly; the most current information is available in the OIE/World Animal Health Information Database. (http://www.oie.int/). The California Department of Food and Agriculture (CDFA) and the United States Department of Agriculture (USDA) work cooperatively to closely 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 do not respect 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 last outbreak of Foot and Mouth Disease in California was in 1929.

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 an abnormal protein, known as a prion, causes BSE. Scientific evidence shows the same disease agent that causes BSE in cattle also causes the new human disease, variant Creutzfeldt–Jakob disease. 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.

The National Veterinary Services Laboratory in Ames, Iowa, confirmed that a routine surveillance sample obtained 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.

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.

Assessment of State Vulnerability and Potential Losses

No known state vulnerability or loss assessment is available at this time.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

Current Insect Pests Hazard Mitigation Efforts

The California Department of Food and Agriculture (CDFA) has extensive responsibilities to protect the food supply, including protecting and responding to the invasion of plant diseases and pests. As part of the Plant Health and Pest Prevention Services and Pierce's Disease Control Program, CDFA administers the statewide exterior exclusion program, border protection stations, pest detection and emergency projects, trapping, interior exclusion quarantine programs, and Integrated Pest Control weed eradication and biological control program.

The prevention, detection, immediate containment, and eradication of emergency animal diseases are high priorities. Some animal diseases have human health implications, and all affect production and marketability of livestock and poultry. Therefore addressing animal disease contributes to a solid foundation for economic prosperity while decreasing human health risks for the people of California. Activities to achieve these goals include outreach and educational services, routine disease surveillance and disease investigations to detect the introduction and spread of injurious animal pests and diseases, and, when necessary, implementation of animal quarantine to control the spread of disease.

The California Conservation Corps assists in mitigating the impacts of insect pests by providing human resources to assist in state and local eradication efforts, including surveying private yards and business landscapes to detect the Glassy Winged Sharpshooter, striping citrus fruit infected by the Mexican Fruitfly, and helping eradicate the Exotic Newcastle Disease by cleaning and disinfecting backyards.

California county agriculture commissioners are charged with the protection of California agriculture, the environment, and the public's health and safety. These goals are accomplished through the management of programs that combine public outreach, industry, education, and enforcement actions. County agricultural commissioners carry out the following programs to accomplish these aims: Pest Exclusion, Pest Detection, Pest Eradication, Pest Management, Pesticide Enforcement, Seed Certification, Nursery Inspection, Fruits, Nuts and Vegetable Standardization, Egg Inspection, Apiary Inspection, and Crop Statistics.

CDFA licenses the agricultural commissioners and maintains a liaison office to ensure close coordination with the commissioners individually and as a group.

Agricultural pests and diseases are an economic hazard and, in some cases, a hazard to human health. Mitigation for pests and diseases should include an integrated pest management strategy. For additional information visit:
www.ipm.ucdavis.edu/GENERAL/tools.html
http://cadms.ucdavis.edu/
http://www.vetmed.ucdavis.edu/vetext/index.cfm

Progress Summary 6.M: Initiatives and Technology

Progress as of 2013:

California Forest Pest Council
In November 2010, the California Forest Pest Council created a California Firewood Task Force to limit the movement of firewood to help slow the spread of tree pests. The Task Force is conducting a "Buy It Where You Burn It" campaign. The campaign stresses the following messages:

- Leave firewood at home - do not transport it to campgrounds or parks

- Use firewood from local sources - that means the wood was cut within 50 miles of where it will be burned
- Bring only what you will need, and burn responsibly.

For more information visit: http://www.firewood.ca.gov/

Pest Reporting App
The pest reporting app provides the ability to photograph and report suspected harmful pest to state and local agricultural officials. Using camera and GPS technology, the app provides CDFA invasive species specialists with valuable visual information.

The mobile app is connected to CDFA's "Report a Pest" database where an invasive species specialist can identify and return a contact back to the citizen. Owners of IPads and IPhones can choose to use GPS coordinates to show the location of the find, allowing the department to respond quickly to invasive pest emergencies. For more information visit: http://www.cdfa.ca.gov/apps/reportapest.html

Opportunities for Enhanced Insect Pests Hazard Mitigation

CDFA is using USDA Specialty Crop Block grants to leverage state and local efforts for research and public outreach programs.

6.6.2 DAM FAILURE

Identifying Dam Failure Hazards

Dam failure is the uncontrolled release of impounded water from behind a dam. Flooding, earthquakes, blockages, landslides, lack of maintenance, improper operation, poor construction, vandalism, and terrorism can all cause a dam to fail. Dam failure causes downstream flooding that can affect life and property.

Profiling Dam Failure Hazards

Dams and reservoirs of jurisdictional size are defined in the California Water Code Sections 6000 through 6008. There are currently more than 1,400 dams of jurisdictional size in California. Approximately 1,250 of these dams are under the jurisdiction of California's Department of Water Resources, Division of Safety of Dams. Dams and reservoirs owned by the federal government are not subject to state jurisdiction except as otherwise provided by federal law. In California, there are currently 149 dams owned by federal government agencies such as the United States Forest Service (USFS), Bureau of Reclamation (USBR), Army Corps of Engineers (USACE), and the U.S. military.

Los Angeles leads the state as being the county with the most jurisdictional-size dams, with 100 dams. The county of Sonoma is second behind Los Angeles with 63 dams. Del Norte County is the only county in the state having no dams of jurisdictional size.

The term "dam failure" encompasses a wide variety of circumstances. Situations that would constitute a dam failure vary widely, from developing problems to a partial or catastrophic collapse of the entire dam. Potential causes of a dam failure are numerous and can be attributed to deficiencies in the original design of the dam, the quality of construction, the maintenance of the dam and operation of the appurtenances while the dam is in operation, and acts of nature including precipitation in excess of the design, flood, and damage from earthquakes. Water over-topping the dam crest is a common cause of failure in earth dams. Overtopping will cause erosion of the dam crest and eventual dam breach. Piping of earth dams is another common form of failure. Piping is a form of erosion that occurs underground caused by rodent burrowing and the presence of extensive root systems from vegetation growing on and around the dam.

In the past 50 years, there have been only a small number of dam failures in California. The most catastrophic dam failure in California's history is that of the infamous St. Francis Dam in Los Angeles County, which failed in March 1928 shortly after construction of the dam was completed. This failure resulted in the deaths of more than 450 people and destruction of nearly 1,000 homes and buildings. Numerous roads and bridges were also destroyed and/or damaged beyond repair. The Division of Safety of Dams came into existence as a direct result of this catastrophe. Other significant dam failures in California's history include Baldwin Hills in 1963 and the near-failure of the Lower San Fernando Dam in 1971.

Assessment of State Vulnerability and Potential Losses

No assessment of state vulnerability or potential losses is available at this time.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans. Local planning departments have access to the state's inventory of inundation maps, which are kept on a server and published annually as DVDs. These DVDs are provided without cost to both governmental agencies and non-governmental parties upon request.

Current Dam Failure Hazard Mitigation Efforts

Since 1929, the state has supervised all non-federal dams in California to prevent failure for the purpose of safeguarding life and protecting property. Supervision is carried out through the state's Dam Safety Program under the jurisdiction of DWR. The legislation requiring state supervision was passed in response to the St. Francis Dam Failure and concerns about the potential risks to the general populace from a number of water storage dams. The law requires:

- Examination and approval or repair of dams completed prior to August 14, 1929 (the effective date of the statute)
- Approval of plans and specifications for and supervision of construction of new dams and the enlargement, alteration, repair, or removal of existing dams
- Supervision of maintenance and operation of all dams under the state's jurisdiction

The 1963 failure of the Baldwin Hills Dam in Southern California led the legislature to amend the California Water Code to include within state jurisdiction both new and existing off-stream storage facilities. Dams and reservoirs subject to state supervision are defined in California Water Code Sections 6002 through 6004, with exemptions defined in Sections 6004 and 6025. In administering the Dam Safety Program, DWR must comply with the provisions of the California Environmental Quality Act (CEQA). As such, all formal dam approval and revocation actions must be preceded by appropriate environmental documentation.

In 1972, Congress moved to reduce the hazards from the 28,000 non-federal dams in the country by passing Public Law 92-367, the National Dam Inspection Act. With the passage of this law, Congress authorized the USACE to inventory dams located in the United States. The action was spurred by two disastrous earthen dam failures during the year in West Virginia and South Dakota that caused a total of 300 deaths.

The Water Resources Development Act of 1986 (Public Law 99-662) authorized the USACE to maintain and periodically publish an updated National Inventory of Dams (NID). The Water Resources Development Act of 1996 (Public Law 104-303), Section 215, re-authorized periodic updates of the NID by the USACE. Section 215 further established the National Dam Safety Program and named the Administrator of FEMA as its coordinator. The Dam Safety Act of 2006 (Public Law 109-460) reauthorized the National Dam Safety Program through 2011.

FEMA has recently launched an effort under its Risk MAP program to communicate risk of dam failure and to coordinate state and private mitigation and preparedness efforts. According to FEMA's James Demby,

most people living downstream of a dam are unaware of the potential hazards associated with dam failure, have never seen the respective dam failure inundation map, and are unaware of an evacuation plan or an Emergency Action Plan associated with the failure of that dam. There is a need, therefore, to include dam failure risk awareness as part of a comprehensive flood risk communication strategy and develop a communication strategy that reports on dam failure risk and promotes dam safety. The audience for these strategies includes dam owners/operators, dam regulators, emergency managers, floodplain managers, planners, public and private decision makers, and the population at risk.[64]

Mitigation of dam failure is constantly occurring at both the federal and state level. For example, the U.S. Bureau of Reclamation is planning to replace the longest earthen section of Folsom Lake's dam in order to mitigate earthquake damage. At the state level, officials are currently reviewing an $84 million project to remove a 106-foot-high dam on the Carmel River to mitigate earthquake damage and deal with flood safety issues. These are just two examples of the numerous dam mitigation projects currently being undertaken.

Engineers and engineering geologists at the California Division of Safety of Dams review and approve plans and specifications for the design of dams and oversee their construction to ensure compliance with the approved plans and specifications. Reviews include site geology, seismic setting, site investigations, construction material evaluation, dam stability, hydrology, hydraulics, and structural review of appurtenant structures. In addition, division engineers inspect over 1,200 dams on a yearly schedule to ensure they are performing and being maintained in a safe manner. More information can be found at:
www.water.ca.gov/damsafety/index.cfm

There are 696 high hazard dams in the state. For the period 2007-2009, remediation needs were identified at 45 dams, of which 30 are high hazard. Remediation was completed at 77 dams, of which 51 are high hazard. The remediation included work to address remediation needs identified before 2007. As of July 2010, remediation was under way (i.e., identified or under construction) at 102 dams, of which 72 are high hazard.

Opportunities for Enhanced Dam Failure Hazard Mitigation

Cal OES is required by state law to work with other state and federal agencies, dam owners and operators, floodplain managers, planners, and the public to make available dam inundation maps for the benefit of citizens interested in learning their dam failure inundation risk. Dam inundation maps can be useful in the preparation of Local Hazard Mitigation Plans (LHMPs) and general plan safety element (and all elements of a general plan, whether mandatory or optional, must be consistent with one another) updates. An opportunity for enhanced outreach to local governments and the public lies with inclusion of digital dam inundation mapping data on the MyPlan website under design by Cal OES (see Chapter 3, Section 3.5.5).

6.6.3 EPIDEMIC/PANDEMIC/VECTOR BORNE DISEASE HAZARDS

Identifying Epidemic/Pandemic/Vector-Borne Diseases

Pandemic Flu

Influenza, also known as the flu, is a disease that attacks the respiratory system (nose, throat, and lungs) in humans. Although mild cases may be similar to a viral "cold," influenza is typically much more severe. It usually comes on suddenly; may include fever, headache, tiredness (which may be extreme), dry cough, sore throat, nasal congestion, and body aches; and can result in complications such as pneumonia. Seasonal influenza is a yearly occurrence that kills primarily persons aged 65 and older and those with chronic health

[64] James E. Demby, Jr., PE, FEMA ,"Dam Failure – the Other Flood Hazard." Presentation, 2009 American Planning Association National Planning Conference, Minneapolis, April 25-29, 2009.

conditions. Those who are exposed but do not succumb develop immunity to the strain circulating that year.

Worldwide pandemics of influenza occur when a novel virus emerges to which the population has little immunity. The 20th century saw three such pandemics, the most notable of which was the 1918 Spanish influenza pandemic that was responsible for 20 million deaths throughout the world.

Secondary impacts include significant economic disruption that can occur due to loss of employee work time and costs of treating or preventing spread of the flu.

Vector Borne Diseases

The Vector Borne Disease Section of the California Department of Public Health identifies 17 types of vector borne diseases as follows:

- *Africanized Honeybees.* Africanized honeybees (AHB) are a strain of bees that were imported from Africa into South America in the 1950s and have since spread north into Central and North America. AHB resemble other honeybees but are more aggressive and prone to swarm if provoked. A swarm of AHB can inflict hundreds of stings within a few seconds. Serious allergic reaction and possibly death can result in adults, children, or domestic animals who are stung after disturbing an AHB colony

- *Bed Bugs.* Bed bugs are small parasitic insects that feed on the blood of mammals and birds. Bed bugs live in mattresses, linens, and headboards, as well as in the walls, flooring, and other furniture in areas where people sleep in homes, hotels, and other dwellings. Because bed bugs usually feed at night when people are sleeping, most people do not realize they were bitten. The only evidence that a person was bitten may be itchy welts that appear a few days later. Bed bugs do not transmit disease, but they are a nuisance and infestations should be controlled by a licensed pest control operator.

- *Body Lice.* Body lice are small insects that live on the body and in the clothing or bedding of humans. They feed only on human blood. Homeless persons who cannot get clean changes of clothes or take a bath or shower regularly are at risk for getting body lice.

- *Cat Scratch Disease.* Cat Scratch Disease (CSD) is an infection caused by Bartonella henselae bacteria. In healthy people, it most often causes a swollen lymph node and mild illness. The domestic cat is the animal that carries the CSD bacteria, which are transmitted between cats by the cat flea. People can get CSD when they are bitten or scratched by a cat with a flea infestation. The feces of cat fleas contain the CSD bacteria. A person can become infected when the flea feces enter a break in the skin during a cat scratch or bite. Direct contact with cat fleas is unlikely to be a cause of infection. Infected cats usually do not look sick.

- *Conenose Bugs.* Conenose bugs (also known as kissing bugs or Mexican bedbugs) are night-time blood sucking insects that feed on small wild mammals, but will also bite humans. Adults are ½ to ¾ inch long, dark brown to black in color, have wings neatly folded on their backs, and have an elongated, coneshaped head. Conenose bugs usually live in woodrat nests. They are found in the foothill areas surrounding the Central Valley and throughout the desert and foothill regions of Southern California. In rural and suburban communities near wildland habitats where woodrats live, conenose bugs may leave woodrat nests and enter homes. Adult conenose bugs are strongly attracted to lights.

- *Hantavirus Cardiopulmonary Syndrome.* Hantavirus Cardiopulmonary Syndrome (HCPS) is a potentially severe disease of the lungs that was first recognized in 1993 in the "Four Corners" area of the southwestern United States (where Utah, Colorado, Arizona, and New Mexico meet). The disease is

caused by a virus called Sin Nombre that is carried by wild mice and shed in their feces, urine, and saliva. HCPS is a rare, but often fatal, disease.

- *Head lice.* Head lice are small insects that live in people's hair and feed on their blood. Lice glue their eggs, or "nits," to hair so that the nits do not get brushed off. Lice die quickly (within two days) without feeding so they cannot live very long away from a person's head. Nits take six to nine days to hatch, and the lice take seven or more days to become egg-laying adults. Children and adults can give head lice to other children or adults when they share combs, hats, clothing, barrettes, helmets, scarves, headphones, or other personal items. Head lice are a problem in homes, day care centers, elementary, and preschools. Children are much more likely to get lice from family members and playmates than from classmates at school.

- *Lyme Disease.* Lyme disease is caused by a spirochete (a corkscrew shaped bacteria) called Borrelia burgdorferi and is transmitted by the western black-legged tick. Lyme disease was first described in North America in the 1970s in Lyme, Connecticut, the town for which it was then named. This disease has since been reported from many areas of the country, including most counties in California.

- *Mosquitoes.* Mosquitoes are small blood-sucking insects that depend on standing water to reproduce. Female mosquitoes must feed on blood to lay eggs. They feed by sticking their mouthparts into the skin of an animal, and rapidly sucking blood. Sometimes mosquitoes carry germs like viruses that can be transmitted to a person while the mosquito is feeding. Preventing mosquitoes from breeding and avoiding mosquito bites are the best ways to avoid getting these diseases. Although 12 mosquito-borne viruses are known to occur in California, only West Nile virus (WNV) western equine encephalomyelitis virus (WEE), and St. Louis encephalitis virus (SLE) are significant causes of human disease.

- *Murine Typhus.* Murine Typhus is a bacterial illness transmitted by fleas from wild rats or opossums. Typhus is typically a mild illness, is readily treated with antibiotics, and rarely results in death. Only a dozen or so cases are reported each year in California and most of these are in residents of a few small areas in the Los Angeles basin. Persons living in areas endemic for typhus should avoid contact with opossums and maintain proper flea control on their outdoor pets.

- *Plague.* Plague is a bacterial disease that people can get if they are bitten by an infected rodent flea. Most people with plague develop fever and swollen lymph nodes. Plague is treatable with antibiotics, but can progress to severe and sometimes fatal illness if diagnosis and treatment are delayed. Squirrels, chipmunks, and other rodents in many areas of California can carry plague. Persons visiting, hiking, or camping in these areas should avoid contact with rodents.

- *Ticks.* Ticks are small, insect-like creatures most often found in naturally vegetated areas. Ticks feed by attaching to animals and humans, sticking their mouthparts into the skin, and sucking blood for up to several days. There are many different kinds of ticks in California, but only six kinds are known to commonly bite humans. Sometimes these ticks carry bacteria or viruses that can be transmitted to a person while the tick is attached and feeding. Avoiding tick-bites is the best way to avoid getting these diseases.

