Section 4: Hazard Analysis

This section identifies and profiles the hazards that could affect Monterey County. It consists of the following three subsections:

- 4.1 Overview of a Hazard Analysis
- 4.2 Hazard Identification and Screening
- 4.3 Hazard Profiles

4.1 Overview of a Hazard Analysis

A hazard analysis includes the identification and screening of potential hazards, and subsequently the development of hazard profiles to more thoroughly describe and evaluate each hazard. Hazard identification is the process of recognizing the range of natural or human-caused events that threaten an area. Natural hazards result from uncontrollable, naturally occurring events such as flooding, windstorms, and earthquakes, whereas human-caused hazards result from human activity and include technological hazards and terrorism. Technological hazards are generally accidental or result from events with unintended consequences (for example, an accidental hazardous materials release). Terrorism is defined as the calculated use of violence (or threat of violence) to attain goals that are political, religious, or ideological in nature. Even though a particular hazard may not have occurred in recent history, all hazards that may potentially affect the planning area are considered in the initial hazard identification step. Then, through the subsequent screening process, hazards that are deemed unlikely to occur, or for which the risk of damage is accepted as being very low, are eliminated from further consideration.

Hazard profiling is accomplished by describing hazards in terms of their nature, history, magnitude, frequency, location, and probability. Hazard profiles are developed through the collection of historical and anecdotal information, review of existing plans and studies, and preparation of hazard maps of the study area. Hazard maps are used to determine the geographic extent of the hazards and define the approximate boundaries of the areas at risk.

4.2 Hazard Identification and Screening

For the initial hazard analysis in 2006, the Planning Team identified 20 possible hazards that could affect Monterey County and the participating communities. The Planning Team evaluated and screened the comprehensive list of potential hazards based on a range of factors, including prior knowledge or perception of the relative risk presented by each hazard, the ability to mitigate the hazard, and the known or expected availability of information on the hazard. The Planning Team determined that 10 hazards pose the greatest threat to Monterey County: coastal erosion, dam failure, earthquake, flood (including coastal storm), a hazardous materials event, landslide, tsunami, wildland fire, and windstorm.

For the plan update in 2013, the Planning Team reaffirmed the initial hazard identification and screening but added three new hazards for consideration: agricultural emergencies, sea level rise, and drought. It was also determined that the description and analysis of debris flows (under landslides) would be bolstered during the plan update process. Lastly, it was decided that the existing hazard analysis would be amended during the plan update to identify and describe the anticipated effects of climate change on all hazards, as applicable.

Table 4-1 lists the full range of 22 hazards identified and screened for further consideration in the plan update process. Of these, 13 hazards were determined by the Planning Team to pose the greatest risk to Monterey County and should be further described and evaluated through hazard profiles. The remaining 9 hazards excluded through the screening process were considered to pose a lower threat to life and property in Monterey County due to the low likelihood of occurrence or the low probability that life and property would be significantly affected. Should the risk from these hazards increase in the future, the MJHMP can be updated to incorporate vulnerability analyses for these hazards.

Table 4-1
Identification and Screening of Hazards

Hazard Type	Should It Be Profiled?	Explanation
Agricultural Emergencies	Yes	Monterey County's economy is heavily based on agricultural production in the Salinas Valley which is susceptible to a range of hazards.
Avalanche	No	Monterey County is not located in area prone to frequent or significant snowfall.
Coastal Erosion	Yes	Several participating jurisdictions and areas of the unincorporated county are located along the Pacific Coast.
Coastal Storm	Yes (See Flood)	Several participating jurisdictions and areas of the unincorporated county are located along the Pacific Coast. This hazard will be addressed in the flood hazard profile.
Dam Failure	Yes	Several State-sized dams are located within Monterey County.
Drought	Yes	Whereas existing local plans and policies (including water conservation activities of the Monterey Peninsula Water Management District Law, landscaping plans, and existing development and new construction water conservation requirements) help diminish the effects of this hazard, recent drought conditions have placed high local attention on this hazard as a hazard that should be addressed in the Plan.
Earthquake	Yes	Several active faults, including the San Andreas Fault, run through Monterey County.
Expansive Soils	No	No historic events have occurred in Monterey County.
Extreme Heat	No	While extreme temperatures are known to occur, prolonged heat waves are rare.
Flood	Yes	History of flooding is associated with coastal storms and heavy rainfall.
Hailstorm	No	No significant historic events have occurred in Monterey County.
Hurricane	No	No significant historic events have occurred in Monterey County.
Land Subsidence	No	No historic events have occurred in Monterey County.
Landslide	Yes	Monterey County is vulnerable to slope instability in the Santa Lucia Mountain Range and fault zones, especially after prolonged rainfalls, and particularly in areas recently burned by wildland fire.
Sea Level Rise	Yes	Several participating jurisdictions and areas of the unincorporated county are located along the Pacific Coast and considered susceptible to future sea level rise inundation.
Severe Winter Storm	No	Whereas there have been a number of disaster declarations related to winter storm conditions in Monterey County, in most

Hazard Type	Should It Be Profiled?	Explanation
		cases these have been the result of conditions associated with other hazard types and not severe winter weather in the traditional sense.
Tornado	No	No significant historic events have occurred in Monterey County.
Tsunami	Yes	Several participating jurisdictions and areas of the unincorporated county are located along the Pacific Coast.
Volcano	No	No significant historic events have occurred in Monterey County.
Wildland Fire	Yes	The terrain, vegetation, and weather conditions in the region are favorable for the ignition and rapid spread of wildland fires.
Windstorm	Yes	Sustained inland sea breezes occur annually from March to October.
Other: Hazardous Materials	Yes	Hazardous materials facilities and major transportation routes are located throughout Monterey County.

Since 1953, Monterey County has experienced a total of 19 federal disaster declarations as listed in **Table 4-2**. The county has also experienced additional emergencies and disasters that were not severe enough to require federal disaster relief through a presidential declaration, many of which are further described in Section 4.3. This information, coupled with local historical and anecdotal information provided by the Planning Team, helped inform the hazard identification and screening process.

Table 4-2
Federal Disaster Declarations for Monterey County, 1953 – Present

Declaration Date	Incident Type	Declaration Type	Description
4/18/2011	Tsunami	Major Disaster	Tsunami Waves
7/4/2008	Fire	Fire Management	Basin Fire Complex
6/28/2008	Fire	Emergency	Wildfires
3/13/2007	Freezing	Major Disaster	Severe Freeze
9/13/2005	Hurricane	Emergency	Hurricane Katrina Evacuation
2/9/1999	Freezing	Major Disaster	CA - Citrus Crop Damage 2/2/99
2/9/1998	Severe Storm(s)	Major Disaster	Severe Winter Storms, and Flooding
1/4/1997	Severe Storm(s)	Major Disaster	Severe Storms, Flooding, Mud and Landslides
3/12/1995	Severe Storm(s)	Major Disaster	Severe Storms, Flooding Landslides, Mud Flow
1/10/1995	Severe Storm(s)	Major Disaster	Severe Storms, Flooding, Landslides, Mud Flows
2/3/1993	Flood	Major Disaster	Severe Storm, Mud & Landslides, and Flooding
2/11/1991	Freezing	Major Disaster	Severe Freeze
10/18/1989	Earthquake	Major Disaster	Loma Prieta Earthquake
7/18/1985	Fire	Major Disaster	Grass, Wildlands, & Forest Fires
2/9/1983	Coastal Storm	Major Disaster	Coastal Storms, Floods, Slides & Tornadoes
2/15/1978	Flood	Major Disaster	Coastal Storms, Mudslides & Flooding
1/20/1977	Drought	Emergency	Drought
1/26/1969	Flood	Major Disaster	Severe Storms & Flooding
1/2/1967	Flood	Major Disaster	Severe Storms & Flooding

Source: FEMA

4.3 Hazard Profiles

The specific hazards selected by the Planning Team for profiling have been examined in a methodical manner based on the following factors:

- **Nature:** Provides general definitions and brief descriptions of the hazard, its characteristics, and potential effects.
- **History:** Provides information on the history of previous hazard events in the planning area, including their impacts on people and property.
- **Location:** Provides information on the geographic areas within the planning area that are susceptible to occurrences of the hazard.
- **Extent:** Provides information on the potential strength or magnitude of the hazard.
- **Probability of future events:** Describes the likelihood of future hazard occurrences in the planning area. This includes a summary of any anticipated effects that climate change may have on the frequency, duration, and intensity of future hazard events.[1]

The hazards profiled for Monterey County (including the participating jurisdictions) are presented in the rest of Section 4.3 in alphabetical order. The order of presentation does not signify the level of importance or risk.

4.3.1 Agricultural Emergency

Nature

For purposes of this plan, an agricultural emergency is any type of unintentional event that threatens human health and the economic stability of the agricultural industry in Monterey County. These types of events primarily include natural hazards, pests, and diseases which have the ability to cause widespread losses to crops, livestock and farm property. These types of events may also include accidental threats related to the release of hazardous materials including chemical, biological, radiological, nuclear, and/or explosive hazards which have the ability to not only cause agricultural losses but also directly affect human health.

Agriculture-related emergencies and disaster designations are quite common. According to the United States Department of Agriculture (USDA), one-half to two-thirds of the counties in the nation have been designated as disaster areas in each of the past several years, even in years of record crop production. The Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. The most common cause of these disasters over the past several years nationally and for the State of California have been as follows, in order of frequency: drought, extreme heat, windstorms, wildland fire, and insects.

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. The Monterey County Office of the Agricultural Commissioner carries out such

[1] The definitions for the descriptors used for probability of future hazard occurrences are: "unlikely" equals less than a 1% annual probability; "possible" equals between a 1 and 10% annual probability; "likely" equals between a 10 and 100% annual probability; and "highly likely" equals a 100% annual probability.

programs, with pest and disease prevention among one of the most critical due to their potential to cause economic and human health disasters. As such there are active programs in place to monitor, detect, exclude (quarantine), eradicate, and manage pest and disease threats to Monterey County's agricultural sector. The primary pests and diseases of current concern for Monterey County include the European Grapevine Moth and Light Brown Apple Moth (recent finds of significance); Pitch Canker and Sudden Oak Death (of quarantine concern); and the following pests of significance for detection programs: Fruit Flies, Glassy Winged Sharp Shooter, Asian Citrus Psyllid, Japanese Beetle, Gypsy Moth, European Corn Borer, Melon Fruit Fly, Mediterranean Fruit Fly, Mexican Fruit Fly, and Oriental Fruit Fly.

History

Monterey County has experienced numerous agricultural-related disasters of varying magnitudes. The County received presidential major disaster declarations for severe freezing and crop damages in 2007, 1999, and 1991, and for a severe drought emergency in 1977. Major agricultural losses have also occurred following many of the other presidentially declared major disasters for Monterey County. For instance it is estimated that the 1995 flood disaster resulted in $240 million in losses to crop production in the Salinas Valley.

Monterey County has received USDA (secretarial) disaster declarations on a much more frequent basis. USDA declarations make emergency loan assistance available to eligible family farmers to cover physical and production losses. Since 1999, Monterey County has been included in at least 40 such declarations for a wide range of events that have affected it as a primary disaster area or as a county contiguous to such an area. Of these 40 declarations recorded by USDA since 1999, seven were issued for damages and losses specifically recorded in Monterey County and most of these were caused by incidents of drought or extreme heat conditions. While nearly all declarations were issued due to the consequences of naturally occurring events, there were two based on damages and losses associated with quarantine, for the Light Brown Apple Moth in 2008 and the Peach Fruit Fly in 2006.

According to National Weather Service records there have been an estimated $30 million in crop damages for Monterey County since 1996. The majority of these ($21 million) were associated with the severe freezing temperatures in 2007, while approximately $7 million were attributed to wildfire events and nearly $2 million to flood events. Historical data on crop damages or losses associated with other events including drought is not readily available.

Prior to 2014, Monterey County had been included in only two major Federal or State disaster declarations for drought since 1950. On January 17, 2014 Governor Jerry Brown declared a statewide drought emergency in response to California's driest year on record, with nearly 99 percent of the state considered abnormally dry or worse, and almost two-thirds of the state (including Monterey County) in extreme drought conditions. The emergency declaration sets the stage for additional State action and drought relief beyond the loan assistance programs available through a previous USDA declaration.

Location, Extent, and Probability of Future Events

The potential extent of agricultural emergencies in Monterey County can perhaps best be quantified by the exposure of its crop production value. Crop values vary from year to year based on production, market, and weather conditions, but according to the 2012 Monterey County Crop Report the total production value for Monterey County is $4.14 billion.

The hazard with the potentially most severe and widespread destructive impact on crops in Monterey County is a prolonged multi-year drought. According to historical data prepared by the National Drought Mitigation Center, Monterey County experienced severe to extreme drought conditions from 5 to 10 percent of the time between 1895 and 1995. Monterey County's agricultural sector is particularly vulnerable to these types of conditions, with consequences that directly relate to the water available to farmers for irrigation purposes. In the Salinas Valley this water is made available from groundwater sources that are recharged by the Salinas River, which relies on releases from the Nacimiento and San Antonio reservoirs as controlled by the Monterey County Water Resources Agency.