- *West Nile Virus.* West Nile virus (WNV) is a mosquito-borne disease first detected in the United States in 1999. This disease is also found in Africa, Asia, the Middle East, Canada, and Mexico. WNV first appeared in California in 2002 and by 2004 had spread to all 58 counties. Infection by WNV is minimized through the concerted actions of local and state public health and vector control agencies. People can protect themselves by taking precautions to avoid being bitten by mosquitoes.

- *Red Imported Fire Ants.* Red imported fire ants (RIFA) are highly aggressive insects that were introduced into the United States from South America in the 1920s. Today, RIFA have spread

throughout the southeastern United States. In California, RIFA colonies have been found in nurseries, orchards, and other agricultural areas in Los Angeles, Riverside, and Orange Counties, as well as some parts of the San Joaquin Valley. These small (less than 1/4 inch) reddish brown ants live in large colonies that resemble mounds of sand. Thousands of RIFA will swarm to defend their colony if it is disturbed. Illnesses following RIFA bites depend on the number of bites sustained and can range from small painful welts to severe allergic reactions requiring immediate medical attention.

- *Scabies.* Scabies is an infestation of the skin caused by parasitic mites called Sarcoptes scabei. Scabies mites are found worldwide and can affect all races and socioeconomic classes in all climates. The female mite burrows under the top layer of the skin to lay eggs and can remain there for two months. The eggs hatch and become adult mites within ten days and can continue the infestation until proper treatment is applied.

- *Swimmer's Itch.* Swimmer's itch is an allergic reaction to a small parasite called a blood fluke. These tiny parasites are released from infected snails into fresh and salt water such as lakes, ponds, and ocean bays. Normally, the blood flukes infect a bird or mammal by burrowing into these animals' skin. Sometimes the blood flukes may burrow into the skin of people wading, playing, or swimming in infested shallow waters. After entering the skin of people, the flukes die, causing an allergic reaction that results in intense itching, a rash, and sometimes small blisters.

- *Tularemia.* Tularemia is an infectious bacterial disease (Francisella tularensis). Tularemia is usually a disease of wild animals, but severe illness and death may also occur in humans. The bacterium that causes tularemia is common in various kinds of ticks and in small and medium-sized mammals, especially rabbits, hares, beavers, muskrats, and voles. In the United States, there are two main sources of infection for humans: 1) bites by ticks or biting flies, and 2) contact with infected animals or their carcasses, especially the cottontail rabbit. People may also become infected from eating improperly cooked rabbit or hare meat or from contact with contaminated water, dust, hay, mud, or animal bites. The disease is not spread from human-to-human.

Although all of these vector borne diseases occur in California, only those that cause a significant risk to people are discussed further in this section, these include West Nile virus, Hanta Virus Cardiopulmonary Syndrome (HCPS) and Lyme disease. Additional information about the other vector borne diseases can be found at the California Department of Public Health website:
http://www.cdph.ca.gov/programs/vbds/Pages/default.aspx

Profiling Epidemic/Pandemic/Vector-Borne Diseases

Pandemic Flu

The year 2009 saw the rise of H1N1, popularly referred to as the swine flu. According to the California Center for Infectious Diseases, the H1N1 flu (2009 H1N1 influenza virus) is a type of influenza virus that causes respiratory disease that can spread between people. While most people who have been sick have recovered without needing medical treatment, hospitalizations and deaths from infection with this virus have occurred. Spread of H1N1 flu occurs in the same way that seasonal flu spreads. Flu viruses are spread mainly from person to person through coughing or sneezing by people with influenza. As a result of preparation and mitigation strategies such as vaccinations and public education, the threat of a full-blown H1N1 pandemic in the U.S. is receding. The possibility for a pandemic still exists, however.

A previous pandemic flu threat that still looms is the Avian Flu. Birds can contract Avian Flu and pass it along to humans. Some strains of the Avian Flu are more virulent than others. Public health experts continue to be alert to the risk of a possible re-emergence of a 2003 epidemic of Avian Flu among people primarily in Asia. People who had been in very close contact with infected birds (for example, people who lived with

chickens in their houses) contracted a virulent form of Avian Flu and there was a significant death rate from this disease. Thus far, the Avian Flu virus has not mutated and has not demonstrated easy transmission from person to person. However, were the virus to mutate in 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 influenza outbreak. Such a pandemic could disrupt all aspects of society and severely affect the economy.

Vector Borne Disease

Mosquito -Borne Viruses

Mosquito-borne viruses belong to a group of viruses commonly referred to as arboviruses (for arthropod-borne). Although 12 mosquito-borne viruses are known to occur in California, only West Nile virus (WNV), western equine encephalomyelitis virus (WEE) and St. Louis encephalitis virus (SLE) are significant causes of human disease. WNV continues to seriously affect the health of humans, horses, and wild birds throughout the state. Since 2004, there have been 3,622 WNV human cases with 129 deaths and 1,188 horse cases. Consequently, the California Arbovirus Surveillance Program emphasizes forecasting and monitoring the temporal and spatial activity of WNV, WEE, and SLE. These viruses are maintained in wild bird-mosquito cycles that do not depend upon infections of humans or domestic animals to persist. Surveillance and control activities focus on this maintenance cycle.[65]

West Nile virus (WNV) first appeared in the United States in 1999 in New York and rapidly spread to many regions of California in subsequent years. California has historically maintained a comprehensive mosquito-borne disease surveillance and control program. In anticipation of the arrival of WNV, the Department of Public Health, in consultation with local mosquito and vector control agencies, developed a Mosquito-Borne Disease Surveillance and Response Plan. WNV first appeared in California in 2002 with the identification of one human case. In 2003, three human cases occurred in California and WNV activity was detected in six southern counties. By 2004, WNV activity was observed in all 58 counties in California and 830 human infections were identified.

In 2012, 479 human West Nile Virus (WNV) cases were identified from 31 counties: Alameda (2), Butte (10), Colusa (3), Contra Costa (4), Fresno (24), Glenn (7), Imperial (1), Kern (25), Kings (3), Lake (1), Los Angeles (163), Madera (3), Merced (13), Monterey (1), Orange (42), Placer (12), Riverside (19), Sacramento (30), San Bernardino (32), San Diego (1), San Francisco (1), San Joaquin (13), Shasta (1), Solano (2), Stanislaus (26), Sutter (8), Tehama (4), Tulare (7), Ventura (7), Yolo (10), and Yuba (4). Twenty cases resulted in human death.

Table 6.P: West Nile Virus Activity 2003-2012

Element	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	*Total*
Human cases (fatal)	3[1] (0)	779 (29)	880 (19)	278 (7)	380 (21)	445 (15)	112 (4)	111 (6)	158 (9)	479 (20)	*3,625 (130)*
Horses	1[2]	540	456	58	28	32	18	19	15	22	*1,189*
Dead birds	96	3,232	3,046	1,446	1,396	2,569	515	416	688	1,644	*15,048*
Mosquito samples	32	1,136	1,242	832	1,007	2,003	1063	1305	2087	2,849	*13,556*
Sentinel chickens	70	809	1,053	640	510	585	443	281	391	540	*5,322*
Squirrels	-	49	48	32	26	32	10	24	24	23	*268*

[1] *Plus twenty imported human cases.*
[2] *Plus three imported horse cases*

Table 6.P summarizes WNV activity for the period of 2003 to2012. To date in 2013, 14 human cases of WNV have been reported. Those cases occurred in Glenn (2), Los Angeles (7), Sacramento (2), Solano (1),

[65] California Mosquito-Borne Virus Surveillance & Response Plan

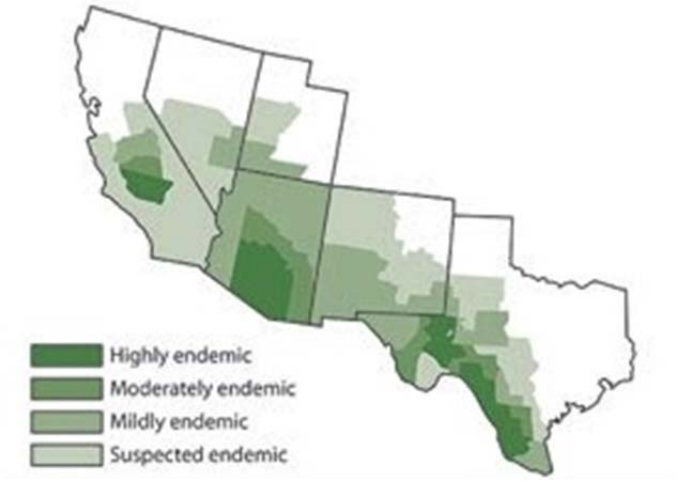
Riverside (1), Yolo (1). Current information on incidence of WNV in 2013 is available on the website maintained by the Department of Public Health at: www.westnile.ca.gov

Valley Fever

Valley fever is caused by Coccidioides, a fungus that lives in the soil in the southwestern United States and parts of Mexico, Central America, and South America. Inhaling the airborne fungal spores can cause an infection called coccidioidomycosis, which is also known as "cocci" or "valley fever." Most people who are exposed to the fungus do not get sick, but some people develop flu-like symptoms that may last for weeks to months. In a very small proportion of people who get valley fever, the infection can spread from the lungs to the rest of the body and cause more severe conditions, such as meningitis or even death. Valley fever cannot spread from person to person.

Most cases of valley fever in the US occur in people who live in or have traveled to the southwestern United States, especially Arizona and California. Map 6.S below, which was generated from studies in the 1950s, shows the areas where the fungus that causes valley fever is thought to be endemic, or native and common in the environment. The full extent of the current endemic areas is unknown and is a subject for further study.

MAP 6.S: Valley Fever Endemic Areas in the Southwestern U.S.



Source: http://www.cdc.gov/features/valleyfever/

A March 2013 Morbidity and Mortality Weekly Report published by the Centers for Disease Control (CDC) notes that more than 20,000 cases of valley fever are reported each year in the United States, but many more cases likely go undiagnosed. Some researchers estimate that each year the fungus infects more than 150,000 people, many of whom are sick without knowing the cause or have cases so mild they are not detected.

The annual number of cases has been increasing in recent years, possibly because of higher numbers of people exposed to the fungus or because of changes in the way cases are being detected and reported.

Anyone, including children, can get valley fever, but it is most common among older adults, particularly those 60 and older. People who have recently moved to an area where the disease naturally occurs are at higher risk for infection. Several groups of people are at higher risk for developing the severe forms of valley fever; these groups include, African Americans, Asians, women in their third trimester of pregnancy, and people with weak immune systems, including those with an organ transplant or who have HIV/AIDS.

Additional information about valley fever may be found at: http://www.cdc.gov/features/valleyfever/

Lyme Disease

As already noted above, lyme disease is caused by a spirochete (a corkscrew- shaped bacteria) called Borreliaburgdorferi and is transmitted by the westernblack-legged tick. Lyme disease was first described in North America in the 1970s in Lyme, Connecticut, the town for which it was then named. This disease has since been reported from many areas of the country, including most counties in California. Additional information about Lyme disease may be found at:
http://www.cdph.ca.gov/programs/vbds/Pages/default.aspx

Assessment of State Vulnerability and Potential Losses

The impact of an actual epidemic, pandemic or vector borne disease outbreak cannot be predicted precisely, as it will depend on the virulence of the virus, speed at which the virus spreads, the availability of vaccines and antivirals, and the effectiveness of medical and non-medical containment measures.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments may be found in Local Hazard Mitigation Plans.

Current Epidemic/Pandemic/Vector-Borne Disease Hazard Mitigation Efforts

Pandemic Flu

The California Department of Public Health (CDPH) is the lead pandemic planning agency in the state. It coordinates the public health response to a pandemic with local health departments, the health care community, the federal government, and other key partners. CDPH prepared a Pandemic Preparedness Plan, which will be implemented in collaboration with the Emergency Medical Services Authority (EMSA), California Health and Human Services Agency, Cal OES, local health departments, and tribal entities. While primarily a preparedness and response plan, the plan also identifies potential mitigation actions that can be taken to reduce the impacts of the pandemic, including:

- Ensuring rapid and early detection of a novel virus
- Confirming the identity or type of a novel virus by laboratory identification
- Identifying the exposure source of the outbreak and the population at risk
- Controlling and containing the spread of influenza through pharmaceutical and non-pharmaceutical community containment strategies, including isolation, quarantine, infection control, antiviral treatment and prophylaxis, and, if available, vaccination
- Managing and disseminating accurate information for scientific, resource, and policy decisions in public health and healthcare delivery settings

In 2009, the Governor established a Cabinet Pandemic Influenza Working Group that meets monthly to report on H1N1 activity and review the state's response. The California Health and Human Services Agency (CHHS) and Cal OES decided to continue prior statewide planning efforts initiated to meet Centers for Disease Control (CDC) grant requirements to benchmark the level of state agency preparedness and response through preparation of the Statewide Concept of Operations for Pandemic Influenza, a supplement to the CDPH Pandemic Influenza Response and Response Plan.

The Statewide Concept of Operations discusses communication and coordination at the local, state, and federal government levels. At the local level, the Statewide Concept of Operations includes checklists to assist with local government pandemic influenza preparedness, including alert and warning considerations and suggested response actions. At the state level, the Statewide Concept of Operations includes a

discussion of how public health and medical information should flow and how resources should be ordered among the levels of government. At the federal level, the Statewide Concept of Operations describes the established federal role in managing the Strategic National Stockpile, which is vital to pandemic influenza response planning and State Operations Center coordination.

The Statewide Concept of Operations emphasizes that all events begin at the local level and recommends that each local agency prepare a pandemic influenza operations plan. At the state level, the plan outlines 27 preparedness, response, and recovery objectives under three strategic goals as established by the CDC and outlines the agencies that have plans and procedures for each objective. The plan also includes a State Agency Responsibilities Matrix that lists the state agencies that have lead and support roles for each CDC objective. For more information, see:
http://www.chhs.ca.gov/Pages/Pandemicflu.aspx

Vector-Borne Diseases

The Vector-Borne Disease Section (VBDS) of the California Department of Public Health (CDPH) protects the health and well-being of Californians from diseases transmitted to people from insects and other animals. VBDS conducts prevention, surveillance, and control of vector-borne diseases, including Hantavirus Cardiopulmonary Syndrome, plague, Lyme disease, West Nile virus, and other tick-borne and mosquito-borne diseases.

VBDS staff, located in four regional offices and headquartered in Sacramento, provides the following services:

- Develop and implement statewide vector-borne disease surveillance, prevention, and control programs
- Design and conduct scientific investigations to further knowledge of vector-borne diseases in California
- Coordinate preparedness activities for detection and response to introduced vectors and vector-borne diseases, such as West Nile virus
- Conduct emergency vector control when disease outbreaks occur
- Advise local agencies on public health issues related to vector-borne diseases
- Oversee local vector control agency activities through a Cooperative Agreement
- Oversee the Vector Control Technician Certification and Continuing Education programs
- Provide information, training, and educational materials to governmental agencies and the public
- Provide assistance in coordinating issues related to the management of Africanized honey bees, red imported fire ants, head lice, and bed bugs

Progress Summary 6.N: California Mosquito-Borne Virus Surveillance and Response Plan

Progress as of 2013: The California Mosquito-Borne Virus Surveillance and Response Plan was developed by the California Department of Public Health in conjunction with the Mosquito & Vector Control Association of California and the University of California, Davis. Published in April 2013, the plan is designed to enhance the surveillance and response program for mosquito-borne viruses in California. Specifically, the plan:

- Provides guidelines and information on the surveillance and control of mosquito-borne viruses in California, including West Nile, St. Louis encephalitis, and western equine encephalomyelitis viruses;
- Incorporates surveillance data into risk assessment models;
- Prompts surveillance and control activities associated with virus transmission risk level;
- Provides local and state agencies with a decision support system; and
- Outlines the roles and responsibilities of local and state agencies involved with mosquito-borne virus surveillance and response.

The California Mosquito-Borne Virus Surveillance and Response Plan provides statewide guidelines which can be modified to meet local or regional conditions. The complete plan may be found at: http://www.cdph.ca.gov/programs/vbds/Pages/default.aspx

Opportunities for Enhanced Epidemic/Pandemic/Vector Borne Disease Hazard Mitigation

There are no additional opportunities identified at this time to prevent or mitigate the impacts of this hazard. Surveillance, monitoring, mosquito abatement and public education are the keys to mitigating these diseases.

6.6.4 HAZARDOUS MATERIALS RELEASE

Identifying Hazards Due to Release of Hazardous Materials

A hazardous material is defined in California's State Hazardous Materials Incident Contingency Plan (1991) 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; and/or pose a substantial present or potential hazard to humans or the environment."[66] Hazardous materials are one or more of the following: flammable, corrosive or an irritant, oxidizing, explosive, toxic (poisonous or infectious), thermally unstable or reactive, or radioactive. See Section 6.6.8 for discussion of radiological accidents.

Hazardous materials are ubiquitous in modern society and may be found at all stages of production, consumption, and disposal. Federal and state laws permit the intentional release of some hazardous materials into the environment, typically in quantities, in a form, and/or in locations such that the risk to human health and the environment is thought to be acceptable. However, sometimes releases are unintentional, resulting from leaks, accidents, or natural hazards. This section focuses on unintentional releases. Deliberate sabotage or terrorism are not covered here; see instead Section 6.6.9.

During the past two decades or so, increasing attention has been given to hazardous materials releases resulting from natural disasters. The term "natech" (an abbreviation for "natural disaster which triggers a technological accident") is generally used to refer to such releases. As pointed out by various authors including Lindell and Perry (1996), Young, Balluz, and Malilay (2004), and Steinburg, Sengul, and Cruz (2008), natechs are of particular concern because:

- They may have a simultaneous effect on many industrial facilities, overwhelming the capacity for response.
- Mitigation measures may fail (e.g., an outer containment system constructed to contain a release from within may itself be damaged so badly that it allows the hazardous material to escape)
- There may be cascading disasters, resulting in a "domino effect" (e.g., a fire in one facility may cause an explosion in a neighboring facility which in turn damages a third facility, and so on).
- Response personnel typically focus on search and rescue first and give attention to the presence of hazardous materials only secondarily, if at all.
- Response may be hindered by a disaster's impact on the physical environment (e.g., roadways may be cut or blocked; power lines and communication towers may be toppled).
- Determining the appropriate response may be difficult (e.g., it may not be obvious as to whether, following an earthquake, people should shelter in place for protection against a chemical release or be evacuated to avoid being harmed by aftershocks).