Another significant and growing threat to crops in Monterey County is the destructive potential for a major flood event along the Salinas River. Due to environmental regulations, no clearing of the river channel has occurred since 2008 which has resulted in the accumulation of brush, vegetation, sediment, and debris that severely limits the channel's ability to adequately convey flood waters downstream during a major event. This could result in the destruction and potential soil contamination of all those lands currently used for crop production in the adjacent floodplains.

It is anticipated that the effects of climate change will result in an increase in the frequency, duration, and extent of agricultural emergencies in Monterey County. Data and tools made available through Cal Adapt project the following relevant impacts for agriculture along the California Central Coast: increased temperatures, reduced precipitation, and reduced agricultural productivity. The projected change in annual average temperature for Monterey County is between 2.9 and 4.9 degrees Fahrenheit by the year 2100 depending on low versus high emissions scenarios, respectively. The projected number of extreme heat days for Monterey County is also anticipated to sharply increase from a historical average of 4 days per year to as high as between 50 and 90 more days by the year 2100. These changes along with the expected increase in severe drought and wildfire occurrences make the probability of future agricultural emergencies in Monterey County highly likely.

4.3.2 Coastal Erosion

Nature

Erosion is a process that involves the wearing away, transportation, and movement of land. Erosion rates can vary significantly, occurring rather quickly after a flash flood, coastal storm, or other event or slowly as the result of long-term environmental changes. Erosion is a natural process, but its effects can be exacerbated by human activity.

Coastal erosion is sometimes referred to as cliff, bluff, or beach erosion. However, other times these erosion types encompass different categories of erosion altogether. For this profile, tidal, bluff, and beach erosion will be nested within the term coastal erosion.

Coastal erosion is the attrition of land resulting in loss of beach, shoreline, dune, or cliff material from natural activity or human influences. Coastal erosion occurs over the area roughly from the edge of a cliff and the top of the bluff out into the near-shore region to about a depth of 30 feet. It is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time. Bluff recession is the most visible aspect of coastal erosion because of the dramatic change it causes to the landscape. As a result, this aspect of coastal erosion usually receives the most attention.

The forces of erosion are embodied in waves, currents, and winds on the coast. However, surface-water and groundwater flow and freeze-thaw cycles may also play a role. Not all of these forces may be present at any particular location. Coastal erosion can occur from rapid, short-term daily, seasonal, or annual natural events such as waves, storm surge, wind, coastal storms, and flooding, but it can also occur from human activities, including boat wakes and dredging. The most dramatic erosion often occurs during storms, particularly because the highest energy waves are generated under storm conditions.

Coastal erosion may also be due to multiyear impacts and long-term climatic change such as sea level rise, lack of sediment supply, subsidence, or long-term human factors such as aquifer depletion or the construction of shore protection structures and dams.

Ironically, attempts to control erosion though shoreline protective measures, such as groins, jetties, seawalls, or revetments, can actually lead to increased erosion activity. This development occurs because shoreline structures eliminate the natural wave run-up and sand deposition processes and can increase reflected wave action and currents at the waterline. The increased wave action can cause localized scour both in front of and behind structures and prevent the settlement of suspended sediment.

History

Rain, wind, and waves along the coast of Monterey County induce large amounts of erosion, especially during winter storms. In particular, El Niño events have produced large waves that have stripped volumes of sand from Monterey Bay, leaving the beaches, dunes, and cliffs exposed to high tides and wave attack. As a result of the 1982–1983 El Niño events, approximately 20 to 40 feet of the marine terraces by Scenic Drive in Carmel fell into the sea. In the 1997–1998 El Niño winter storm event, a Light Detection and Ranging survey revealed that maximum dune erosion occurred in the vicinity of Fort Ord (43-foot retreat) and the city of Marina (50-foot retreat). During both El Niño events, several extremely steep cliffs (100 percent slope) near Big Sur failed as a result of increased wave attack.

In addition to winter storms, earthquakes have caused the Monterey cliffs to erode. The October 17, 1989 Loma Prieta Earthquake produced several isolated cliff failures throughout the county.

Location, Extent, and Probability of Future Events

The largest concentrations of coastal dunes within California are the Monterey Bay dunes, which cover about 40 square miles from Moss Landing to Pacific Grove. Recent studies suggest that the average dune erosion rate for southern Monterey Bay (from Moss Landing to Pacific Grove) is approximately 2.6 feet a year and higher than any other region in the state. Historically, the highest dune erosion rates have occurred in the Fort Ord area (7 feet annually) and Marina (4.5 feet annually) because of wave refraction patterns that produce larger waves.

Rocky cliffs and marine terraces are located along Monterey Peninsula from Pacific Grove to Carmel. Although the granite cliffs have shown very little erosion over the past several years, areas with overlying marine terraces are subject to higher erosion rates, especially during strong storm years. Coastal erosion analysis indicates that average retreat rates for marine terraces are between 2 to 4 inches a year.

Steep cliffs within Monterey County are located along the Big Sur coast, where the rugged Santa Lucia Mountains descend abruptly into the Pacific Ocean. U.S. Geological Survey (USGS) studies suggest cliff retreats within this area average about 7 inches per year; however, failure can be much greater in weakened, fractured, or faulted areas.

For coastal management purposes, average annual coastal erosion retreats have been projected over a 100-year period (as shown in Figure E-3 [Appendix E]). Although coastal erosion can occur with any annual winter storm, damage is more likely to occur during El Niño events. Ocean storms that have some amount of coastal impact can be expected every year. El Niño events occur about every 5 to 7 years and typically last 16 to 18 months. Historically, strong El Niño conditions have only occurred every 20 to 40 years.

It is anticipated that the effects of climate change, including sea level rise, will result in an increase in the frequency and extent of coastal erosion. Higher sea levels will expose larger areas of the coast to more persistent erosional forces. It has been estimated that a 1.4 meter rise in sea level (the upper bound estimate used by the State of California for coastal adaptation purposes) has the potential to erode 41 square miles of California's coastline by 2100. According to a statewide study by the California Energy Commission, a total of 4.4 square miles of coastline is susceptible to erosion and the maximum distances coastal dunes and sea cliffs are expected to retreat in this region are approximately 1,300 and 720 feet, respectively. Overall, the probability of coastal erosion occurring within the county is considered highly likely.

4.3.3 Dam Failure

Nature

A dam failure is the structural collapse of a dam that releases the water stored in the reservoir behind the dam. A dam failure is usually the result of the age of the structure, inadequate spillway capacity, or structural damage caused by an earthquake or flood. Failures due to prolonged periods of rainfall can result in overtopping (the most common cause), and total failure occurs if internal erosion, overtopping, or damage results in a complete structural breach. The sudden release of water has the potential to cause human casualties, economic loss, and environmental damage. This type of disaster is dangerous because it can occur rapidly, providing little warning and evacuation time for people living downstream. The flows resulting from dam failure generally are much larger than the capacity of downstream channels and can therefore lead to extensive flooding. Flood damage occurs as a result of the momentum of the flood caused by the sediment-laden water, flooding over the channel banks, and impact of debris carried by the flow.

History

Four major dams and reservoirs, as well as several small dams, are located in and within the vicinity of Monterey County. The four largest dams, the Nacimiento Dam, San Antonio Dam, San Clemente Dam, and Los Padres Dam, have never failed or been subject to significant damage. However, Lake Nacimiento (Nacimiento Dam) has spilled over three times (1958, 1969, and 1983) over the last 50 years, and Lake San Antonio (San Antonio Dam) has spilled twice (1982 and 1983) over the past 40 years. There is no record of any damages, fatalities, or injuries associated with dam failure in the planning area.

Location, Extent, and Probability of Future Events

As shown in Figure E-4 (Appendix E), four state-size dams and reservoirs in and near Monterey County pose the risk of inundation within the county. State-size dams, which are regulated by the California Division of Safety of Dams (DSOD), are more than 25 feet in height and hold back more than 15 acre-feet of water or are more than 6 feet in height and hold more than 50 acre-feet of water. The four state-size dams are as follows:

- The earth-filled Nacimiento Dam was completed in 1957. It provides water conservation capacity of 377,900 acre-feet in Lake Nacimiento. When full, the lake is 18 miles long and has a shoreline of 165 miles. The Nacimiento Dam and its reservoir are located in northern San Luis Obispo County, 15 miles northwest of Paso Robles, along the Nacimiento River. However, it was constructed and is owned by Monterey County Water Resources Agency. It serves as a flood control, water conservation, and recreation facility.
- San Antonio Dam and its reservoir, Lake San Antonio, were completed in 1965, with 335,000 acre-feet of water conservation capacity. When full, it is 16 miles long and has approximately 100 miles of shoreline. San Antonio Dam and Lake San Antonio are located southwest of Bradley along the San Antonio River. Like Nacimiento Dam, San Antonio Dam is owned by Monterey County Water Resources Agency and serves as a flood control, water conservation, and recreation facility.
- The concrete-arched San Clemente Dam was built in 1921 in the Cachagua area along the upper reaches of the Carmel River. It originally was constructed to hold 2,000 acre-feet of water; however, today it holds back mostly mud and sediment. The dam, which is owned and operated by California-American Water Company, had served as a flood control and water conservation facility, but today serves no useful purpose now that water is no longer diverted from upstream. The dam is now scheduled for removal as part of the Carmel River Reroute and San Clemente Dam Project. The construction phase for this project began in 2013 and is scheduled for completion in 2016, with demolition of the dam structure in 2015.
- Los Padres Dam was constructed in 1949, 6 miles upstream from San Clemente Dam. It is a rock-and-earth-filled dam that had an original storage capacity of 3,000 acre-feet that has now dwindled to 1,500 acre-feet. The dam, which is also owned and operated by California-American Water Company, serves as a flood control and water conservation facility.

Dam inundation maps show that the greatest risk from dam failure is in Carmel Valley, where failure of either Los Padres or San Clemente Dam would cause inundation of urbanized areas and alter the riparian corridor. A 1997 analysis conducted by the DSOD indicates that a dam failure of San Clemente Dam would send 100 to 150 acre-feet of water and mudflow downstream as far as Camp Stefani on the Carmel River, resulting in 1 to 6 feet of flooding. Dam failure in Salinas Valley would also be significant, whether caused by the failure of San Antonio or Nacimiento Reservoir. Studies reveal that either failure would overflow the 100-year floodplain in Salinas Valley. However, the risk would predominately be to agricultural land.

Although all four dams and reservoirs are inspected annually by the DSOD to ensure that they are in good operating condition, the dams are susceptible to floods and seismic events. During the winter, temporary flood storage is provided in flood pools along Nacimiento and Lake San Antonio Dams. Along Los Padres and San Clemente Dams, excess water can be released through transmission pipes, valves, and spillway systems. However, dam overspills would most likely occur during severe winter storms, when the dams and reservoirs are inundated with flooding. Based on previous occurrences, an overspill due to flooding would likely occur every 10 years making the probability of future occurrences possible.

In addition to flood hazards, all four dams are susceptible to seismic hazards. Engineering studies conducted by the DSOD in 1992 indicate that San Clemente Dam could give way in a magnitude 5.5 earthquake along the Tularcitos Fault or a magnitude 7.0 earthquake along the San Andreas Fault.

As noted in Section 5.3.4, recent research by the USGS shows that the San Andreas Fault has a 21 percent probability of a magnitude 6.7 or greater earthquake by 2032.

The permanent removal of the San Clemente Dam in 2015 will eliminate the risks to public safety identified above. The dam's removal will not affect the volume or timing of flood flows on the river, and sediment transport and flood modeling studies completed by the project team verify that removal of the dam will not exacerbate the existing downstream flooding problems.

It is anticipated that the effects of climate change will not increase the probability of dam failure events, though projections for future changes in precipitation patterns should continue to be considered in the regulation, construction, operation, and maintenance or repair of dam structures.

4.3.4 Drought

Nature

Drought is a natural climatic condition caused by an extended period of limited rainfall beyond that which occurs naturally in a broad geographic area. High temperatures, high winds, and low humidity can worsen drought conditions, and can make areas more susceptible to wildfire. Human demands and actions can also hasten drought-related impacts.

Droughts are frequently classified as one of the following four types: meteorological, agricultural, hydrological, or socio-economic. Meteorological droughts are typically defined by the level of "dryness" when compared to an average, or normal amount of precipitation over a given period of time. Agricultural droughts relate common characteristics of drought to their specific agricultural-related impacts (when the amount of moisture in soil does not meet the needs of a particular crop). Hydrological drought is directly related to the effect of precipitation shortfalls on surface and groundwater supplies. Human factors, particularly changes in land use, can alter the hydrologic characteristics of a basin. Socio-economic drought is the result of water shortages that affect people and limit the ability to supply water-dependent products in the marketplace.

Drought conditions typically do not cause property damages or threaten lives, but rather drought effects are most directly felt by agricultural sectors. At times, drought may also cause community-wide impacts as a result of acute water shortages (regulatory use restrictions, drinking water supply, and salt water intrusion). The magnitude of such impacts correlates directly with local groundwater supplies, reservoir storage, and development densities. Drought conditions can also contribute to or exacerbate extreme heat concerns, particularly with regard to elderly populations.