Profiling Hazardous Materials Release and Toxic Substance Hazards

Accidental hazardous materials releases occur many times during any given day. In 2012, the California State Warning Center received more than 11,000 reports on hazardous material incidents and potential

[66] Note that the term "toxic substance" is sometimes used interchangeably with "hazardous material." However, toxicity is only one of many characteristics that may cause a material to be hazardous. In this section, the more general term "hazardous material" will be used except where reference to toxicity in particular is intended.

hazardous material incidents. Of these incidents, most are minor but some do cause significant impacts such as injuries, evacuation, and the need for cleanup.

For example, in Roseville, California, on April 28, 1973, a railroad accident focused national attention on the hazards of munitions involved in fires. A hot brake shoe ignited the oak-wood floor of a Department of Defense boxcar carrying 250-pound bombs filled with Tritonal (TNT/aluminum). The bombs were being transported from the Naval Ammunition Depot in Hawthorne, Nevada, to the ship load-out port facility at the Naval Weapons Station in Concord, California. The train had just entered the yard in Roseville when a fire was observed coming from one of the boxcars. The fire department was summoned but before they could act, a large explosion demolished a boxcar and spread the fire. Over a period of approximately 32 hours, 18 boxcars exploded in succession. The railroad yard was essentially destroyed. Fortunately no one was killed; however, later local newspaper reports suggest that about 100 people were injured. There was about $24 million in property damage to the railroad yard and the surroundings. The litigation that followed lasted for several years and cost the government millions of dollars. (http://www.insensitivemunitions.org/history/railroad-train-fires-and-munition-explosions /)

More recently, on August 6, 2012, following a leak and the subsequent ignition of diesel fuel, a series of explosions and fires occurred at Chevron's refinery in Richmond, California. Thousands of East Bay residents were ordered to stay in their homes (shelter in place) with the windows and doors closed. Fortunately, there were no fatalities, but one refinery worker suffered burns to his wrist and was treated at the on-site clinic.

Much of the knowledge about the occurrence and impacts of natechs is anecdotal, although information has been reported with greater regularity in recent years, especially in relation to events involving earthquakes and tsunamis. Precise data can be difficult to obtain as company managers may be reluctant to divulge the nature and extent of releases. Table 6.Q lists examples of what has been reported by various authors.

Table 6.Q: Examples of Hazardous Materials Releases Triggered by Natural Disasters

Date	Location	Disaster	Reported Releases of Hazardous Materials	Citation(s)
1964	Alaska	Earthquake (magnitude 9.2) and tsunamis	Standard Oil Company's storage tanks toppled; break in hose connections to tanker loading diesel fuel; fire; rail cars exploded; Texaco bulk oil storage yard ignited	Lindell and Perry, 1996
1971	San Fernando	Earthquake (magnitude 6.6)	100 natural gas leaks responded to by fire departments; one-third caused fires; also 18 hazardous materials leaks; 12 of which caused fires.	Perkins and Wyatt, 1990; Lindell and Perry, 1996
1983	Coalinga	Earthquake (magnitude 6.7)	Many natural gas line breaks; at least nine hazardous materials releases, including a spill of strong acids and bases at a community college; one caused a fire	Ibid.
1987	Whittier Narrows	Earthquake (magnitude 6.1)	1411 natural gas line breaks; 3 of which caused fires; 30 hazardous materials releases	Ibid.
1989	Loma Prieta	Earthquake (magnitude 6.7)	Hundreds of natural gas leaks; over 300 releases of hazardous materials, including asbestos	Ibid.

Date	Location	Disaster	Reported Releases of Hazardous Materials	Citation(s)
1994	Northridge	Earthquake (M 6.8)	More than 15,000 natural gas leaks; over 200 fires; hazardous materials problems at 134 locations; 60 incidents requiring offsite hazardous materials response; included fires and hazardous materials releases at California State University (CSU) Northridge science laboratory complex	Lindell and Perry, 1996; Lindell and Perry, 1997
1999	Kocaeli, Turkey	Earthquake (magnitude 7.4)	Eight percent of facilities handling hazardous materials suffered earthquake-triggered releases of hazardous materials.	Cruz and Steinberg, 2005
2002	Czech Republic	Floods	Release of over 400 kilograms of chlorine from Spolana Chemical Works Company at Neratovice, north of Prague	European Commission, 2002; Cruz and Okada, 2008
2004	Sumatra, Indonesia	Earthquake (magnitude 9.1) and tsunami	Leakage of 8,000 cubic meters of oil from Pertamina oil depot in Banda Aceh	UNEP, 2005; Cruz and Okada, 2008
2008	Sichuan (Wenchuan), China	Earthquake (magnitude 8.0)	Leaks of ammonia, sulphuric acid, and other substances; also fires and explosions	Krausmann, Cruz, and Affeltranger, 2010
2011	Tohoku, Japan	Earthquake (magnitude 9.0) and tsunami	Extensive damage to facilities handling hazardous materials; several documented major fires, explosions, spills	Krausmann and Cruz, 2013

Assessment of State Vulnerability and Potential Losses

There is no comprehensive statewide vulnerability assessment available at this time. Validated historical data on which to base a model of vulnerability and potential losses from natechs (for example) are scarce, although a PC-compatible diskette of nearly 400 hazardous materials problems in 32 past earthquakes, including over 150 problems from the Loma Prieta earthquake, was made available in 1990 by the Association of Bay Area Governments (ABAG). It is likely that many such hazardous materials releases have received little attention in the past because public authorities, the media, and the public have overlooked them in the rush to address and recover from immediate disaster threats (Breslin, 1993; Young, Balluz, and Malilay, 2004). Furthermore, responsible parties may have an incentive to understate the extent of releases or not to report them at all.

With regard to earthquakes, as pointed out by Lindell and Perry (1997), historically there appears to have been no correlation between earthquake magnitude and the number of earthquake-triggered hazardous materials releases reported. Such releases depend not only on event magnitude but also on soil conditions, the number and structural characteristics of hazardous materials facilities in the area, and the seismic resistance of building contents. “The Northridge experience establishes that (releases) may occur even when structural damage is minimal or absent, which indicates that chemical containment systems are more fragile than the buildings in which they are housed.”

Assessment of Local Vulnerability and Potential Losses

Information related to vulnerability and loss assessments for California communities may be found in Local Hazard Mitigation Plans.

Current Hazardous Materials Release and Toxic Substance Mitigation Efforts

Many federal and state laws regulate hazardous materials, in terrestrial, aquatic, and atmospheric environments. At the federal level these include (as amended): the Clean Air Act, the Occupational Safety and Health Act, the Clean Water Act, the Hazardous Materials Transportation Act, the Resource Conservation and Recovery Act, the Toxic Substances Control Act, the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund), and others. Brief descriptions of some of the most relevant federal and state legislative and regulatory provisions are provided below.

Emergency Planning and Community Right-to-Know Act

Title III of the federal Superfund Amendments and Reauthorization Act, also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), was established to encourage and support emergency planning efforts at the state and local levels and to provide the public and local governments with information concerning potential chemical hazards present in their communities. The law requires facilities to furnish information about the quantities and health effects of chemicals that they use and to promptly notify local and state officials whenever a significant release of hazardous materials occurs. Broadly representative Local Emergency Planning Committees (LEPCs) have been appointed for each of six Emergency Planning Districts, which have the same boundaries as the Mutual Aid Regions. In carrying out the community right-to-know requirements of EPCRA, the committees provide a forum for emergency management agencies, responders, industry and the public to work together to evaluate, understand, train about, coordinate, and communicate chemical hazards in the community and develop regional hazardous materials emergency plans. Local plans, developed with stakeholder participation, are reviewed annually and provide information about chemicals in the community to citizens, government agencies, and emergency responders.

California's Unified Program

California law established the Unified Program which consolidates, coordinates, and makes consistent the administrative requirements, permits, inspections, and enforcement activities of six environmental and emergency response programs: the Hazardous Materials Business Plan/Emergency Response Plan, Hazardous Waste/Tiered Permitting, Underground Storage Tanks, Above-Ground Storage Tanks, California Accidental Release Prevention Program, and Uniform Fire Code Hazardous Materials Management Plan. The state agencies responsible for these programs set the standards for their program while local governments implement and enforce the standards. The California Environmental Protection Agency (Cal/EPA) oversees the implementation of the Unified Program as a whole (California Code of Regulations, Title 27, Division I, Subdivision 4, Chapter 1, Sections 15100-15620).

The Unified Program is implemented at the local level by government agencies certified by the Secretary of Cal/EPA. These Certified Unified Program Agencies (CUPAs) have typically been established as a function of a local environmental health or fire department. Some CUPAs also have contractual agreements with one or more other local agencies, "participating agencies" (PAs) that implement one or more program elements under the oversight of the CUPA.

At the state level, Hazardous Materials Business Plan/Emergency Response Plans (California Health and Safety Code, Chapter 6.95) seek to prevent or minimize the damage to public health and safety and the environment from a release or threatened release of hazardous materials and to satisfy community right-to-know laws. This is accomplished by requiring businesses that handle hazardous materials in quantities

equal to or greater than 55 gallons, 500 pounds, or 200 cubic feet of gas or extremely hazardous substances above the threshold planning quantity (40 CFR, Part 355, Appendix A) to:

- Inventory their hazardous materials
- Develop an emergency plan
- Implement a training program for employees

Most hazardous materials facilities in the state are regulated by a Hazardous Materials Business Plan. The state contains approximately 140,000 such businesses, which range from the smallest gas station to the largest chemical facility.

California Accidental Release Prevention (CalARP)

The California Accidental Release Prevention (CalARP) program is intended to prevent accidental releases of substances that can cause serious harm to the public and the environment, to minimize the damage if releases do occur, and to satisfy community right-to-know laws. This is accomplished by requiring businesses that handle more than a threshold quantity of a regulated substance listed in the regulations to develop a Risk Management Plan (RMP). An RMP is a detailed engineering analysis of the potential accident factors present at a business and the mitigation measures that can be implemented to reduce this accident potential. The RMP contains:

- Safety information
- A hazard review
- Operating procedures
- Training requirements
- Maintenance requirements
- Compliance audits
- Incident investigation procedures

Various mitigation efforts relating to the transport of hazardous materials, are required and implemented as the result of federal and state regulations, as follows:

- Placards and labeling of containers
- Proper container established for material type
- Random inspections of transporters
- Safe-handling policies and procedures
- Hazard communications
- Training for handlers
- Permitting
- Transportation flow studies (e.g., restricting the transportation of hazardous materials over certain routes)

California's Source Reduction Requirement

A more proactive approach to mitigating the impacts of hazardous materials releases is California's Hazardous Waste Source Reduction and Management Review Act of 1989, also known as Senate Bill 14. This act requires hazardous waste generators to seriously consider source reduction as the preferred method of managing hazardous waste. Source reduction is preferable to recycling and treatment options because source reduction avoids waste generation costs and management liability. Source reduction also provides the best protection for public health and the environment. Facilities generating more than 12 kilograms of hazardous waste or 12 kilograms of extremely hazardous waste are required to do source reduction planning. Hazardous waste generators subject to Senate Bill 14 are required to prepare various documents including a Source Reduction Evaluation Review and Plan.

Opportunities for Enhanced Hazardous Materials Release and Toxic Substance Mitigation

Steinberg, Sengul, and Cruz (2008) have identified several approaches to mitigating the risks posed by natechs. Similar approaches may be used to mitigate hazardous materials risks more generally. The identified approaches are:

- Design criteria (e.g., more stringent building codes so that structures containing hazardous materials are better protected against earthquakes and other likely hazards)
- Chemical process and facility safety measures (e.g., consideration of potential natural disaster-triggered process failures in safety management and planning for chemical processing plants, required every five years by the U.S. Occupational Health and Safety Administration – 29CFR1910.119)
- Land use planning (e.g., restriction of development in high risk areas, relocation of exposed elements, etc.)
- Local hazard mitigation planning (e.g., consideration of natechs in LHMPs)
- Adoption of sustainable industrial processes (e.g., substitution of less hazardous raw materials and intermediate products for those that are more hazardous)

The authors acknowledge that California is ahead of many other states in the extent to which action has already been taken to address natechs and other hazardous materials releases. For example, the CalARP program, mentioned above, specifically requires industry to analyze seismic events in the hazard review. Nevertheless, it is evident that much more could be done in this area.

Following the 2012 Richmond refinery fire, an Interagency Working Group on Refinery Safety was formed, composed of thirteen state agencies and departments and the Governor's office. The working group met over eight months to examine ways to improve public and worker safety through enhanced oversight of refineries, and to strengthen emergency preparedness in anticipation of any future incident. Regular internal meetings were informed by meetings with a wide variety of stakeholders including those from industry, labor, community and environmental groups, academic institutions, and local emergency response units. The working group's draft report, issued in July 2013, includes an assessment of the current state of refinery safety with input from stakeholders, a study by the RAND Corporation, and findings by the Division of Occupational Safety and Health (Cal OSHA), the U.S. Chemical Safety Board, and Chevron's own internal investigation.

Recommendations of the working group most relevant to mitigation include: (1) the creation of an Interagency Refinery Task Force, housed within Cal EPA, to coordinate agencies' activities and carry out the recommended actions; (2) the strengthening of existing regulations, and the development of new regulations and practices to address the underlying causes of safety problems including, but not limited to, inherently safer systems, periodic assessments of safety culture, complete root-cause analysis after significant accidents or releases, and accounting for 'human factors' to manage and reduce error; (3) enhanced enforcement and increased worker involvement in improving the methods and culture of safety at refineries (http://www.calepa.ca.gov/Publications/Reports/2013/Refineries.pdf).

The Interagency Refinery Task Force has since been established and met for the first time in August 2013. Although initially it will address safety issues relating to refineries, members have agreed that its focus should subsequently be expanded to other high risk facilities including, but not limited to, those covered by the CalARP program.

There are many other opportunities for enhanced mitigation of hazardous materials releases in California. Increased research into the potential risks associated with various hazardous materials, coupled with greater public awareness, may lead to additional regulatory requirements and personal choices regarding

the use of certain chemicals and other substances identified as potentially harmful themselves or manufactured from (or using) other materials that are hazardous.

Product designers often have opportunities to minimize impacts on human health and the environment long before products reach the marketplace. California's proposed Safer Consumer Products Regulation, currently thought to be nearing adoption, creates a predictable process for reducing toxic ingredients in products. In its simplest terms, the regulation requires manufacturers whose consumer product contains a toxic ingredient to ask: "Is this ingredient necessary? Is there a safer alternative? Is that alternative ingredient feasible?" In addition, by listing the chemicals that the State of California will be examining in consumer products, the regulation gives manufacturers have the opportunity to design out the use of those chemicals ahead of time.

6.6.5 MARINE INVASIVE SPECIES

Identifying and Profiling Marine Invasive Species

The introduction of non-indigenous species (NIS) into coastal marine and estuarine waters can cause significant and enduring economic, human health, and environmental impacts. In coastal environments, commercial shipping is the most important vector for species introductions. Commercial ships transport organisms through two primary mechanisms (vectors): ballast water and vessel biofouling. Ballast water is taken on and released by a vessel during cargo loading and discharging operations to maintain the vessel's trim and stability. Biofouling organisms are aquatic species attached to or associated with submerged or wetted hard surfaces.

Assessment of State Vulnerability and Potential Losses

Ships transfer organisms to California waters from throughout the world. The transfer of ballast water from "source" to "destination" ports results in the movement of many organisms from one region to the next. Additionally, as vessels move from port to port, biofouling communities are transported along with their "host" structure. Once introduced, invasive species are likely to become a permanent part of an ecosystem and may flourish, creating environmental imbalances, presenting risks to human health, and causing significant economic problems. Examples include the zebra and quagga mussel infestations in the Colorado River Aqueduct System and California waterways, and the propagation of aquatic weeds, such as water hyacinth, in the California Delta.

Assessment of Local Vulnerability and Potential Losses

Information related to community vulnerability and loss assessments related to marine invasive species, if any, may be found in Local Hazard Mitigation Plans.

Current and Future Marine Invasive Species Hazard Mitigation Efforts

The Marine Invasive Species Act of 2003 (MISA) reauthorized, enhanced, and renamed the state's original ballast water management program, which established a statewide, multi-agency program to prevent or reduce the introduction and spread of NIS into the state waters. The MISA applies to all U.S. and foreign vessels over 300 gross registered tons that arrive at a California port or place after operating outside of California waters. (http://www.slc.ca.gov/Spec_Pub/MFD/Ballast_Water/Ballast_Water_Default.html)

Progress Summary 6.O: Marine Invasive Species

Progress as of 2013: Under the MISA, vessels are required to submit a ballast water reporting form for each arrival to a California port or place. Between July 2010 and June 2012, over 18,000 forms were submitted to the California State Lands Commission. Compliance with this requirement regularly exceeds 95 percent. According to the 2013 Biennial Report on the California Marine Invasive Species Program, "Of the more than 122 million metric tons [MMT] of vessel-reported ballast water carried into State waters between July 2010 and June 2012, over 97.9 percent, or 120 MMT, was managed in compliance with California law." Furthermore, "noncompliant ballast water has accounted for a smaller proportion of all ballast water discharges through the years, with slight variation, from 23.8 percent in the latter half of 2006 to 9.5 percent in the first half of 2012." These numbers signify a reduction in the threat of invasive species introductions from ballast water discharges to the waters of California.