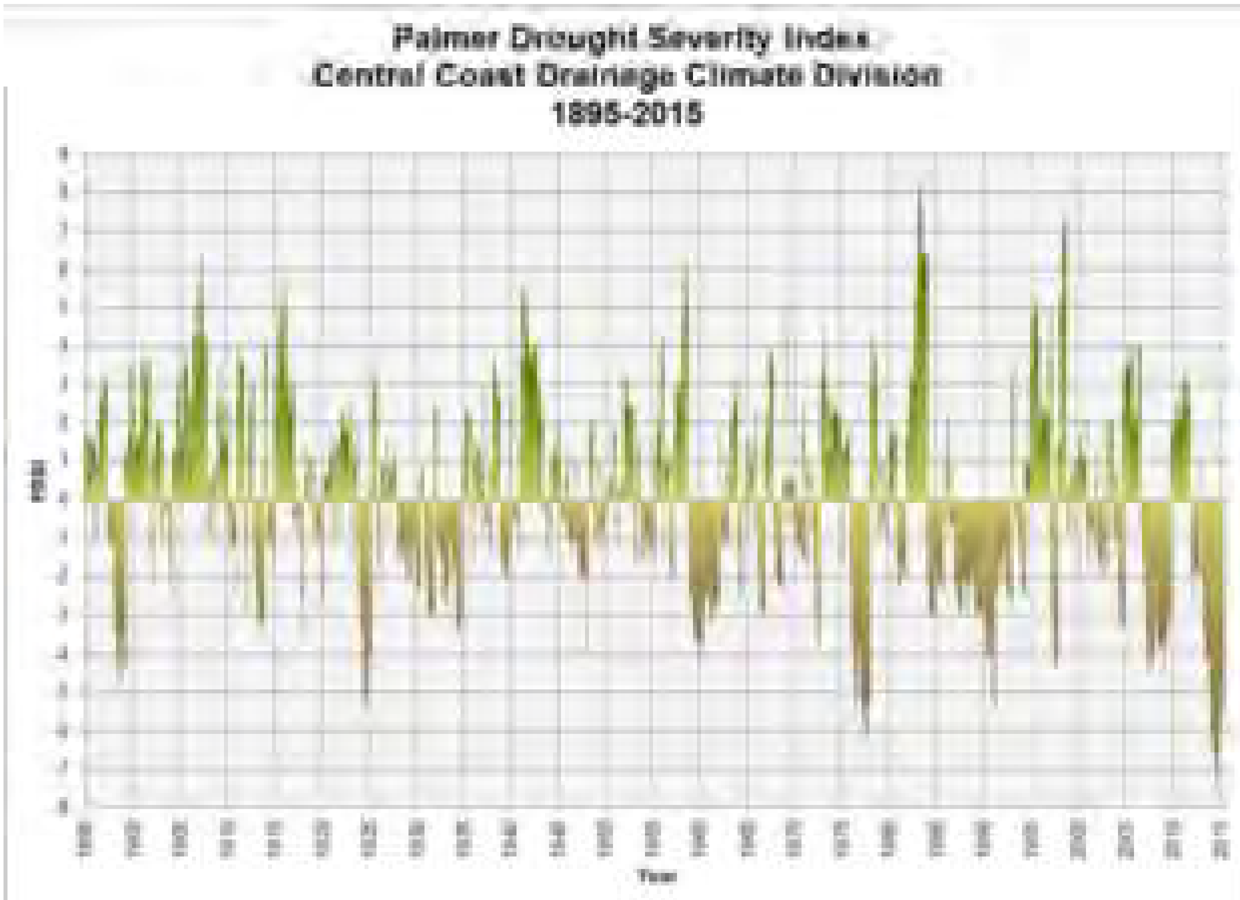
History

Most recently, California, including Monterey County, in 2014, has faced one of the most severe droughts on record. Governor Brown declared a drought State of Emergency in January 2014 and directed State officials to take all necessary actions to prepare for water shortages during what the State considers an "unprecedented" drought.

Prior to the 2014 drought conditions described above, the National Climatic Data Center has recorded no instances of severe drought conditions in the Monterey County forecast zone for the period of 1/1/1996 through 12/31/2013.

Figure 4-1 shows Palmer Drought Severity Index (PDSI) information based on the Central Coast Climate Division which Monterey County is a part of ranging from 1895 to the present.

Figure 4-1
Palmer Drought Severity Index Information[2]



Location, Extent, and Probability of Future Events
Typically the National Weather Service looks at drought as an episodic hazard that impacts a widespread forecast "zone," and therefore it is not common to pinpoint a specific location within a planning area that is more susceptible to this hazard than others. From this viewpoint, each jurisdiction in the planning area is considered uniformly at risk to drought. However, the most significant financial losses are likely to occur in areas that are primarily agricultural. The probability of occurrence is considered to be likely.

Current modeling of the effects of climate change and global warming on precipitation in California show little change in total annual precipitation in California. Furthermore, among several models, precipitation projections do not show a consistent trend during the next century.
The Mediterranean seasonal precipitation pattern is expected to continue, with most precipitation falling during winter from North Pacific storms. One of the four climate models projects slightly

[2] "0" represents normal conditions, and more negative values represent more extreme drought conditions. A value of -4 indicates an extreme drought. Positive numbers indicate periods of wetness. Extreme peaks and longevity of drought conditions are used to identify long-term droughts. For example, the extremity of the current historic drought can be noted by both the duration of drought conditions (almost completely negative since the start of 2012), and from the actual values (the lowest value on record occurred in July 2014). It is possible to interpret from the chart that droughts may be becoming more frequent, more extreme, and lasting longer.

wetter winters, and another projects slightly drier winters with a 10 to 20 percent decrease in total annual precipitation. Nevertheless, even minor fluctuations will increase pressure on Monterey County's water resources, which are already over-stretched by the demands of a growing agriculture economy and population. Decreasing snowmelt and spring stream flows coupled with increasing demand for water resulting from both a growing population and hotter climate could lead to increasing water shortages. By the end of the century, if temperatures rise to the medium warming range and precipitation decreases, late spring stream flow could decline by up to 30 percent. Agricultural areas could be hard hit, with California farmers losing as much as 25 percent of the water supply they need. Reduction in precipitation coupled with heat stress could adversely impact crop production. Loss of ground water will increase sea water intrusion and contaminates nitrates in the wells adversely impacting drinking water.

4.3.5 Earthquake

Nature

An earthquake is a sudden motion or trembling caused by a release of strain accumulated within or along the edge of the earth's tectonic plates. The effects of an earthquake can be felt far beyond the site of its occurrence. Earthquakes usually occur without warning and, after just a few seconds, can cause massive damage and extensive casualties. The most common effect of earthquakes is ground motion, or the vibration or shaking of the ground during an earthquake.

Ground motion generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. It causes waves in the earth's interior, also known as seismic waves, and along the earth's surface, known as surface waves. Two kinds of seismic waves occur: P (primary) waves are longitudinal or compressional waves similar in character to sound waves that cause back-and-forth oscillation along the direction of travel (vertical motion), and S (secondary) waves, also known as shear waves, are slower than P waves and cause structures to vibrate from side to side (horizontal motion). Also two kinds of surface waves occur: Raleigh waves and Love waves. These waves travel more slowly and typically are significantly less damaging than seismic waves.

In addition to ground motion, several secondary natural hazards can occur from earthquakes, such as the following:

- **Surface Faulting** is the differential movement of two sides of a fault at the earth's surface. Displacement along faults, both in terms of length and width, varies but can be significant (e.g., up to 20 feet), as can the length of the surface rupture (e.g., up to 200 miles). Surface faulting can cause severe damage to linear structures, including railways, highways, pipelines, and tunnels.
- **Liquefaction** occurs when seismic waves pass through saturated granular soil, distorting its granular structure, and causing some of the empty spaces between granules to collapse. Pore water pressure may also increase sufficiently to cause the soil to behave like a fluid for a brief period and cause deformations. Liquefaction causes lateral spreads (horizontal movements of commonly 10 to 15 feet, but up to 100 feet), flow failures (massive flows of soil, typically hundreds of feet, but up to 12 miles), and loss of bearing strength (soil deformations causing structures to settle or tip). Liquefaction can cause severe damage to property.
- **Landslides/Debris Flows** occur as a result of horizontal seismic inertia forces induced in the slopes by the ground shaking. The most common earthquake-induced landslides include

shallow, disrupted landslides such as rock falls, rockslides, and soil slides. Debris flows are created when surface soil on steep slopes becomes totally saturated with water. Once the soil liquefies, it loses the ability to hold together and can flow downhill at very high speeds, taking vegetation and/or structures with it. Slide risks increase after an earthquake during a wet winter.

- **Tsunamis:** As an Oceanic Plate is subducted beneath a Continental Plate, it sometimes brings down the lip of the Continental Plate with it. Eventually, too much stress is put on the lip and it snaps back, sending shockwaves through the earth's crust, causing a tremor under the sea, known as an Undersea Earthquake. Factors that affect tsunami generation from an earthquake event include magnitude (generally, a 7.5 magnitude and above), depth of event (a shallow marine event that displaces seafloor), and type of earthquake (thrust as opposed to strike-slip).

The severity of an earthquake can be expressed in terms of intensity and magnitude. Intensity is based on the damage and observed effects on people and the natural and built environment. It varies from place to place depending on the location with respect to the earthquake epicenter, which is the point on the Earth's surface that is directly above where the earthquake occurred. The severity of intensity generally increases with the amount of energy released and decreases with distance from the fault or epicenter of the earthquake. The scale most often used in the United States to measure intensity is the Modified Mercalli (MM) Intensity Scale. As shown in Table 5-3, the MM Intensity Scale consists of 12 increasing levels of intensity that range from imperceptible to catastrophic destruction. Peak ground acceleration (PGA) is also used to measure earthquake intensity by quantifying how hard the earth shakes in a given location. PGA can be measured in *g*, which is acceleration due to gravity (see Table 5-3).

Magnitude is the measure of the earthquake strength. It is related to the amount of seismic energy released at the earthquake's hypocenter, the actual location of the energy released inside the earth. It is based on the amplitude of the earthquake waves recorded on instruments, known as the Richter magnitude test scales, which have a common calibration (see Table 5-3).

Table 4-3
Magnitude/Intensity/Ground-Shaking Comparisons

Magnitude	Intensity	PGA (% g)	Perceived Shaking
0 – 4.3	I	<0.17	Not Felt
	II-III	0.17 – 1.4	Weak
4.3 – 4.8	IV	1.4 – 3.9	Light
	V	3.9 – 9.2	Moderate
4.8 – 6.2	VI	9.2 – 18	Strong
	VII	18 – 34	Very Strong
6.2 – 7.3	VIII	34 – 65	Severe
	IX	65 – 124	Violent
	X	124 +	Extreme
7.3 – 8.9	XI		
	XII		

History

Historically, most of the earthquakes that have occurred in Monterey County have originated from movement along the San Andreas Fault system, which runs through the southeastern portion of the county for approximately 30 miles (Figure E-5 [Appendix E]). It is the source of the area's earliest recorded great earthquake event, which occurred in June 1838. It is believed that this earthquake was a magnitude 7.0 to 7.4. Monterey County's next large earthquake occurred almost 20 years later on January 9, 1857. This estimated 8.3 earthquake, dubbed the Fort Tejon earthquake, occurred on the southern segment of the San Andreas Fault, northwest of the unincorporated community of Parkfield. The next large earthquake, known as the Great San Francisco earthquake, occurred on April 18, 1906. This event lasted 45 to 60 seconds and was in the range of magnitude 7.7–7.9. In Monterey, Hotel Del Monte was nearly destroyed, and four or five people were killed.

Available data suggest that between five to 10 small earthquakes have been felt each year in Monterey County and one moderate earthquake has been felt along the San Andreas Fault near Parkfield every 22 years (1857, 1881, 1901, 1922, 1934, 1966, and 2004) over the past 150 years. However, the next large earthquake did not occur for over 80 years, from 1906 until 1989. On October 17, 1989, the Loma Prieta earthquake occurred near Mt. Loma Prieta in neighboring Santa Cruz County. The earthquake lasted only 10 to 15 seconds, but had a magnitude 6.9 to 7.1. In Moss Landing, liquefaction destroyed the marine laboratory and seriously damaged a power plant.

Since 2007 there have been 47 earthquake events recorded in Monterey County, but none with a magnitude greater than 4.4 and none causing any damages, fatalities, or injuries in the planning area.

Location, Extent, and Probability of Future Events

As noted above, the San Andreas Fault system is the most active fault system in California. In its entirety, it runs 800 miles down the California coastline, including 30 miles in the southeastern portion of Monterey County. To the north and south of the County, the fault appears to be currently locked with no detectable movement. Between these locked sections, within the County, the San Andreas Fault creeps (slips aseismically). From San Juan Bautista to Parkfield, the creeping section produces numerous small to moderate (mostly magnitude 6.0 and smaller) earthquakes but no large ones. The stretch of the fault between Parkfield and Gold Hill defines a transition zone between the creeping and locked behavior of the fault.