Opportunities for Enhanced Marine Invasive Species Mitigation

The MISA includes mandates to improve the ability of the state's ballast water management program to prevent future NIS introductions. In 2006, the California State Lands Commission submitted a report to the legislature with recommendations to reduce the discharge of NIS from vessel biofouling. As a result of that report, the California legislature amended the MISA in 2007 to clarify existing provisions requiring vessels operating in California waters to remove biofouling organisms on a regular basis. The commission was also given the authority to collect hull husbandry and other biofouling-related information from vessels operating in California to fill key information gaps. The commission is using this information in conjunction with results from commission-funded biological research to develop regulations governing the management of biofouling in California waters.

6.6.6 NATURAL GAS PIPELINE HAZARDS

Identifying Natural Gas Pipeline Hazards

The United States is heavily dependent on transmission pipelines to distribute energy and fuel sources. Virtually all natural gas, which accounts for about 28 percent of energy consumed annually, is transported by transmission pipelines.[67] 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. Increased urbanization is resulting in more people living and working closer to existing gas transmission pipelines that were placed prior to government agencies adopting and implementing land use and other pipeline safety regulations.

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.

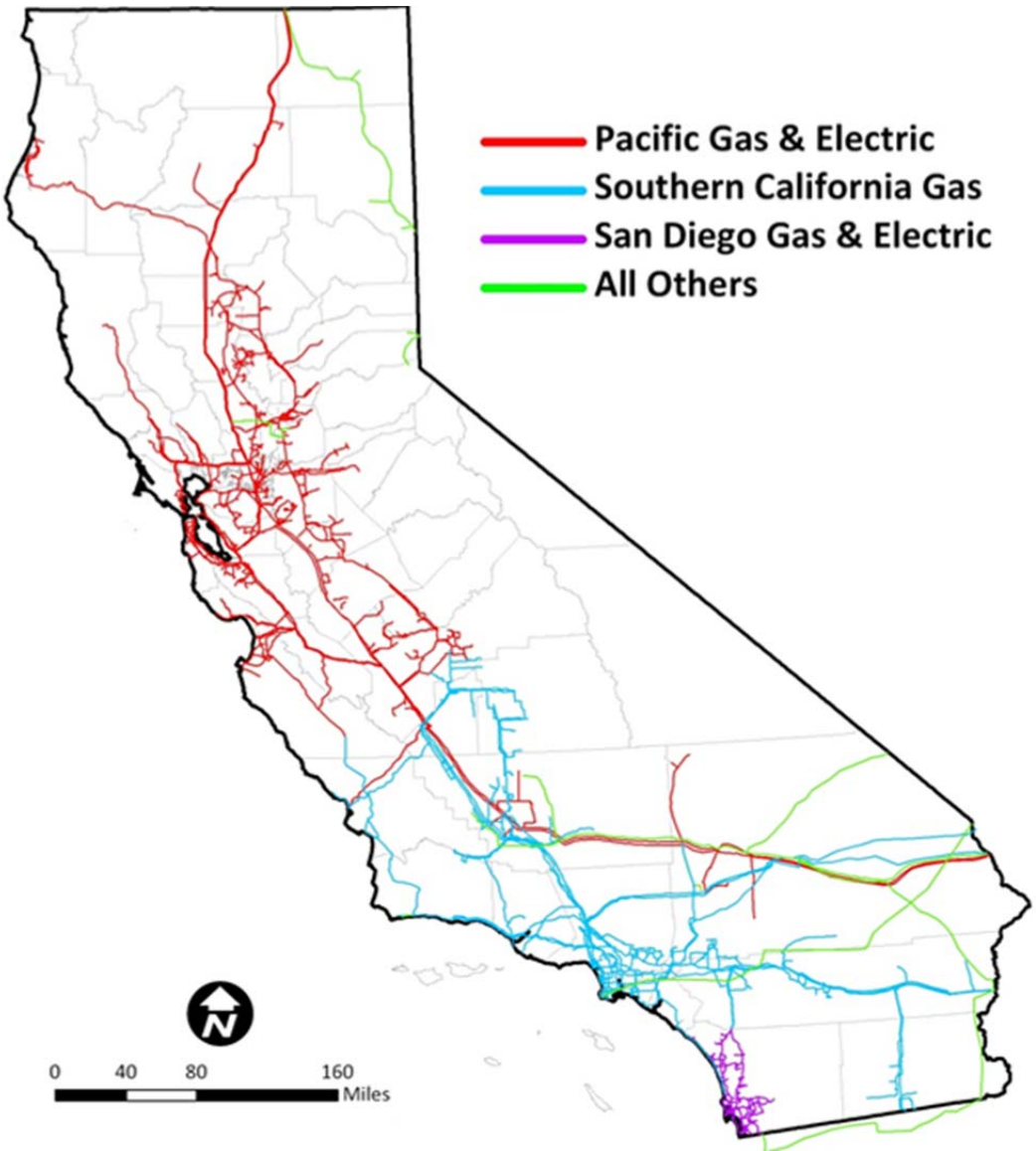
Profiling Natural Gas Pipeline Hazards

Most of the natural gas used in California comes from out-of-state natural gas basins. It is delivered to California via the interstate natural gas pipeline system. In 2012, California customers received 42 percent of their natural gas supply from basins in the Southwest, 22 percent from Canada, 23 percent from the

[67] Transmission Pipelines and Land Use, p.1

Rocky Mountains, and 12 percent from California.[68] Natural gas transported via the interstate pipelines, and some of the California-produced natural gas, is delivered into the Pacific Gas & Electric (PG&E) and Southern California Gas (SoCal Gas) intrastate natural gas transmission pipeline systems (commonly referred to as California's "backbone" natural gas pipeline system). Natural gas on the utilities' backbone pipeline systems is then delivered into the local transmission and distribution pipeline systems, or to natural gas storage fields. PG&E and SoCal Gas own and operate several natural gas storage fields that are located in Northern and Southern California.[69]

MAP 6.T: California Natural Gas Pipelines



Source: California Energy Commission, http://www.energy.ca.gov/maps/Natural_Gas_Pipelines.pdf

Map 6.T shows the location and ownership of the natural gas pipeline system. Many of the pipelines are located in areas with high seismic activity, crossing the San Andreas and other active faults. *Note: This map was updated in 2011. The updated map can be found at*

[68] CEC website: http://energyalmanac.ca.gov/overview/energy_sources.html
[69] CPUC website: http://www.cpuc.ca.gov/puc/energy/gas/natgasandca.htm

http://www.energy.ca.gov/maps/infrastructure/natural_gas.html

Generally speaking, transmission lines are large-diameter steel pipes carrying natural gas at high pressure and compressed to provide higher carrying capacity. Transmission lines are both interstate and intrastate, with the latter connecting to smaller distribution lines delivering gas directly to homes and businesses. Data compiled by the Pipeline and Hazardous Materials Safety Administration (PHMSA) report a total of 115,292 miles of gas pipelines in California, of which 12,414 miles are classified as gas transmission lines, 403 miles are gas-gathering lines, and the majority, 102,475 miles, are for gas distribution. Nearly 40 percent of gas transmission lines are located in Los Angeles, Kern, and San Bernardino counties.[70]

Incidents and Losses from Pipeline Accidents

PHMSA tracks significant incidents and losses as a result of pipeline accidents occurring on gas transmission lines and gas distribution lines. Significant incidents are those reported by pipeline operators with either 1) a fatality or injury requiring in-patient hospitalization, or 2) $50,000 or more in total costs, measured in 1984 dollars. From 2000 to 2009, a total of 22 incidents were reported on California transmission lines, causing one fatality, two injuries, and $12 million in property damage. For that period, a total of 65 incidents were reported on local gas distribution lines, resulting in three fatalities, 16 injuries, and $14 million in property damage.[71]

San Bruno Gas Transmission Line Explosion

Given the extensive gas transmission and distribution systems in place in California, annual average losses of approximately $1 million may not seem of concern. However, the potential for serious damage and loss of life from a single pipeline explosion can be substantial. On September 9, 2010, a 30-inch steel natural gas transmission pipeline owned and operated by PG&E ruptured and exploded in a residential neighborhood in San Bruno, California. The rupture produced a crater about 72 feet long by 26 feet wide. The section of pipe that ruptured, which was about 28 feet long and weighed about 3,000 pounds, was found 100 feet south of the crater. PG&E estimated that 47.6 million standard cubic feet of natural gas was released. The released natural gas ignited, resulting in a fire that destroyed 38 homes and damaged 70. There were eight confirmed deaths and 66 reported injuries. Cal OES has identified preliminary damage estimates at $15.4 million, including $2.5 million for debris removal, $10.2 million for protective measures, $2.1 million for roads and bridges, and $0.6 million for utilities and other facilities.

A report issued by the National Transportation Safety Board (NTSB) in August 2011, determined that the probable cause of the accident was PG&E's 1) inadequate quality assurance and quality control in 1956 during its Line 132 relocation project, which allowed the installation of a substandard and poorly welded pipe section with a visible seam weld flaw that, over time grew to a critical size, causing the pipeline to rupture during a pressure increase stemming from poorly planned electrical work at the Milpitas Terminal; and 2) an inadequate pipeline integrity management program, which failed to detect and repair or remove the defective pipe section.

Contributing to the accident were the California Public Utilities Commission (CPUC) and the U.S. Department of Transportation exemptions of existing pipelines from the regulatory requirement for pressure testing, which likely would have detected the installation defects. Also contributing to the accident was the CPUC's failure to detect the inadequacies of PG&E's pipeline integrity management program. Contributing to the severity of the accident were the lack of either automatic shutoff valves or remote control valves on the line and PG&E's flawed emergency response procedures and delay in isolating the rupture to stop the flow of gas.

[70] http://primis.phmsa.dot.gov/comm/reports/safety/CA_detail1.html?nocache=8324
[71] ibid

The NTSB report included a series of recommended actions to be undertaken by federal and state government agencies and PG&E. These recommendations and resulting legislation are discussed in subsequent sections.

Assessment of State Vulnerability and Potential Losses

No known current assessment of state vulnerability or potential losses from gas pipeline failures is available at this time. However, it can be logically assumed that any state facility in close proximity to a natural gas transmission pipeline is at risk. This risk is heightened if the facility is also located in an area of high seismicity, where multiple gas line failures and resulting fires can be expected.[72]

Assessment of Local Vulnerability and Potential Losses

Individual Local Hazard Mitigation Plans may include information on pipeline vulnerability pertinent to their communities, if this information is known. Earthquake planning scenarios produced by the California Geological Survey and others are the best source of information on potential disruptions, length of outages, and estimates of post-earthquake fire. For a discussion of vulnerability of gas and other pipelines to earthquake, see Chapter 5, Section 5.2.4.2 under the heading “Pipeline Networks - Natural Gas, Oil and Water”.

Specific information on pipeline vulnerability is maintained by owners/operators such as PG&E and SoCal Gas. This information is not always readily available to local government planners. PG&E monitors system status in real time on a 24-hour basis and regularly conducts leak inspections, surveys, and patrols of all its natural gas transmission pipelines to identify issues to be addressed immediately. PG&E also uses the data it collects to help plan and set priorities for future work. One of the tools PG&E uses is a risk management program that inventories and evaluates each of the 20,000 segments within PG&E's natural gas transmission pipeline system. A pipeline segment may be identified for further study and long-range planning based on its risk for one of several factors:

- Potential for third-party damage
- Potential for corrosion
- Potential for ground movement
- Physical design and characteristics
- Overall, did not score high in any one factor, but scored moderately high in more than one factor

PG&E also considers proximity to high-density populations, potential reliability impacts, and environmentally sensitive areas. Based on these factors, PG&E determines which segments warrant further evaluation, monitoring, or other future action. PG&E also creates a list of the "Top 100" segments to help inform future work plans. As conditions change from year to year, PG&E reevaluates the segments included on the list.[73]

As a result of the 2010 San Bruno gas pipeline explosion, PG&E has launched a website application with an interactive map that individuals can use to learn more about the gas pipelines in their neighborhoods. The website can be found at:
http://www.pge.com/myhome/edusafety/systemworks/gas/transmissionpipelines/

Current Gas Pipeline Hazard Mitigation Efforts

Mitigation for gas pipelines is accomplished primarily through federal regulation and safety standards. The federal government establishes minimum pipeline safety standards under 44 CFR, Title 49 "Transportation," Parts 190-199. The Office of Pipeline Safety (OPS), within the U.S. Department of Transportation (DOT),

[72] NTSB Number: PAR-11-01
[73] Gas Transmission Pipeline Long Range Planning http://www.pge.com/myhome/customerservice/response/pipelineplanning/

Pipeline and Hazardous Materials Safety Administration (PHMSA), has overall regulatory responsibility for hazardous liquid and gas pipelines under its jurisdiction in the United States. The Natural Gas Pipeline Safety Act of 1968 as amended (NGPSA) authorizes DOT to regulate pipeline transportation of natural (flammable, toxic, or corrosive) gas and other gases.

State and Federal Regulatory Activities

Through certification by OPS, the State of California regulates, inspects, and enforces intrastate gas and liquid pipeline safety requirements. By signed agreement with OPS, the State of California also inspects interstate liquid pipeline safety requirements. The California Office of the State Fire Marshal (OSFM) performs this work. California state regulations can be found at: http://osfm.fire.ca.gov/pipeline/pipeline.php.

The California Public Utilities Commission (CPUC) regulates natural gas utility service for approximately 10.7 million customers that receive natural gas from PG&E, SoCal Gas, San Diego Gas & Electric (SDG&E), Southwest Gas, and several smaller natural gas utilities. The CPUC also regulates independent storage operators Lodi Gas Storage and Wild Goose Storage. The CPUC regulates the California utilities' natural gas rates and natural gas services, including in-state transportation over the utilities' transmission and distribution pipeline systems, storage, procurement, metering, and billing. The CPUC has regulatory jurisdiction over 100,000 miles of utility-owned natural gas pipelines, which transported 79 percent of the total amount of natural gas delivered to California's gas consumers in 2008.[74]

Operator compliance with state and federal pipeline safety regulations is monitored through a comprehensive inspection and enforcement program. The program is comprised of field inspections of operations, maintenance, and construction activities; programmatic inspections of operator procedures, processes, and records; incident investigations and corrective actions; and direct dialogue with operator management. The OSFM and CPUC work in partnership with the federal Pipeline and Hazardous Materials Safety Administration (PHMSA) to assure pipeline operators are meeting requirements for safe, reliable, and environmentally sound operation of their facilities. Data on probable violations discovered and compliance actions taken are reported annually by the state to PHMSA. Information on enforcement actions taken by PHMSA is available at the Pipeline Safety Enforcement Program homepage: http://primis.phmsa.dot.gov/comm/reports/enforce/Enforcement.html?nocache=7044

OPS is authorized to reimburse a state agency up to 80 percent of the actual cost for carrying out its pipeline safety program, including the cost of personnel and equipment. The actual amount of federal reimbursement depends upon the availability of appropriated funds and state program performance. OPS also provides grant funding to state partners to improve communication among excavators and owners of underground facilities. The PIPES Act of 2006 also authorizes grants to state authorities, designated by the Governor, to create or augment effective state damage-prevention programs. For more information, go to Grants to States for One-Call and Damage Prevention.

Chart 6.F, on the following page, depicts the dramatic decline in gas pipeline incidents in the past 40 years, with the greatest improvement occurring from 1980 to 1985, in substantial part due to effectiveness of state and federal regulations.

Guidance for Local Land Use Planning

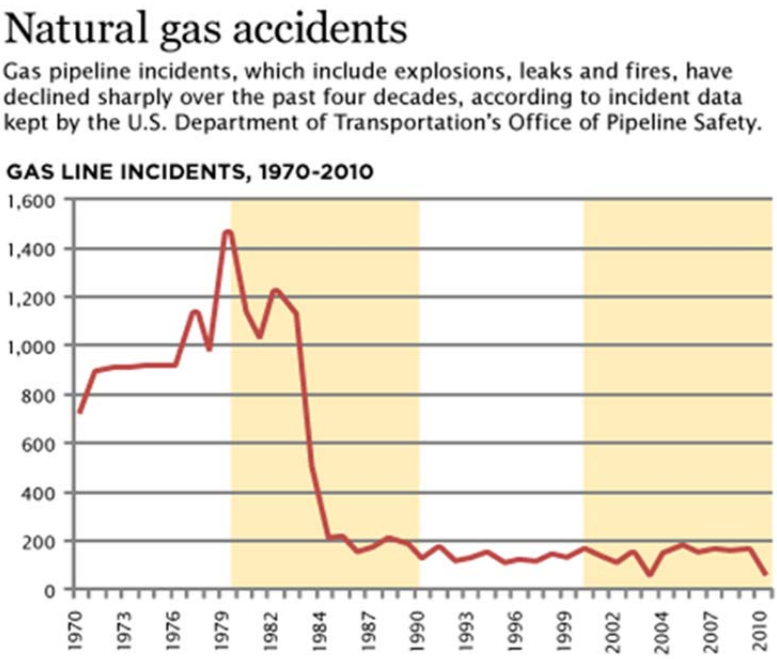
To reduce risk to public safety posed by natural gas transmission lines, local governments rely on zoning ordinances and control of easements. To better understand issues related to land use planning, PHMSA, in conjunction with the Federal Energy Regulatory Commission (FERC), sponsored a comprehensive study of land use practices, zoning ordinances, and preservation of environmental resources on transmission pipeline rights-of-way. In an October 2004 report, the Transportation Research Board (TRB) recommended

[74] California Public Utilities Commission website. http://www.cpuc.ca.gov/puc/energy/gas/natgasandca.htm

that PHMSA "develop risk-informed land use guidance for application by stakeholders." In response, the Pipelines and Informed Planning Alliance (PIPA), representing a wide spectrum of stakeholders developed recommended practices related to protecting communities and pipelines. Approximately 130 stakeholder participants undertook the work to develop the PIPA recommended practices.

The final report "Partnering to Further Enhance Pipeline Safety In Communities Through Risk-Informed Land Use Planning" was released in November 2010. The report includes recommended practices for local governments, property developers and owners, transmission pipeline operators, and real estate boards to be aware of and to implement as appropriate. PHMSA plans to continue working with stakeholders to ensure that a sound implementation strategy is developed and that the PIPA recommended practices are communicated to and understood by those that need to adopt them. Lessons learned from implementation of these practices are expected to lead to improvement and expansion of the practices. The most current version of this information will be available on PHMSA's Pipeline Safety Stakeholder Communications website.

Chart 6.F: Natural Gas Incidents



Source: U.S. Department of Transportation's Office of Pipeline Safety / msnbc.com

Opportunities for Enhanced Gas Pipeline Hazard Mitigation

The NTSB's Pipeline Accident Report for the San Bruno Gas Pipeline Explosion resulted in a series of recommendations to improve the nation's and California's gas pipeline safety practices. At the federal level recommendations were made to the U.S Secretary of Transportation, the Pipeline and Hazardous Materials Safety Administration, the American Gas Association and the Interstate Natural Gas Association of America, Additional details regarding NTSB's recommended actions to these agencies can be found at: http://www.ntsb.gov/investigations/summary/PAR1101.html

Recommendations specific to the State of California (quoted directly from the NTSB report):

To the Governor of the State of California:

- Expeditiously evaluate the authority and ability of the pipeline safety division within the California Public Utilities Commission to effectively enforce state pipeline safety regulations, and, based on the results of this evaluation, grant the pipeline safety division within the California Public Utilities Commission the direct authority, including the assessment of fines and penalties, to correct noncompliance by state regulated pipeline operators

To the California Public Utilities Commission:

- With assistance from the Pipeline and Hazardous Materials Safety Administration, conduct a comprehensive audit of all aspects of Pacific Gas and Electric Company operations, including control room operations, emergency planning, record-keeping, performance-based risk and integrity management programs, and public awareness programs
- Require the Pacific Gas and Electric Company to correct all deficiencies identified as a result of the San Bruno, California, accident investigation, as well as any additional deficiencies identified through the comprehensive audit, and verify that all corrective actions are complete
- Develop an implementation schedule for the requirements of safety recommendations to Pacific Gas and Electric Company (PG&E) and ensure, through adequate oversight, that PG&E has aggressively and diligently searched documents and records relating to pipeline system components, such as pipe segments, valves, fittings, and weld seams, for PG&E natural gas transmission lines in class 3 and class 4 locations and class 1 and class 2 high consequence areas that have not had a maximum allowable operating pressure established through prior hydrostatic testing as outlined in safety recommendations to PG&E. These records should be traceable, verifiable, and complete; should meet your regulatory intent and requirements; and should have been considered in determining maximum allowable operating pressures for PG&E pipelines
- If such a document and records search cannot be satisfactorily completed, provide oversight to any spike and hydrostatic tests that Pacific Gas and Electric Company is required to perform
- Through appropriate and expeditious means, including posting on your website, immediately inform California intrastate natural gas transmission operators of the circumstances leading up to and the consequences of the September 9, 2010, pipeline rupture in San Bruno, California, and the National Transportation Safety Board's urgent safety recommendations to Pacific Gas and Electric Company so that pipeline operators can proactively implement corrective measures as appropriate for their pipeline systems

To the Pacific Gas and Electric Company:

- Revise your work clearance procedures to include requirements for identifying the likelihood and consequence of failure associated with the planned work and for developing contingency plans
- Establish a comprehensive emergency response procedure for responding to large-scale emergencies on transmission lines; the procedure should (1) identify a single person to assume command and designate specific duties for supervisory control and data acquisition staff and all other potentially involved company employees; (2) include the development and use of trouble-shooting protocols and checklists; and (3) include a requirement for periodic tests and/or drills to demonstrate the procedure can be effectively implemented
- Equip your supervisory control and data acquisition system with tools to assist in recognizing and pinpointing the location of leaks, including line breaks; such tools could include a real-time leak detection system and appropriately spaced flow and pressure transmitters along covered transmission lines.

- Expedite the installation of automatic shutoff valves and remote control valves on transmission lines in high consequence areas and in class 3 and 4 locations, and space them at intervals that consider the factors listed in Title 49 Code of Federal Regulations 192.935(c)
- Revise your postaccident toxicological testing program to ensure that testing is timely and complete
- Assess every aspect of your integrity management program, paying particular attention to the areas identified in this investigation, and implement a revised program that includes, at a minimum, (1) a revised risk model to reflect the Pacific Gas and Electric Company's actual recent experience data on leaks, failures, and incidents; (2) consideration of all defect and leak data for the life of each pipeline, including its construction, in risk analysis for similar or related segments to ensure that all applicable threats are adequately addressed; (3) a revised risk analysis methodology to ensure that assessment methods are selected for each pipeline segment that address all applicable integrity threats, with particular emphasis on design/material and construction threats; and (4) an improved self-assessment that adequately measures whether the program is effectively assessing and evaluating the integrity of each covered pipeline segment
- Conduct threat assessments using the revised risk analysis methodology incorporated in your integrity management program, as recommended in safety recommendations, and report the results of those assessments to the California Public Utilities Commission and the Pipeline and Hazardous Materials Safety Administration
- Develop, and incorporate into your public awareness program, written performance measurements and guidelines for evaluating the plan and for continuous program improvement
- Aggressively and diligently search for all as-built drawings, alignment sheets, and specifications, and all design, construction, inspection, testing, maintenance, and other related records, including those records in locations controlled by personnel or firms other than Pacific Gas and Electric Company, relating to pipeline system components, such as pipe segments, valves, fittings, and weld seams for Pacific Gas and Electric Company natural gas transmission lines in class 3 and class 4 locations and class 1 and class 2 high consequence areas that have not had a maximum allowable operating pressure established through prior hydrostatic testing. These records should be traceable, verifiable, and complete.)
- Use the traceable, verifiable, and complete records located by implementation of Safety Recommendation P-10-2 (Urgent) to determine the valid maximum allowable operating pressure, based on the weakest section of the pipeline or component to ensure safe operation, of Pacific Gas and Electric Company natural gas transmission lines in class 3 and class 4 locations and class 1 and class 2 high consequence areas that have not had a maximum allowable operating pressure established through prior hydrostatic testing
- If you are unable to comply with safety recommendations to accurately determine the maximum allowable operating pressure of Pacific Gas and Electric Company natural gas transmission lines in class 3 and class 4 locations and class 1 and class 2 high consequence areas that have not had a maximum allowable operating pressure established through prior hydrostatic testing, determine the maximum allowable operating pressure with a spike test followed by a hydrostatic pressure test
- Require your control room operators to notify, immediately and directly, the 911 emergency call center(s) for the communities and jurisdictions in which your transmission and/or distribution pipelines are located, when a possible rupture of any pipeline is indicate

Progress Summary 6.P: Gas Pipeline Safety Laws

Progress as of 2013: Three gas pipeline safety bills were introduced into the California legislature as a result of the 2010 San Bruno gas pipeline explosion. On September 23, 2010, all three were signed into law by Governor Jerry Brown. A brief description of each bill is outlined below. Full text of the laws can be found at: http://www.leginfo.ca.gov/calaw.html

AB 578 requires the California Public Utilities Commission (CPUC) to adopt gas pipeline safety recommendations made by the National Transportation Safety Board (NTSB). If the CPUC opts not to adopt the standards, it must submit reasons for that decision in writing.

AB 861 prohibits a public utility from either cutting spending on operations and maintenance or increasing rates to recover expenses that were used to pay executive bonuses.

AB 1546 requires the CPUC to adopt performance metrics for pipeline safety and evaluate the state's gas utilities against those metrics. The bill allows the CPUC to levy penalties on the utility for poor performance.

Progress Summary 6.Q: Gas Safety Action

Progress as of 2013: The California Public Utilities Commission (CPUC) created a comprehensive, high-level, Gas Safety Action Plan to guide and promote the CPUC's shift in culture from the traditional compliance model to a regulatory structure that sets, monitors, and enforces rules for regulated utilities based on risk assessment and risk management. The Gas Safety Action Plan also tracks the CPUC's implementation of improvements responsive to recommendations made by the Independent Review Panel and the National Transportation Safety Board in response to the PG&E San Bruno pipeline explosion that occurred on September 9, 2010. As part of the plan, the CPUC engages in an in-depth review of its current practices and procedures to seek areas for improvement in gas pipeline safety.

The Gas Safety Action Plan categorizes the efforts of the CPUC into four basic goals that embrace the elements of the CPUC's overall mission to protect the public and utility workers from unsafe practices and events involving gas pipeline facilities in California:

1. Ensuring the safety of the existing gas system
2. Upgrading and replacing the gas system to make it safer
3. Reforming the CPUC - making safety its first priority
4. Instilling safety culture in gas operators

To accomplish these goals, the plan's focus is to:

- Proactively identify, evaluate, and mitigate risks
- Verify compliance with rules, standards, and risk mitigation measures
- Propose and litigate enforcement actions
- Develop policies and procedures to assess the safety culture of natural gas pipeline operators
- Educate operators to promote the elements of the plan
- Review and improve CPUC policies, practices, and procedures

The Gas Safety Action Plan is designed to be a living document that will drive the CPUC's overarching strategies to improve its Gas Pipeline Safety Program. This "safety action plan" concept will not be limited to the CPUC's Gas Pipeline Safety Program, as the CPUC is also in the process of developing similar plans for the Electric and Railroad Safety Programs with innovative safety measures and methods with the goal of instilling a culture that inspires the values of utility safety and reliability throughout California, and the nation. The Natural Gas Safety Action Plan can be viewed at:
http://www.cpuc.ca.gov/PUC/safety/Pipeline/Natural_Gas_Safety_Action_PlanApril2013.htm

Progress Summary 6.R: PG&E Pipeline Safety

Progress as of 2013: Pacific Gas & Electric Company (PG&E) validated the safe operating pressure of an additional 194 miles of natural gas transmission pipeline in 2012, through hydrostatic pressure testing and rigorous records validation.

These activities were completed in areas throughout Northern and Central California as part of PG&E's Pipeline Safety Enhancement Program (PSEP) and through regularly scheduled projects to verify the integrity of natural gas transmission lines—the large-diameter pipes that carry gas across long distances. Since PSEP projects were launched in 2011, PG&E has successfully tested a total of 409 miles of gas transmission pipeline.

PG&E also started construction on a state-of-the-art gas control center at its new gas operations headquarters at Bishop Ranch in San Ramon, California. The center will serve as a central location from which PG&E will monitor the safe and reliable operation of its 6,700 miles of transmission pipeline and 42,000 miles of smaller-diameter distribution mains. Completion of the gas control center is expected in the summer of 2013.
http://www.pge.com/web/about/newsroom/newsreleases/20121218/pgampe_verifies_strength_of_194_miles_of_pipeline_in_2012_begins_construction_of_state-of-the-art_gas_control_center1.shtml

6.6.7 OIL SPILLS

Identifying Oil Spill Hazards

An oil spill is a release of liquid petroleum into the environment due to human activity that results in pollution of land, water, and air. Oil releases also occur naturally through oil seeps either on land or under water. Oil spills can result from the release of crude oil from offshore oil platforms, drilling rigs, wells, pipelines, tank trucks, and marine tank vessels (tankers). Refined petroleum products such as gasoline, diesel, and heavier fuels such as bunker fuel used by cargo ships are also sources of potential oil spill releases.

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. Spill clean-up and remediation activities may cost millions of dollars and impacts can last for years. The California Department of Fish and Wildlife Oiled Wildlife Division treats countless thousands of oiled birds/ wildlife annually. Oil slicks/ spills (as well as naturally occurring oil plumes) have a devastating impact on wildlife.

In addition to the oiled wildlife division, the California Department of Fish and Wildlife also has an Oil Spill Prevention and Response office. The mission of the Office of Spill Prevention and Response (OSPR) is to provide best achievable protection of California's natural resources by preventing, preparing for, and responding to spills of oil and other deleterious materials, and through restoring and enhancing affected resources. http://www.dfg.ca.gov/ospr/. OSPR staff participated in Deepwater Horizon oil spill among many others.

The environmental impacts contribute to short- and long-term impacts on economic activities in areas affected by oil spills. Moratoriums may be temporarily imposed on fisheries, and tourism may decline in beach communities, resulting in economic hardship on individuals dependent on those industries for their livelihood and on the economic health of the community as well.

Profiling Oil Spill Hazards

The complex array of petroleum-related industries and distribution networks throughout the state of California makes the majority of the state vulnerable to oil spills. Currently, there are 26 production

platforms, 1 processing platform, and 6 artificial oil and gas production islands located in the waters offshore of California. Of the 27 platforms, 4 are located in state waters offshore of Santa Barbara and Orange counties, and 23 are located in federal waters offshore of Santa Barbara, Ventura, and Los Angeles counties. There are also 80 marine terminals in state waters and numerous land-based oil production, transportation, and storage facilities.[75]

The platforms and artificial islands off California each have multiple wells, the number of which varies from fewer than 10 to more than 50. The amount of oil produced by each structure varies from a few hundred to more than 20,000 barrels per day.

Platforms in federal waters are regulated by the U.S. Department of the Interior's Minerals Management Service (MMS). The facilities located in state waters less than three nautical miles from shore are regulated by the California State Lands Commission and the California Department of Oil, Gas, and Geothermal Resources.

A report prepared by the U.S. Department of the Interior Minerals Management Service in 2003 states 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 bbl (oil barrel unit) or greater occurring during that period is estimated at 41.2 percent for federal operations and 8.4 percent for state operations."

Under the Lempert Keen Oil spill Prevention and Response Act, the State Lands Commission exercises oversight for the prevention of oil spills from off- shore oil platforms; and on- shore and off- shore marine oil terminals. At these marine facilities large oceangoing tank vessels and smaller barges transfer oil between shore and the tank vessel. Due to numerous interfaces and interactions, there is great propensity for human-caused oil spills, fire and/ or explosion.

The California Resources Agency maintains data sets on the number, location, owner/operator, lease, and other characteristics of oil and gas wells. Currently the data catalog has information on nearly 200,000 oil and gas wells in California.

The following is a discussion of historic oil spills that have either occurred in California or have contributed to environmental legislation and regulatory requirements for the oil industry. A summary table of significant oil spills is included as Table 6.R.

Kern County

Known as the Lakeville Gusher, an oil well being drilled at 2,440 feet below the surface in Kern County between the towns of Taft and Maricopa blew out on March 15, 1910. The well was drilled into a high-pressure oil-bearing zone. The uncontained oil blew much of the steel casing out of the well and resulted in an estimated 9 million barrels of crude oil pouring from the ground. This was considered the largest documented oil spill in history and has only recently been surpassed by the Deepwater Horizon Oil Spill in the Gulf of Mexico.

To mitigate the spread of oil, workers circled the well with sandbags and built an earthen dam 20 feet high and 50 feet thick in the canyon mouths above the well to prevent flash flooding from further dispersing the oil. The well ultimately caved in and sealed itself on September 9, 1911, nearly 18 months after it blew. The site is designated as California Historical Landmark Number 485.

[75] http://www.ceres.ca.gov/ocean/theme/mineral_background.html

Santa Barbara

In 1953, Congress enacted legislation authorizing the federal leasing of submerged Outer Continental Shelf (OCS) lands. The first lease sale was conducted in 1966 and resulted in the installation of the first platform in federal waters offshore Santa Barbara County in 1967. Additional lease sales were conducted the following year; in September 1968, Union Oil Platform A was installed in 188 feet of water approximately five miles offshore of Summerland. By January 1969, four wells had been drilled and work began on a fifth well. Union Oil asked the U.S. Geological Survey to waive various well casing requirements and the waiver was approved.

Drilling began on January 14 and continued for two weeks until January 28 when drilling was halted for evaluation and maintenance. Pressure built up in the 3,500-foot-deep well as a pipe was being extracted. A burst of natural gas blew out the drilling mud that was being pumped into the well, split the steel casing, and caused cracks to form in the sea floor surrounding the well. The large volume of oil and gas being released caused a "blowout" of the well, releasing approximately three million gallons of oil over an 11-day period. Workers pumped chemical mud down the 3,500-foot shaft at a rate of 1,500 barrels an hour. It was then topped by a cement plug. Although capped, gas continued to escape and another leak sprung up weeks later releasing oil for several more months. Union Oil drilled a relief well and pumped cement into a leaking well bore, thereby killing it. However, small amounts of oil continue to leak from fractures in the sea floor to this day. Platform A is still in operation.

The cause of the blowout and spill was attributed to the inadequate protective casing allowed by the U.S. Geological Survey waiver. Investigators postulated that more steel pipe sheathing inside the drilling hole would have prevented the rupture.

The incident received international attention and was a major catalyst in the development of modern environmental law in the United States. The spill influenced the passage of major state and federal legislation, such as the National Environmental Policy Act (NEPA), Clean Water Act, California Environmental Quality Act (CEQA), California Coastal Initiative in 1972 (Proposition 20), and California Coastal Act of 1976. Pursuant to these and other statutes, development permits for onshore or offshore oil and gas facilities cannot be issued without provisions to protect terrestrial, marine, visual, recreational, and air resources.

Exxon Valdez

Although the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska did not directly affect the California environment or economy, it is significant for several reasons. First, it highlights the interconnectivity of oil production and distribution systems. The Exxon Valdez was en route from the Alyeska Pipeline Terminal to Long Beach, California when it ran aground, rupturing 8 of the 11 cargo tanks holding crude oil. Secondly, although in size the spill is no longer listed in the top 50 international oil spills, it is still considered to be one of the largest in terms of environmental damage. Finally, because of the environmental impacts, the Exxon Valdez oil spill resulted in landmark environmental legislation and more rigorous oil industry regulations.