In addition to the San Andreas Fault, two other active faults are located in Monterey County: the Palo Colorado–San Gregorio Fault zone and the Monterey Bay–Tularcitos Fault zone. The Palo Colorado–San Gregorio Fault zone connects the Palo Colorado Fault near Point Sur south of Monterey with the San Gregorio Fault near Point Año Nuevo in Santa Cruz County. It is a right-lateral strike-slip fault zone oriented generally north-south consisting of two or more parallel and fairly continuous fault segments that extend at least 60 miles. The Monterey Bay–Tularcitos Fault zone lies seaward of the city of Seaside, extending northwesterly to the Pacific Ocean. It is composed of short, discontinuous parallel fault segments ranging from 3 to 9 miles in length. The Monterey Bay Fault–Tularcitos zone is either truncated or merges with the San Gregorio fault segment of the Palo Colorado–San Gregorio Fault zone.

In addition to these active faults, several less active faults are located in Monterey County, as shown in Figure E-6 (Appendix E).

As noted earlier, the severity or extent of an earthquake can be expressed in terms of intensity, and the PGA measures the earthquake's intensity by quantifying how hard the earth shakes in a given location. PGA can be measured in *g*, which is acceleration due to gravity. The seismic shaking hazard map, as shown in Figure E-6 (Appendix E), shows the level of ground motion that has an annual probability of 1 in 475 of being exceeded each year, which is equal to a 10 percent probability of being exceeded in 50 years. As such, this map shows that the northern and southeastern portions of Monterey County are most susceptible to severe to extreme shaking (MMI VIII-X) and the central and western portion of the county is least susceptible to shaking (MMI V-VI).

Geologic studies show that over the past 1,400 to 1,500 years large earthquakes have occurred at about 150-year intervals on the southern segment of the San Andreas Fault (south of Parkfield). As the last large earthquake on the southern San Andreas Fault segment occurred in 1857, that section of the fault is considered a likely location for an earthquake within the next few decades. The northern segment of the fault (north of San Juan Baustista) has a slightly lower potential for a great earthquake, as only about 100 years have passed since the 1906 earthquake. However, as noted above, Monterey County experiences several small detectable earthquakes every year. Also, moderate-sized, potentially damaging earthquakes could occur in this area at any time.

Recent research by the USGS shows that the San Andreas Fault has a 21 percent probability and the San Gregorio–Palo Colorado Fault zone has a 10 percent probability of a magnitude 6.7 or greater earthquake by 2032. Because Monterey County experiences small earthquakes every year, the overall probability of occurrence of this hazard to some degree is considered to be highly likely.

4.3.6 Flood

Nature

Flooding is the accumulation of water where usually none occurs or the overflow of excess water from a stream, river, lake, reservoir, or coastal body of water onto adjacent floodplains. Floodplains are lowlands adjacent to water bodies that are subject to recurring floods. Floods are natural events that are considered hazards only when people and property are affected.

Nationwide, floods result in more deaths than any other natural hazard. Physical damage from floods includes the following:

- Inundation of structures, causing water damage to structural elements and contents.
- Erosion or scouring of stream banks, roadway embankments, foundations, footings for bridge piers, and other features.
- Impact damage to structures, roads, bridges, culverts, and other features from high-velocity flow and from debris carried by floodwaters. Such debris may also accumulate on bridge piers and in culverts, increasing loads on these features or causing overtopping or backwater effects.
- Destruction of crops, erosion of topsoil, and deposition of debris and sediment on croplands.
- Release of sewage and hazardous or toxic materials as wastewater treatment plants are inundated, storage tanks are damaged, and pipelines are severed.

Floods also result in economic losses through closure of businesses and government facilities, disrupt communications, disrupt the provision of utilities such as water and sewer service, result in excessive expenditures for emergency response, and generally disrupt the normal function of a community.

In Monterey County two types of flooding occur: riverine flooding, also known as overbank flooding, due to excessive rainfall, and coastal flooding due to wave run-up. Riverine floodplains range from narrow, confined channels in the steep valleys of mountainous and hilly regions to wide, flat areas in plains and coastal regions. The amount of water in the floodplain is a function of the size and topography of the contributing watershed, the regional and local climate, and land use characteristics. Flooding in steep, mountainous areas is usually confined, strikes with less warning time, and has a short duration. Larger rivers typically have longer, more predictable flooding sequences and broad floodplains.

Localized flooding may occur outside of recognized drainage channels or delineated floodplains due to a combination of locally heavy precipitation, increased surface runoff, and inadequate facilities for drainage and stormwater conveyance. Such events frequently occur in flat areas and in urbanized areas with large impermeable surfaces. Local drainage may result in "nuisance flooding," in which streets or parking lots are temporarily closed and minor property damage occurs.

Coastal flooding in Monterey County is generally associated with Pacific Ocean storms in the months of November through February that work in conjunction with high tides and strong winds to cause significant coastal flooding.

History

Historical records from 1911 through 2013 indicate that flood conditions and flood damage were experienced in portions of Monterey County during the following periods: March 1911, January 1914, February 1922, November 1926, December 1931, February 1937, February 1938, March 1941, January 1943, February 1945, January 1952, December 1955, January 1956, April 1958, February 1962, December 1966, January and February 1969, February 1973, February 1978, March 1983, January and March 1995, February 1998, January 2008, October 2010, and March 2011. As indicated by the dates listed here, most historic flood events have occurred during the winter months as a result of winter Pacific storms.

In the past 20 years, Monterey County has received five federal disaster declarations that covered flood events. During the January flood event of 1995, sustained precipitation fell throughout the region and over 125 residential properties in the Carmel Valley sustained damage. Two months later, Monterey County experienced a second significant winter storm, which resulted in further sustained precipitation falling on already saturated watersheds. Devastating flooding occurred throughout Monterey County, particularly in the unincorporated communities of Castroville, Mission Fields, Carmel Valley, Cachagua, Carmel Highlands, Spreckels, and Big Sur. Over 1,500 residences and 100 businesses were damaged. Five years later, in 1998 a series of El Niño winter storms contributed to intense flooding in which over 15 inches of rain fell during the month of February. Several small streams flooded and several coastal communities experienced flooding from wave run-up. In addition, Pajaro's entire population of 3,500 was ordered to evacuate after the levee along the Pajaro River was breached in several places.

More recent flood events have occurred in Monterey County but did not result in damages or impacts warranting a federal disaster declaration. This includes a strong coastal storm in January 2008 that brought flooding rains, high winds, record high surf and coastal flooding to Monterey County and resulted in nearly $1 million in property damages. Approximately 30 homes in the Carmel Lagoon area were affected by some degree of flooding. In October 2010 a strong low pressure system made its way through Central California and led to record breaking heavy rains across the area, causing an estimated $200,000 in damages. In Salinas, the Pacific Coast Christian Academy and Little Lamb Preschool were flooded after Little Bear Creek breached its banks. In March 2011 a series of systems affected Monterey County with heavy rain and strong winds causing an estimated $1 million in property damages. Nearly 1,300 acres of crops or croplands were impacted by flooding from the Salinas River and its tributaries causing an estimated $1.5 million in losses.