American Trader

On February 7, 1990, off Huntington Beach, California, the oil tanker American Trader ran over its anchor, puncturing its hull and spilling an estimated 416,598 gallons of crude oil. An estimated 3,400 birds were killed as well as an unknown number of fish, and recreational beach use was seriously disrupted. The biological component of the resulting litigation was settled out of court for $3.45 million for bird and fish-related injuries, plus an additional $360,000 for water monitoring projects, while the recreational component was eventually settled, following a jury trial, for $11.6 million.
(http://www.dfg.ca.gov/ospr/NRDA/american-trader.aspx)

Guadalupe Dunes

The Guadalupe Dunes oil spill typifies another variety of oil spill that can occur in California. The Guadalupe-Nipomo Dunes, located along the southern coast of San Luis Obispo County, is one of the largest dune complexes along the California coast, measuring approximately 15,500 acres.

Oil exploration and production began in the area in the late 1940s. By 1953, Unocal Corporation was producing up to 2,000 barrels of oil per day from 34 wells. Oil field operations continued until March 1990 with gradual expansion to 215 wells producing approximately 4,500 barrels per day. Because of the highly viscous nature of the oil being extracted from the field, diluent (a diesel-like crude oil thinner) was introduced in the 1950s to assist in the production and transportation of the heavy crude. A 145-mile network of pipelines was built across the dunes to carry the diluent. Over the years, the pipelines rusted and became buried in the shifting sands, where they sprang leaks in 80 to 90 places, releasing as much as 12 million gallons of diluent into the dunes, beach, groundwater, and Pacific Ocean.

The spill came to the attention of state officials when an oily sheen was noticed by surfers and sea lions and seals began washing up dead on the shore. On March 23, 1994, a lawsuit was filed by the California State Attorney General, the California Department of Fish and Wildlife, the California Regional Water Quality Control Board Central Coast Region, the California Department of Toxic Substances Control, and the Coastal Conservancy against Union Oil Company of California. The state plaintiffs alleged in this action that on numerous occasions since Unocal began using diluent at the Guadalupe oil fields, it had leaked from the pipelines and storage tanks at numerous locations into the groundwater, surface water, and marine water. An agreement was reached between the parties in July 1998, for $43,800,000, of which $9 million was allocated for dune restoration activities. Six state and federal agencies now oversee the cleanup activities. Unocal has dismantled and removed the pipelines, storage tanks, and other infrastructure related to the oil field operations.

Cosco Busan

This San Francisco oil spill occurred on November 7, 2007, as a result of a container ship, the M/V Cosco Busan, striking the fender surrounding a footing of the western span of the San Francisco Bay Bridge. The collision caused no substantial damage to the bridge and the ship hull ruptured, causing medium-grade fuel oil to leak from its tank. Unlike oil tankers, container and cargo ships are not required to have double hulls, a regulation that was adopted following the Exxon Valdez oil spill discussed earlier.

Numerous local jurisdictions border the bayfront coastline and were affected by the oil spill. Local proclamations were issued by the counties of Alameda, Contra Costa, Marin, San Francisco, San Mateo, Solano, and Sonoma; the cities of Albany, Berkeley, and Oakland; and the East Bay Regional Park District. The Governor's proclamation covered the City and County of San Francisco and the counties of Alameda, Contra Costa, Marin, San Mateo, Solano, and Sonoma. The incident period for the event closed nearly one year following the oil spill on October 31, 2008.

Numerous state and federal agencies were involved in the oil spill response, cleanup, and subsequent investigations, including the United States Coast Guard, California Department of Fish and Wildlife (DFG) Office of Oil Spill Prevention and Response (OSPR), and California Environmental Protection Agency (CEPA) Office of Environmental Health Hazard Assessment (OEHHA). The 226 identified affected shoreline sites were ranked based on spill specifics such as the location of the release, nature of the release, volume of the release, and other established criteria. (For details on the oil spill response organization and activities, please see the Cosco Busan San Francisco Bay Area Oil Spill After Action/Corrective Action Report published by the California Emergency Management Agency, now Cal OES.)

Two new response and cleanup initiatives were developed as a result of this oil spill: DFG developed Shoreline Cleanup and Assessment Techniques (SCAT) teams to oversee beach and shoreline cleanup, and,

OSPR has taken a lead role in expanding its convergent volunteer program to include opportunities outside of wildlife rehabilitation.

Gulf of Mexico

The Deepwater Horizon oil spill occurred in the Gulf of Mexico on April 20, 2010, as a result of an explosion that killed 11 platform workers and injured 17 others. It is the largest offshore marine oil spill in United States history. After releasing approximately 4.9 million barrels of crude oil, the leak was stopped by capping the wellhead. The spill caused extensive damage to marine and wildlife habitats as well as the Gulf's fishing and tourism industries.

While a six-month moratorium of off shore drilling was imposed after the explosion, it was lifted shortly thereafter by the United States District Court. Investigations into the causes of the explosion and spill are under way by the United States Coast Guard, Minerals Management Service, National Academy of Engineering, National Commission on the BP Deepwater Oil Spill and Offshore Drilling, United States House Committee on Energy and Commerce, and others.

Table 6.R: Summary of California and Other Significant Oil Spills

Spill	Date	Area Affected	Estimated Amount	Wildlife Impacts (estimated deaths)	Estimated Costs
Lakeville Gusher - Kern County	5/14/1910-9/1911	Not available	378,000,000 gallons(9,000,000 barrels)	Unknown	Unknown
Santa Barbara	1/28/69-2/8/69	35 miles mainland coastline;800 -square mile slick	3,000,000 gallons (102,620 barrels)	3,600 birds, seals, dolphins, fish, intertidal invertebrates	$17 million in lawsuit settlements for property damage
Exxon Valdez	3/24/89	1,300 miles of shoreline	11,000,000 gallons (257,000 barrels)	250,000 seabirds, 2,800 sea otters, 300 harbor seals, 250 bald eagles,33 killer whales, billions of salmon and herring eggs	$2.1 billion for clean-up by Exxon
American Trader	2/7/90	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
Guadalupe Oil Field - San Luis Obispo	1950s-1994	2,700 acres	9,000,000-12,000,000 gallons (212,570 barrels)	Soil and water contamination; dune habitat; wetlands; groundwater; intertidal habitat	$44 million in penalties to Unocal, $9 million for restoration

Spill	Date	Area Affected	Estimated Amount	Wildlife Impacts (estimated deaths)	Estimated Costs
Cosco Busan - San Francisco Bay	11/7/07	200 miles of coastline	58,000 gallons (1,375 barrels)	2,225 birds, seals, herring eggs	$2.1 million for ship damage $1.5 million for bridge damage $70 million for cleanup
Deepwater Horizon - Gulf of Mexico	4/20/10-7/15/10	2,500-square-mile slick	180,000,000 gallons (4,900,000 barrels)	4,642 birds, 540 sea turtles, 75 mammals, (as of 8/22/10)	TBD - a $20 billion response fund established by BP

Source: Multiple sources listed in "References" at the end of this section.

Assessment of State Vulnerability and Potential Loss to Oil Spill Hazards

In his testimony to the U.S. House of Representatives Natural Resources Committee on May 27, 2010, California Congressman John Garamendi stated that the coastal environment of the state of California provides $22 billion in annual economic activity and employs 369,000 people. This is in addition to the immeasurable wealth and value that are difficult to quantify relative to the coastal environmental assets, including land, water, wildlife and habitat. While even a catastrophic oil spill such as the recent Deepwater Horizon explosion and spill in the Gulf of Mexico would affect only a portion of these economical and aesthetic assets, the potential impacts could be sizeable and long-lasting.

Current Oil Spill Hazard Mitigation Efforts

The 1969 oil spill off the coast of Santa Barbara was a pivotal event in the history of offshore oil safety. Since 1969, a number of preventive measures have been initiated, including stringent regulations covering OCS operational and environmental safety, a rigorous MMS inspection program in the Pacific OCS Region, continuous evaluation and improvement in OCS facilities' oil spill response, and the development of a highly organized oil spill response structure (Bornholdt and Lear, 1997).

Following the Exxon Valdez oil spill in Alaska in 1989, both the United States and California government enacted laws to prevent oil spills. The International Safety Management Code, enforced since 1998, requires ships entering U.S. ports to meet certain standards, including procedures for reporting accidents and requiring qualified crew. In 1990, the U.S. enacted the Oil Pollution Act (OPA). OPA requires that oil tankers be double-hulled and that existing single-hull tankers be phased out. A double hull further protects a ship from damage to its cargo tank, reducing the risk of oil spilling during an accident. California enacted the Lempert-Keene Seastrand Oil Spill Prevention and Response Act in 1990, which established the Office of Spill Prevention and Response within the (now) Department of Fish and Wildlife (DFW). This office is authorized to direct spill response, cleanup, and natural resource damage assessment activities, as well as regulate all private vessels over 300 gross tons (672,000 pounds) that enter California ports. That Act also gave oversight of all marine oil terminals in the state to the State Lands Commission, with the mandate to protect the public health, safety, and the environment by preventing spills at these facilities.

Non-tanker vessels (like the container ship that spilled oil in San Francisco) have their own regulations, which are less stringent than those for tanker vessels. 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. Non-tank vessels over 300 gross tons must carry $300 million of insurance, while the requirement for tanker vessels is $1 billion.

The State Lands Commission has prevention programs for exercising the oversight at all oil platforms and oil terminals under the Lempert Keen Oil spill Prevention and Response Act. Under the authority of this Act, the State Lands Commission exercises oversight over the oil production operation on oil platforms and oil transfer operations between the ships and the shore. Each production activity generates its risk to the public and the environment. The State Lands Commission is charged with oversight responsibility under the Act. The oversight is exercised by the Commission staff on oil production work, to ensure adequate precautions are taken by industry. This is done through a comprehensive regulatory frame work of performance standards. The Commission staff periodically inspects and regularly monitors the operations at oil platforms and in marine oil terminals for conformance to performance standards.

Oil Spill Response Plans and Procedures

Local Marine Oil Spill Contingency Plans are developed by local governments that have marine waters within their borders. They may develop or update a Local Oil Spill Contingency Plan, consistent with state policy, as a supplement to their Area Plan. Although not required, most local governments have undertaken this planning process.

Harbor Safety Plans are created pursuant to California Government Code Section 8670.23.1. Harbor Safety Committees were created in each of the major active port areas in the state to address oil spill prevention issues in those regions. The plans created by the committees are designed to ensure safe navigation and operation of vessels within each harbor. The California Department of Fish and Wildlife, Office of Spill Prevention and Response (DFG-OSPR) is charged for developing regulations for the plans, which are found in 14 CCR § 802.

Region IX Mainland Regional Contingency Plan (RCP) is designed to coordinate timely and effective responses by various federal and state agencies and other organizations to discharges of oil and releases of hazardous substances, pollutants, and contaminants to protect public health, welfare, and the environment. It is meant to ensure that the roles and responsibilities of federal, state, local, and other responders are clearly defined. The plan also describes the Regional Response Team (RRT) organization and its relationship to other contingency plans. The RRT oversees the response operations and removal and remedial actions of hazardous substance, the use of chemical countermeasures such as dispersants and surface washing agency, state-specific response information, notification procedures, and natural resource trustee contacts. The Region IX Mainland RCP is supplemented by marine area plans and inland sub-area plans, which provide detailed information on area of environmental or special economic importance. The RCP also identifies those minimum components of an Inland Area Contingency Plan, which best support the first responders. (See discussion of marine and inland area planning below.)

Marine and Inland Area Contingency Plans (ACPs) are required by Section 311(j) of the Federal Clean Water Act. They are developed and maintained by Area Committees comprised of qualified personnel of federal, state, and local agencies. Area Committees, under the direction of a Federal On-Scene-Coordinator (FOSC), are responsible for preparing ACPs as described in National Contingency Plan (NCP) Section 300.210(c). Although Area Plans are "owned" by their Area Committees, the lead federal agency for marine area plans is the United States Coast Guard (USCG) and for inland area plans it is the United States Environmental Protection Agency (U.S. EPA). Area Committees are also responsible for working with appropriate federal, state, and local officials to enhance the contingency planning of those officials and to assure pre-planning of joint response efforts.

Marine ACPs: In California, there are six geographical marine areas and Area Committees along the coast and three Area Contingency Plans. Each Area Committee, chaired by the USCG and co-chaired by DFW-OSPR, is comprised of a diverse group of participants from federal, state, and local agencies with expertise in environmental and response issues, as well as industry representatives and special interest groups.

Inland ACPs: Currently in California there are six sub-area plans in various stages of completion or currency: the Upper Sacramento River Geographical Response Plan, Truckee River Geographical Response Plan, Carson/Walker Geographical Response Plan, Lake Tahoe Basin Geographical Response Plan, Lower Colorado River Plan, and the Feather River Plan. U.S. EPA is the lead agency for the California Inland Area Committee, which is comprised of federal and state agencies with Cal OES and DFG-OSPR providing California guidance with multi-agency response.

The California Oil Spill Contingency Plan is the State oil spill and marine oil spill contingency plan as required pursuant to California Government Code Sections 8574.1 and 8574.7. DFW-OSPR combined the California Oil Spill Contingency Plan and the Marine Oil Spill Contingency Plan into one plan.

The National Oil, Hazardous Substances, Pollutants, and Contaminants Contingency Plan (NCP) is the nation's main hazardous materials emergency response plan. It is promulgated in Title 40, CFR, Part 300. The NCP is designed to provide for efficient, coordinated, and effective action to minimize adverse impact from oil discharges and hazardous substance releases. The NCP contains the national response strategy that provides the framework for notification, communication, logistics, and responsibility for response to discharges of oil, including worst-case discharges, and discharges that pose a substantial threat to the public health or welfare of the United States. The NCP is supported by the Region IX Regional Contingency Plan (RCP) and Marine and Inland Area Contingency Plans.

Oil Spill Technical Advisory Committee (TAC)

The Oil Spill Technical Advisory Committee (TAC) was established to provide public input and independent judgment of the actions of the DFG-OSPR Administrator and SIOSC. TAC consists of ten appointed members, six of whom are appointed by the Governor, two by the Speaker of the Assembly, and two by the Senate Rules Committee. These appointees must have experience, knowledge, and expertise in the following areas:

- Public representation
- Marine transportation
- Local government
- State government
- Petroleum industry
- Oil spill response and prevention programs
- Environmental protection and the study of ecosystems

The TAC meets as often as necessary, but at least twice a year, and provides the following:

- Provides recommendations to DFG-OSPR, State Lands Commission (SLC), California Coastal Commission (CCC), and SIOSC on any provision of Chapter 7.4 of the California Government Code, including the promulgation of all marine oil spill prevention and response rules, regulations, guidelines, and policies.
- Reports biennially to the Governor and the Legislature on its evaluation of oil spill response and preparedness programs within California. May prepare and send any additional reports it determines to be appropriate to the Governor and the Legislature.
- May study, comment, or evaluate any aspect of oil spill prevention and response in the state, coordinated with ongoing studies by the federal government, DFG-OSPR, SLC, State Water Resources Control Board (SWRCB), and other state and international entities.

Potential for Future Oil Spill Hazard Mitigation Efforts

West Coast Ocean Protection Act

In response to the Deepwater Horizon oil spill in the Gulf of Mexico in 2010, Senators Barbara Boxer and Dianne Feinstein from California joined senators from Oregon and Washington to introduce a bill known as the West Coast Ocean Protection Act that would prohibit offshore oil and gas drilling off the West Coast of the United States. The bill was a companion to a House bill introduced by California Representative John Garamendi. The 2010 bills were not enacted; however, after another unsuccessful attempt in 2011, Senators Boxer and Feinstein have re-introduced their bill once again in 2013. If passed, the bill would amend the existing Outer Continental Shelf Lands Act to prohibit the U.S. Secretary of the Interior from issuing leases for the exploration, development, or production of oil or natural gas in any area of the outer Continental Shelf off the coast of California, Oregon, or Washington. However, development on existing state and federal leases would not be affected and could still occur within offshore areas leased prior to the implementation of leasing restrictions.

The future of mitigation efforts in preventing catastrophic oil spills lies in oil industry adopting systems safety approaches which builds a culture of safety. The systems safety approach balances the production goals to public expectation of risk management as a result of that production. It encompasses managing the sociotechnical risks at the interfaces of human beings, organization and engineered system. In the recommendations of the Deepwater Horizon incident of April 2010, the National Academy of Engineers and the National Research Council (Recommendation 5.5) stated "…Industry should foster an effective safety culture through consistent training, adherence to principles of human factors, system safety and continued measurement through leading indicators." *(p.82)*

Removal of Structures from the Surf Zone

There exist many hazards in the surf zone along Santa Barbara and Ventura County Coastline that are caused by the remnants of past oil and gas development and/or are the result of development along the coastline. These hazards consist of old oil pier remnants H-beam piles and old oil well caissons. The remnants are generally sharp protruding spikes that can cause severe injury to the beach users.

As the underlying fee owner with exclusive jurisdiction over sovereign lands of the State, the California State Lands Commission is responsible for structures located on tide and submerged lands pursuant to Public Resources Code Section 6301 et seq. Failure to provide for public safety exposes the State to tort liability in the event of an accident involving injury or death resulting from public use of the facility. A single loss could exceed the cost of repairs. The State is aware of the hazard and the fact that failure to remediate could be determined as negligent. These lands are held in trust to be used for public purposes such as commerce, navigation, fishing, recreation, and environmental open space and habitat. The hazards represent derelict structures that impede these uses and pose a potential threat to public health and safety.

6.6.8 RADIOLOGICAL ACCIDENTS

Identifying Radiological Accident Hazards

Radioactive materials are routinely transported in California. These materials include the medical and industrial sources described below, as well as wastes that have radioactive components. Many of the radioactive waste shipments come from research and cleanup efforts at national laboratories.

Diablo Canyon Power Plant in San Luis Obispo County is the only operating nuclear power plant (NPP) in California. The Diablo Canyon plant is undergoing seismic studies to identify the location and potential hazards associated with a recently identified off-shore earthquake fault zone as part of relicensing by the California Public Utilities Commission and the federal Nuclear Regulatory Commission (NRC).

The San Onofre plant, has not produced electricity since January 2012 due to the discovery of eroded tubes in recently installed steam generators and was retired in June 2013. Two other nuclear power plants, Humboldt Bay and Rancho Seco, are not operational but have spent fuel stored onsite.

Radiological accidents that result in the release of radioactive materials may result in long-term health risks and contamination of the state resources, including air, water supply, groundwater, and agricultural lands.

Profiling Radiological Accident Hazards

Due to strict regulation of nuclear power plants in the United States, significant nuclear power incidents that can cause harm to the public have low probability of occurrence, and none have occurred to date in California. The probability of a catastrophic event involving a nuclear power plant is low and these plants are extremely well protected. 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 successful terrorist attack on a nuclear power plant that results in a release of radioactive materials could be very significant.

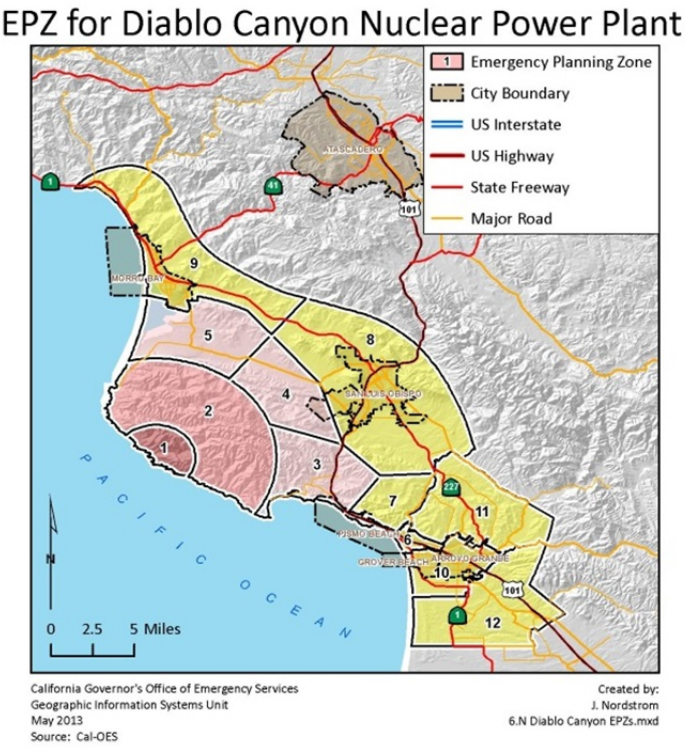
State and local governments having jurisdiction within ten miles of an operating nuclear power plant in the U.S. must plan, train, and conduct emergency exercises annually in accordance with federal regulations. Detailed emergency plans are maintained by each affected agency. Four Emergency Classification Levels (ECLs) have been established in federal regulations to characterize the severity of the emergency and the response actions required. The ECLs must be used as the foundation for emergency response planning, training and exercises (described in Table 6.S).

Table 6.S: Levels of Nuclear Power Plant Emergencies

Emergency Classification Levels (ECL)	ECL Description and Purpose	Populations Affected*	Occurrences
Notification of Unusual Event	Issued when events have occurred that potentially could degrade the level of plant safety. No radioactive releases requiring emergency response are expected.	Onsite only	Average 1-2 per year
Alert	Issued when events have occurred that involves a substantial degradation of plant safety. Any radioactive releases are expected to be a fraction of federal exposure guidelines requiring protective actions.	Onsite only	(SONGS, March 1999, San Onofre)
Site Area Emergency	Issued when events have occurred that involve the failure of major plant functions needed to protect the public. Radioactive releases are not expected to exceed federal exposure guidelines at the site boundary.	Site area, schools, beaches, and transient populations within the Emergency Planning Zone	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 Emergency Planning Zone	0

**Includes only populations with special planning and response operations.*

MAP 6.U: Nuclear Power Plant Emergency Planning Zones (EPZs)



Emergency Planning Zone (EPZ) for Diablo Canyon Nuclear facility is shown in Map 6.U. As part of the planning basis, affected agencies must establish EPZs, which consist of areas within an approximate ten-mile radius drawn around each plant site. The exact EPZ size is established to provide for substantial reduction in early severe health effects in the event of a worst-case core melt accident.

Assessment of Local Vulnerability and Potential Losses

For information on community vulnerability and loss, see Local Hazard Mitigation Plans.

Current Radiological Accident Mitigation Efforts

The Radiological Preparedness Unit (RPU) in Cal OES plans, prepares for, responds to, mitigates, and assists in the recovery from radiological incidents that threaten public health and safety, property, and the environment. The goal of the RPU is to protect the public, property, and the environment from the possible harmful effects of radiation from incidents during transportation, at nuclear power plants and other fixed facilities, and from acts of terrorism. The RPU provides an effective and efficient emergency management system for radiological incidents by coordinating private entities and federal, state, and local government organizations.

The RPU is responsible for two programs:

- The California Radiological Emergency Preparedness (CalREP) Program
- The Nuclear Power Plant (NPP) Program

The CalREP Program includes planning for emergency response and recovery from threats of nuclear terrorism, transportation accidents involving radiological materials and wastes, and radiological accidents at "fixed facilities" (i.e., facilities that are not mobile and are not nuclear power plants). The program trains

emergency response workers to recognize the various types of radiation, effects of radiation, and protective actions needed for a safe response. The primary focus is on protection of the public, emergency workers, property, and the environment from the possible harmful effects of radiation and radioactive contamination.

The NPP Program covers emergency planning issues related to the state's one operating nuclear power plant - Diablo Canyon. The NPP Program works with local, state, federal, and utility officials in emergency planning, training, and exercises to test emergency readiness.

Nuclear Power Plant Safeguards

Triple-safeguard features are designed to prevent the release of radiation at nuclear power plants:

1. Metal tubes or rods, which contain the fuel pellets, act as the first barrier
2. Next, the fuel rods are contained in the reactor vessel within 8-inch-thick steel walls
3. Finally, an airtight containment building is constructed of metal and reinforced concrete walls, totaling more than four feet thick

Control and safety systems within the plant are designed to overlap for safety. Automatic systems have the ability to shut down the reactors within seconds if monitoring devices detect unusual conditions, such as an excessive heat buildup. Should any individual safety component fail, there are back-up systems that take over immediately.

The Nuclear Regulatory Commission (NRC) has resident inspectors assigned to each plant site. The inspectors oversee plant operations and ensure compliance with regulations governing operational and occupational safety. There are automatic communications systems that contact the State Warning Center in Sacramento if certain conditions, such as an earthquake or certain plant conditions, occur. The State Warning Center will be able to contact key personnel needed in an emergency.

Nuclear Power Plant Emergency Preparedness

Planning, preparing, and training for nuclear power plant emergencies are also part of the safeguards. Federal, state, and local emergency management agencies work with the utilities to ensure that nuclear power plants are safe and that each agency and utility has an effective emergency plan describing the actions to be taken in response to an emergency. Residents and businesses near a nuclear power plant should prepare a disaster plan for all emergencies, including nuclear power plant emergencies, and become familiar with the emergency preparedness information. Information regarding nuclear power plant safety issues, in general, is available from the federal NRC at: www.nrc.gov. The NRC has primary jurisdiction over nuclear facilities in the United States and works closely with state and local emergency agencies.

Planning Zones

A series of zones has been established around each nuclear power plant to clearly identify the required activities in the event of an accident. Although three specific zones are identified, efforts to protect public health and safety and the environment are made without regard to whether particular areas are inside or outside of these zones:

- The Emergency Planning Zone is an approximate 10-mile radius around the plants. Plans for this zone are in place to protect people, property, and the environment from the effects of exposure to a radioactively contaminated plume.
- The Ingestion Pathway Zone covers an approximate 50-mile radius around the plant. In this zone, plans are in place to mitigate the effects of radioactive contamination to agriculture, and food processing and distribution.

- Within Public Education Zones, including areas approximately 35 miles from the plants, educational materials are distributed to inform the public about nuclear power plant operations, what to expect in the event of an accident, and what plans are in place for public protection. The utilities that operate the power plants are required to publish and disseminate information for residents and transient populations.

Radiological Waste Transportation

Since 1989, the staff of the Energy Commission has represented California on two western state groups: the Western Governors' Association WIPP Transportation Advisory Group and the Western Interstate Energy Board's High-Level Radioactive Waste Committee. Both groups work with the U.S. Department of Energy and other state regional groups to develop accident prevention and emergency response plans for major federal non-classified shipments of radioactive waste. Staff also coordinates the California Nuclear Transport Working Group that develops and updates accident prevention and emergency response plans for federal shipments of transuranic waste to the Waste Isolation Pilot Plant (WIPP) in New Mexico.

To mitigate disaster, federal regulations require that 1) radiological materials transported by train use special packaging based on the hazard of the shipment, 2) there is extensive worker training and documentation, 3) vehicle and packages of radioactive materials are inspected, and 4) the waste travels via specific, controlled routes. More information about radiological waste transportation can be found on Cal OES's radiological transportation website.

Opportunities for Enhanced Radiological Accident Hazard Mitigation

The nuclear power plant mitigating strategies currently in place were developed in the context of a localized event that was envisioned to challenge portions of a single unit. The events at Fukushima, however, demonstrate that "beyond-design-basis" external events (i.e., events that were not allowed for in a plant's design because they were considered too unlikely) may adversely affect: (1) more than one unit at a site with two or more units, and (2) multiple safety functions at each of several units located on the same site.

Nuclear plants are typically designed with multiple independent and redundant layers of defense to compensate for potential human and mechanical failures so that no single layer, no matter how robust, is exclusively relied upon. This "defense in-depth" strategy includes the use of access controls, physical barriers, redundant and diverse key safety functions, and emergency response measures. However, the events at Fukushima further highlight the possibility that extreme natural phenomena could challenge even this approach to prevention, mitigation, and emergency preparedness.

To address the uncertainties associated with beyond-design-basis external events, the NRC is now requiring a three-phase approach for mitigating such events. The initial phase requires the use of installed equipment and resources to maintain or restore core cooling, containment and spent fuel pool (SFP) cooling capabilities. The transition phase requires providing sufficient, portable, onsite equipment and consumables to maintain or restore these functions until they can be accomplished with resources brought from off site. The final phase requires obtaining sufficient offsite resources to sustain those functions indefinitely. Additionally, the NRC has initiated studies to learn more from the events at Fukushima, which will likely result in further changes in requirements for mitigation, preparedness, and response at U.S. nuclear power plants.

Cal OES is developing the response to an attack using radiological or nuclear weapons. The Radiological Nuclear Emergency Response Program is addressing the immediate and near term issues confronting public safety in such an attack. The challenge is to define the attack, take appropriate actions, and communicate with the affected public in time to save lives. This effort is ongoing and will enhance the State's response stance to an attack.

6.6.9 TERRORISM

Identifying Terrorism Hazards

Disasters are events that can cause loss of life and property, environmental damage, and disruption of governmental, social, and economic activities. They occur when hazards affect human settlements and the built environment.

Technological hazards and terrorism are manmade hazards. These are distinct from natural hazards primarily in that they originate from human activity. In contrast, while the risks presented by natural hazards may be increased or decreased as a result of human activity, natural hazards are not inherently human induced.

The term technological hazards refer to the origins of incidents that can arise from human activities such as the manufacture, transportation, storage, and use of hazardous materials. For the sake of simplicity, this plan assumes that technological emergencies are accidental and that their consequences are unintended.

The term terrorism refers to intentional, criminal malicious acts. There is no single, universally accepted definition of terrorism, and it can be interpreted in many ways. Terrorism is defined in the Code of Federal Regulations as "...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." (28 CFR, Section 0.85). For the purposes of this plan, terrorism refers to the use of weapons of mass destruction, including biological, chemical, nuclear, and radiological weapons; arson, incendiary, explosive, and armed attacks; industrial sabotage and intentional hazardous materials releases; and cyber terrorism.

The process of identifying and mitigating hazards before they become disasters is similar for both natural and manmade hazards. Whether dealing with natural disasters, threats of terrorism, or hazardous materials accidents, a four phase mitigation process should be used: 1) identify and organize resources, 2) conduct a risk assessment and estimate potential losses, 3) identify mitigation actions, and 4) implement the actions, evaluate the results, and keep the plan up-to-date.

In one form or another, planning is an element of almost everything that individuals, institutions, corporations, and governments do. Planning helps to coordinate actions, determine the order in which goals are accomplished, leverage opportunities, and identify priorities for allocating resources. Hazard mitigation planning is the integration of these activities into a community's emergency management programs in order to reduce or eliminate losses of life and property due to terrorism hazards.

Characterizing Terrorism Hazards

Terrorist events have continued to occur in California. A recent example is an attack on a major agriculture facility in the Central Valley in January 2012.

Terrorist threats are difficult to predict. Since a myriad of non-state actors use terrorists attacks for various reasons, the profile of terrorism hazards is large. Two things are clear from the perspective of hazard mitigation: the most often used weapon of terrorists are bombs, and the greatest potential for loss is from weapons of mass destruction. Further concerns include the use of chemical and biological weapons.

Assessment of State Vulnerability and Potential Losses

The following infrastructure has been identified as vulnerable to attack from domestic and international terrorists:

- Water: 34 lakes and reservoirs; 1,468 dams, 140 of which have a capacity greater than 10,000 acre-feet; 701 miles of canals and pipelines; and 1,595 miles of levees
- Transportation: 50,000 lane miles of highways; 246 public use airports, 30 of which provide scheduled passenger service; over 170,000 miles of public roads; and more than 12,000 bridges
- Agriculture: nearly 81,000 farms, and $44.7 billion in farming-related sales.[76] According to the USDA statistic, California was ranked number one among the top five agriculture states for 2011
- Oil and Natural Gas: more than 115,000 miles of pipelines; 20 refineries and over 100 terminal facilities
- Electrical Power: 500 power plants; 25,000 circuit-mile "electron highway"
- Chemical: Approximately 100 "high risk" facilities
- Ports: With 11 seaports, California handles nearly half of all the port traffic in the United States

The vulnerability of various assets to particular threats can change over time. Tracking the vulnerability of different components may be done using various programs and systems, including the National Critical Infrastructure Prioritization Program (NCIPP), the Automated Critical Asset Management System (ACAMS), and other tools which can be used to determine which assets, systems, or networks are nationally critical, state critical, or locally critical based on current risk profiles. Sector partnerships and communication networks, which partner with asset owners to identify high-priority sites in each sector also play a key role in this effort.

The California State Threat Assessment Center (STAC) is the centerpiece of the State's information sharing environment (ISE), and provides for the State's subsequent ability to maintain situational awareness over its broad threat domains in an effort to prevent and mitigate the threats against the lives and property of its citizens. A unique and notable function of the STAC is its ability to aggregate data from all of California's fusion centers, to include national and international data, and in doing so, to provide a larger more contextual strategic assessment of any given situation of relevance to California. This is especially vital in the critical infrastructure/key resource (CI/KR) protection domain, where the vulnerability and/or exploitation of assets may have grave import and consequence.

Cal OES developed a plan to establish four regional, locally-owned and operated homeland security fusion centers in California. This plan resulted in the State Threat Assessment System (STAS), a key component of California's Homeland Security Strategy. The four regional fusion centers mirror California's four federal districts. California's Homeland Security Advisor created the STAS to provide a framework for federal, state, local, and tribal public safety agencies; criminal intelligence agencies; other state agencies; and critical infrastructure and key resource operators to work cooperatively and effectively in California.

Assessment of Local Vulnerability and Potential Losses

At the local level, law enforcement and public safety agencies designate Terrorism Liaison Officers (TLOs) who are trained in the review and assessment of local reporting and conducting outreach to other public safety agencies, critical infrastructure operators, and community groups. The TLO is the local agency point of contact for all terrorism-related alerts, requests for information, warnings, and other notifications from regional, state, or federal homeland security agencies. Through a single web-based state terrorism website, the TLO and his or her agency will have access to all available terrorism alerts, notices, information, and documents through a searchable database and daily information exchange with key federal, state, and local agencies.

Because of the dynamic nature of the terrorist threat and the open nature of California society, all jurisdictions within California are vulnerable to terrorist attack. Vulnerability and loss assessments for California communities may be found in Local Hazard Mitigation Plans.

[76] United States Department of Agriculture, Pacific Region Farm News. August 30, 2013

Current Terrorism Mitigation Efforts

The Cal OES is California's lead state organization for gathering and disseminating information critical to protecting state assets, creating the state's comprehensive security strategy, and designing and implementing critical state, regional and local infrastructure protection programs.

Since 2003, Cal OES has administered more than $1.42 billion in federal grant funds at the state, regional, and local levels to significantly improve physical security at critical sites, upgrade equipment, and conduct training and exercises. In addition, the Cal OES State Threat Assessment Center (STAC) acts as the California statewide information clearinghouse to aid in the prevention, preparation, and response to strategic threats while preserving individual privacy and constitutional rights. The STAC develops intelligence products, including sector-specific critical information threat bulletins, for the state and local law enforcement, fire, and emergency management communities.

Protecting Critical Infrastructure

Since 9/11, California has worked closely with the federal Department of Homeland Security to enhance protection of California's complex and interdependent Critical Infrastructure and Key Resources (CI/KR). A broad range of state and federal initiatives has been designed to nurture public and private sector coordination of security-related activities prerequisite to infrastructure protection.

On December 17, 2003, President George W. Bush signed Homeland Security Presidential Directive Number 7 (HSPD-7). This directive established a national policy to identify and prioritize United States CI/KR and protect them from terrorist attacks. HSPD-7 also mandated the development of strategic enhancements. Tactical security improvements must be rapidly implemented to deter, mitigate, or neutralize potential attacks. To facilitate the accomplishment of HSPD7, California's Critical Infrastructure Protection Objectives, described in the State's Homeland Security Strategy, are three-fold. California is committed to:

- Identifying and assuring the protection of infrastructures and assets deemed most critical in terms of consequences of terrorist attacks or natural disasters that impact California’s public health and safety, governance, economic and national security, and public confidence
- Providing timely warning and assuring the protection of infrastructure and assets that face a specific, imminent threat
- Assuring the protection of other infrastructure and assets that may become terrorist targets over time by pursuing specific initiatives and enabling a collaborative environment in which federal, state, and local governments and the private sector can better protect the infrastructures and assets they control

On February 12, 2013, President Barack Obama signed the Presidential Policy Directive-21 (PPD-21). This directive, which superseded HSPD-7, advances a national unity of effort to strengthen and maintain secure, functioning, and resilient critical infrastructure. PPD-21 emphasizes that critical infrastructure must be secure and able to withstand and rapidly recover from all hazards.

The Cal OES Infrastructure Protection Division (IP Division) works to address emerging issues related to the many varied aspects of infrastructure protection. The IP Division provides a mechanism to foster relationships and facilitate coordination between public-private partnerships throughout infrastructure sectors. The IP Division’s key initiatives and services include critical infrastructure identification and prioritization, physical security and vulnerability assessments, information sharing, geospatial information systems analysis and mapping, and Threat and Hazard Identification and Risk Analysis.

The IP Division serves as an essential link and advocate for local, public and private infrastructure entities, in cooperation with the DHS Office of Infrastructure Protection and FEMA Region IX. Cal OES’s Grant Section is responsible for the overall grant management of the California Port and Maritime Security Grant Program

funded from Proposition 1B funds, the Public Safety Interoperable Communications, Operation Stonegarden and the Interoperable Emergency Communications Center grant programs.

Protecting the Food Supply

Collaboration continues among the Western Institute for Food Safety and Security (WIFFS), California Department of Food and Agriculture (CFDA), Department of Public Health, and UC Davis. The WIFFS is built on the functional relationships of these organizations and the private sector on the challenges of preventing intentional and unintentional contamination of food. Continued collaboration with the Bio-watch Program deploys and maintains a 24/7 operational ability to detect, mitigate, respond to, and recover from a bioterrorism event. This early warning system will detect intentional release of selected aerosol biological agents.

Reducing Risks to Critical State Facilities and Population

Terrorism and physical attacks on buildings have continued to increase in the past decade. The geographical isolation of the United States is not a sufficient barrier to prevent attacks on California. Several methodologies exist for architects and engineers to quantify risk and to identify the most effective mitigation measures to achieve a desired level of protection against terrorist attacks at an acceptable cost. The beginning point is to establish a methodology for design by identifying the threat or hazard to be designed against and applying cost effective countermeasures. Mitigation countermeasures may include; hardening buildings, installing barriers and fencing materials, creating redundant systems, using updated information technologies, establishing community continuity plans, establishing risk and resilience management programs, conducting seismic studies, using secure access and entry point procedures, and establishing a comprehensive cyber-security program.

Opportunities for Enhanced Terrorism Hazard Mitigation

Governor Schwarzenegger signed an Executive Order to create the California Maritime Security Council (CMSC). The CMSC is comprised of top officials from Cal OES; the U.S. Coast Guard; the California Business, Transportation & Housing Agency; the National Guard; the U.S. Navy; other agencies; directors of California's major ports; and representatives from the labor and business communities. The specific duties of the CMSC are identifying potential threats; improving security measures, procedures, and communications; coordinating contingency planning; coordinating information sharing; conducting training exercises; developing a statewide maritime security strategy; and preparing to quickly recover from a catastrophic event at a California port. Such measures can help minimize and reduce losses from potential terrorist threats.

6.6.10 CYBER THREATS

In February 2013, President Barrack Obama signed Executive Order 13636, Improving Critical Infrastructure Cyber Security, which states; "Repeated cyber intrusions into critical infrastructure demonstrates the need for improved cyber security. Critical Infrastructure means systems and assets, whether physical or virtual, so vital to the United States that the incapacity or destruction of such systems or assets would have a debilitating impact on security, national economic security, national public health and safety or any combination of those matters."[77] In May 2011, President Obama signed the Presidential Policy Directive (PPD)-21 on Critical Infrastructure Security and Resilience which is intended to strengthen the security and resilience of critical infrastructure against evolving threats.

The California Department of Technology, Office of Information Security (OIS) plays a critical role in ensuring the State's Information Technology infrastructure is capable of delivering vital services in a secure, reliable, and trustworthy manner. The OIS is involved in a broad range of activities within the state and collaborates with Federal, County, and City security professionals. OIS responsibilities include security incident management, security policy development, disaster recovery planning, risk management, mitigation planning, security training and awareness, public outreach, and coordination with hundreds of Information Security Officers, Privacy Coordinators and DRP professionals across the state. For more information on cyber threats and mitigation planning visit OIS at: http://www.cio.ca.gov/ois/

The OIS is the primary state government authority in ensuring the confidentiality, integrity, and availability of state systems and applications, and ensuring the protection of state information. Their office represents the State to federal, state, and local government entities, higher education, private industry, and others on security-related matters. They are committed to securing the State's information assets to build and maintain the trust of Californians.

Every May, the California Department of Technology is joining schools and community partners statewide to encourage students and families to think critically, behave safely and participate responsibly and ethically online. California Digital Citizenship Month is an opportunity to teach and dialogue on topics impacting California youth such as cyber bullying, digital foot prints, on-line privacy, security and copyrights. By teaching digital citizenship, California is preparing its students to be safe and secure in a 21st century digital world. For more information on how you can raise awareness in your community, visit Common Sense Media at: http://techblog.ca.gov/?p=3277 and www.commonsensemedia.org/California

Each October the Center for Internet Security (CIS) and Multi-State Information Sharing and Analysis Center (MS-ISAC) Center serves as a co-host with the U.S. Department of Homeland Security's National Cyber Security Division, the National Association of Chief Information Officers and the National Cyber Security Alliance in promoting Cyber Security Awareness Month. The MS-ISAC develops and distributes Cyber Security Awareness Toolkit materials to all 50 states, the District of Columbia and its member Territories in support of Cyber Security Awareness Month. More about MS-ISAC and their materials can be found at: http://msisac.cisecurity.org/resources/toolkit/

The CIS is starting a new initiative called the Integrated Intelligence Center (IIC) to serve as a resource for state, local, tribal, and territorial government partners on cyber security information. Through this initiative the IIC will provide fusion centers with access to a broad range of cyber security products, reflecting input from many sources. The goal of this initiative is to ensure actionable information, collected and analyzed by both DHS and the IIC, is shared with fusion centers in a timely manner. CIS, in partnership with DHS, has established a mechanism for all fusion centers to engage in a new collaborative information sharing and analysis environment on cyber security issues. For more information on the fusion center that supports your area of operations, go to the National Fusion Center Association web page at: https://nfcausa.org/

[77] http://www.dhs.gov/publication/fact-sheet-eo-13636-improving-critical-infrastructure-cybersecurity-and-ppd-21-critical, last reviewed, 7 May 2013.

Progress Summary 6.S: California Cyber Security Task Force

Progress as of 2013: In May of 2013, the California Governor's Office of Emergency Services and the California Department of Technology initiated the California Cybersecurity Task Force.

The mission of the California Cybersecurity Taskforce is to act as an advisory body to State of California senior administration officials in matters related to cyber security. The strategic role of the task force is to act in an advisory capacity in the following areas:

- Identifying areas where stakeholders can improve statewide collaboration and information sharing to identify potential threats
- Reviewing areas where coordination will enhance security, emergency response. Communications, contingency planning and other areas of mutual responsibility across the State of California
- Developing and reviewing a statewide cyber security strategy

The taskforce membership is composed of representatives from the public and private sectors, academia and Tribal government. Taskforce members have a vested interest in cyber security and their involvement and commitment will benefit California and its citizens.

Additional information on cyber threats and cyber security can be found at the following websites:

- Information on the Executive Order, and Presidential Policy Directive
- Integrated Task Force Collaboration Community on IdeaScale
- Federal Register Notice on NIST RFI
- NIST Cybersecurity Framework Home Page
- Website for May 29-31 NIST Workshop at Carnegie Mellon
- Website for July 10-12 NIST Workshop at UC San Diego
- NIST RFI Comments
- NIST RFI Initial Analysis
- Department of Homeland Security Incentives Report
- Department of Treasury Incentives Report
- Department of Commerce Incentives Report

6.7 ADDITIONAL HAZARDS

The hazards included in this section are less comprehensive in scope and content because their potential impacts affect a smaller geographic area than those included in preceding sections and they occur less frequently.

6.7.1 AIRLINE CRASHES

Airline crashes, like other transportation accidents, are less likely to lead to a state or federal disaster declaration than other hazards. Cal OES recognizes the severity of these incidents, which often lead to deaths and injuries.

6.7.2 CIVIL DISTURBANCES

As summarized in the Table 6.T, there have been several significant civil disturbances in California since 1950. These disturbances have all taken place in metropolitan areas.

Table 6.T: Civil Disturbances

Disturbance	Location	Year	Deaths	Injuries	Damage
Berkeley	City of Berkeley	1964	0	20	N/A
Watts	South Central Los Angeles	1965	32	874	$45 million
San Francisco	City and County of San Francisco	1966	N/A	42	N/A
Burning of Bank of America	Santa Barbara	1969	0	12+	$275,000-$300,000
Rodney King Riot	City of Los Angeles	1992	53	2,300	N/A

6.7.3 METAL THEFT IN CALIFORNIA

Intelligence assessments on metal theft and the threat to critical infrastructure show that thieves and vandals are threatening California's critical infrastructure by targeting electrical substations, cellular towers, telephone land lines, railroads, water wells, construction sites, and vacant homes. These assessments reveal that the theft of copper, aluminum and other metals from such facilities disrupts the flow of electricity, telecommunications, transportation, water supply, heating, security and emergency services. This presents not only a risk to public safety but to the state economy as well.

There are many different methods to prevent and mitigate the consequences of metal theft, such as conducting physical assessments with subject matter experts, coordinating with local law enforcement for awareness and mitigation training, and establishing community and employee awareness programs to understand the consequences of metal theft to critical infrastructure. Also, employees should be trained to; report metal theft-related vulnerabilities, understand recycling laws, and adopt loss prevention measures, such as labeling unique property most at risk. In addition, communities should also work with their local law enforcement officials to report suspicious actives around critical infrastructures that would assist to disrupt metal thieves. Statewide enforcement of recycling laws can also help to deter metal theft and reduce the economic benefit of said criminal activities.

For other discussions on lifelines vulnerabilities, see section 5.2.4.2 and Annex 3.

6.7.4 TRAIN ACCIDENTS RESULTING IN EXPLOSIONS AND/OR CHEMICAL RELEASES

Train accidents are generally localized and the incidents result in limited impacts at the community level. However, if there are volatile or flammable substances on the train and the train is in a highly populated or densely forested area, death, injuries, and damage to homes, infrastructure, and the environment, including forest fires can occur.

According to Cal OES, there have been 14 train accidents affecting 12 communities since 1950. Several significant train accidents, derailments, fires and hazardous material releases have occurred in California in the past 40 years that resulted in multiple deaths, numerous injuries, and property damage and have, thus, stimulated changes in land use and rail safety regulations.

Roseville Train Explosion

As reported in Section 6.6., a dramatic example in recent California history was the major explosion and chemical plume release that occurred in April 1973 in the Roseville railroad yard when 6,000 bombs on a train bound for the Concord Naval Weapons Stations detonated after a car caught fire. Although no one

was killed, the blast reportedly injured about 100 people and damaged 5,500 buildings, some more than a mile away.[78]

Duffy Street Derailment, San Bernardino

On May 12, 1989, a 6-locomotive/69-car Southern Pacific freight train picked up speed while descending down the Cajon Pass in Southern California. The train reached a speed of 110 miles per hour on a curve at Duffy Street designed for no more than 40 miles per hour. The train derailed and plowed into a residential area on Duffy Street. The conductor, head-end brakeman, and two residents were killed in the crash. Seven homes were destroyed, as was the entire train.

During the cleanup effort, an underground 14-inch high pressure gasoline transit pipeline suffered undetected damage. On May 25, 13 days after the train derailment, the pipeline burst, showering the neighborhood in gasoline and igniting a large fire that killed two people and destroyed 11 more homes. The total property damage was $14.3 million. Many residents moved after this, and homes are no longer allowed to be built next to the rail lines.

Investigations determined several causes that contributed to the derailment: a miscalculation of the weight of the freight, which was underestimated by 40 percent; lack of dynamic brakes on three of the six locomotives; and train engineer error in activating the emergency brake, which cancelled the dynamic brakes on the functioning three locomotives.

Glendale Derailment

On January 26, 2005, a southbound Metrolink commuter train collided with a sport utility vehicle (SUV) that had been abandoned on the tracks near the Glendale-Los Angeles city boundary. The train jackknifed and struck trains on both sides of it, one a stationary freight train and the other a northbound Metrolink train traveling in the opposite direction. The collisions resulted in 11 deaths and 100 to 200 injuries. The driver of the SUV left the vehicle prior to the crash and was later charged and convicted of 11 deaths and arson.

Subsequent criticism focused on the issue of train configuration. Many commuter trains use a “pusher configuration” to avoid turnaround maneuvers and facilities required to reverse a train’s direction. This means the trains are pushed from the back by the locomotive. There were assertions that this type of configuration made the accident worse and claims that if the engine had been in the front, the train might not have jackknifed and caused the second Metrolink train to derail.

To increase rider safety, Metrolink temporarily roped off the first cars in all of their trains and allowed passenger seating in the second car and beyond. Metrolink gradually modified this policy. As of 2007, the line permitted passengers to sit in a portion of the first car when in "push mode," but did not allow seating in the forward-most section of the first car.

Chatsworth Derailment

The September 12, 2008 Chatsworth train accident, resulting in 25 deaths and injuring more than half the train’s passengers, spawned significant changes to national rail safety standards. The head-on collision occurred in Chatsworth, a neighborhood of Los Angeles located at the western edge of the San Fernando Valley, involving a Metrolink commuter train and a Union Pacific freight train. All three locomotives, the leading Metrolink passenger car, and seven freight cars derailed. According to the National Transportation Safety Board (NTSB), the Metrolink train engineer most likely caused the collision because he was distracted by sending text messages while on duty. He failed to obey a red stop signal that indicated it was not safe to proceed from the double-track into the single-track section and, thus, collided head-on with the freight train that was traveling on the same single-track section from the opposite direction. The NTSB also

[78] Roseville Local Hazard Mitigation Plan, 2004; Wikipedia

believed that deployment of a positive train control (PTC), which is a safety back-up system that can automatically stop a train and prevent train collisions, could have avoided the disastrous collision and derailment. Although not required at the time of the Chatsworth accident, PTCs have been a high priority for the NTSB following similar collisions since the mid-1980s, and voluntary implementation has been uneven and incremental across the country since that time, primarily due to the high costs associated with installation and maintenance. Following the Chatsworth collision, Metrolink expanded the existing automated train stop system used on 30 miles of Metrolink track in Orange County across its 350-mile system. Metrolink's automated train stop system will automatically apply the brakes to stop a train if the engineer fails to respond to a warning within eight seconds.
(http://wapedia.mobi/en/2008_Chatsworth_train_collision)

In May 2007, prior to the Chatsworth collision, a bill requiring the installation and operation of PTC systems was introduced in the House of Representatives. The bill was passed by the House in October 2007 and moved on to the Senate, where it was being heard at the time of the Chatsworth collision. Following testimony by California Senator Boxer and others regarding the Chatsworth crash and the potential for avoidance of similar events through the mandatory deployment of PTC systems, the Senate passed the bill in October 2008. The legislation signaled that, despite the implementation costs, railroad employee and general public safety warranted mandatory and accelerated installation and operation of PTC systems.

The Railroad Safety Improvement Act of 2008 (RSIA08) requires the installation and operation of PTC systems on all main lines, meaning all intercity and commuter lines—with limited exceptions and on freight-only lines when they are part of a Class I railroad system, carrying at least 5 million gross tons of freight annually, and carrying any amount of poison- or toxic-by-inhalation (PIH or TIH) materials. The RSIA08 mandates that widespread implementation of PTC across a major portion of the U.S. rail industry be accomplished by December 31, 2015. Each subject railroad was required to submit to the Federal Rail Administration by April 16, 2010, an implementation plan indicating where and how it intends to install PTC systems by December 31, 2015. (http://www.fra.dot.gov/Page/P0395)

6.7.5 WELL STIMULATION AND HYDRAULIC FRACTURING

Hydraulic fracturing, commonly called "fracking", is a process that involves high-pressure injection of water, sand and chemical additives to cause fracturing of subsurface rock resulting in release of gas or oil trapped inside. Fracking is a type of well stimulation treatment that is known to boost oil and gas production. Another type of well stimulation treatment also 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. Possible environmental impacts that could result from fracking and well stimulation include effects on water and air quality and seismic safety, which are considered potential hazards and need further study.

Fracking has occurred in California, mostly within Kern County, for some time, but recent discoveries suggest that Monterey Shale formations in the Central Valley may contain more than 10 billion barrels of oil reachable through fracking.

As a result of these discoveries and the potential increase in fracking activities in the Central Valley (as well as elsewhere in California), the state legislature recently passed Senate Bill (SB) 4 which is intended to regulate well stimulation treatments, including fracking. SB 4, which was signed by the Governor in September 2013, amends the Public Resources Code as well as the Water Code.

Some of the new hydraulic fracturing requirements to be added to the Public Resources Code under SB 4 are the following:

- The California Natural Resources Agency must conduct and complete an independent study on well stimulation treatments no later than January 1, 2015
- The Division of Oil, Gas and Geothermal Resources of the Department of Conservation must adopt rules and regulations specific to well stimulation in consultation with other California agencies no later than January 1, 2015
- Before performing a well stimulation, well operators must apply for a permit that includes a water management plan and a groundwater monitoring plan
- The Division of Oil, Gas and Geothermal Resources must post issued permits on the publicly accessible portion of its internet web site
- Suppliers claiming trade secret protection for the chemical composition of additives used in hydraulic fracturing are required to disclose the composition to the Division of Oil, Gas and Geothermal Resources as part of the permit application

Additionally, the bill requires that the Division of Oil, Gas and Geothermal Resources conduct and certify an overarching environmental impact report to provide information on the environmental impacts of well stimulation in California, no later than July 1, 2015. For the complete text of SB 4 go to: http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB4

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