Table 4-4 shows National Flood Insurance claims and loss figures by jurisdiction, current as of June 2014.

Table 4-4
NFIP Claims and Loss Statistics by Jurisdiction

Jurisdiction	Total Losses	Closed Losses	Total Payments
Carmel By The Sea	1	1	$48,821.33
Del Rey Oaks	1	1	$750.00
Gonzales	10	9	$187,853.14
Greenfield	1	0	$0.00
King City	11	10	$717,517.72
Marina	0	0	$0.00
Monterey County	1,116	818	$21,825,432.16
Monterey	30	10	$2,635,371.97
Pacific Grove	0	0	$0.00
Salinas	30	20	$208,244.90
Sand City	0	0	$0.00
Seaside	1	1	$127.60
Soledad	2	2	$10,134.33

Source: FEMA

Location, Extent, and Probability of Future Events

Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of occurrence. Flood studies often use historical records, such as stream-flow gages, to determine the probability of occurrence for floods of different magnitudes. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in a given year.

The following factors contribute to the frequency and severity of riverine flooding:

- Rainfall intensity and duration
- Antecedent moisture conditions
- Watershed conditions, including steepness of terrain, soil types, amount, and type of vegetation, and density of development
- The existence of attenuating features in the watershed, including natural features such as swamps and lakes and human-built features such as dams
- The existence of flood control features, such as levees and flood control channels
- Velocity of flow

- Availability of sediment for transport, and the erodibility of the bed and banks of the watercourse

The following factors contribute to the frequency and severity of coastal flooding:

- Astronomical tides
- Storm surge, which is the rise in water from wind stress and low atmospheric pressure
- Waves
- Peak still-water elevation

The magnitude of flood used as the standard for floodplain management in the United States is a flood having a probability of occurrence of 1 percent in any given year, also known as the 100-year flood or base flood. The most readily available source of information regarding the 100-year flood is the system of Flood Insurance Rate Maps (FIRMs) prepared by FEMA. These maps are used to support the National Flood Insurance Program (NFIP) and show 100-year floodplain boundaries for identified flood hazards. These areas are also referred to as Special Flood Hazard Areas (SFHAs) and are the basis for flood insurance and floodplain management requirements under the NFIP. FIRMs also show floodplain boundaries for the 500-year flood, which is the flood having a 0.2 percent chance of occurrence in any given year.

Figure E-7 (Appendix E) shows the extent of the 100-year and 500-year floodplains as well as the known localized flooding within the entire county according to current effective FIRMs (2009). An area totaling 232.942 square miles within the county is within the 100-year floodplain and 57.367 square miles is within the 500-year floodplain. As such, shallow (1- to 3-foot) and sheet flooding conditions generally occur in the Salinas, Carmel, Pajaro, and Big and Little Sur Valleys. In addition, flooding can occur along the beach, where it is not uncommon to see winter storms produce 15-foot breakers. Flooding in these areas generally occurs during the rainy season, from October to April.

The rivers and streams for which FEMA has prepared detailed engineering studies may also have designated floodways. The floodway is the channel of a watercourse and portion of the adjacent floodplain that is needed to convey the base or 100-year flood event without increasing flood levels by more than 1 foot and without significantly increasing flood velocities. The floodway must be kept free of development or other encroachments. FEMA has designated floodways within the Salinas River.

Based on previous occurrences, Monterey County can generally expect a serious flood event to occur every 4 years. Overall, the probability of occurrence of this hazard is therefore considered to be likely.

4.3.7 Hazardous Materials Event

Nature

Hazardous materials include hundreds of substances that pose a significant risk to humans. These substances may be highly toxic, reactive, corrosive, flammable, radioactive, or infectious. Numerous federal, state, and local agencies, including the U.S. Environmental Protection Agency (EPA), U.S. Department of Transportation (DOT), National Fire Protection Association, FEMA, the U.S. Army, and the International Maritime Organization regulate hazardous materials.

Hazardous material releases can occur from any of the following:

- Fixed site facilities (such as refineries, chemical plants, storage facilities, manufacturing facilities, warehouses, wastewater treatment plants, swimming pools, dry cleaners, automotive sales/repair, gas stations, etc.)
- Highway and rail transportation (such as tanker trucks, chemical trucks, and railroad tankers)
- Air transportation (such as cargo packages)
- Pipeline transportation (liquid petroleum, natural gas, and other chemicals)

Unless exempted, facilities that use, manufacture, or store hazardous materials in the United States fall under the regulatory requirements of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986, enacted as Title III of the Federal Superfund Amendments and Reauthorization Act (42 USC 11001–11050 [1988]). Under EPCRA regulations, hazardous materials that pose the greatest risk for causing catastrophic emergencies are identified as Extremely Hazardous Substances (EHSs). These chemicals are identified by the EPA in the *List of Lists – Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-to-Know Act (EPCRA) and Section 112 of the Clean Air Act*. Releases of EHSs can occur during transport and from fixed facilities. Transportation-related releases are generally more troublesome because they can occur anywhere, including close to human populations, critical facilities, or sensitive environmental areas. Transportation-related EHS releases are also more difficult to mitigate due to the variability of locations and distance from response resources.

In addition to accidental human-caused hazardous material events, natural hazards may cause the release of hazardous materials and complicate response activities. The impact of earthquakes on fixed facilities may be particularly serious due to the impairment or failure of the physical integrity of containment facilities. The threat of any hazardous material event may be magnified due to restricted access, reduced fire suppression and spill containment, and even complete cut-off of response personnel and equipment. In addition, the risk of terrorism involving hazardous materials is considered a major threat due to the location of hazardous material facilities and transport routes throughout communities and the frequently limited antiterrorism security at these facilities.

History

The National Response Center (NRC) serves as the sole national point of contact for reporting all oil, chemical, radiological, biological, and etiological discharges into the environment anywhere in the United States. According to the NRC's Web-based query system, there have been 897 reported incidents in Monterey County since 1990. Of the 897 reported incidents, 369 (41 percent) occurred in unincorporated Monterey County, including 126 in the vicinity of Moss Landing. 256 reported incidents (29 percent) occurred in the city of Monterey, and 120 incidents (13 percent) occurred in the city of Salinas. According to the reporting system there have been less than 50 incidents reported for other cities. The number of total incidents, types of incidents, and types of materials are presented in Table 4-5.

Table 4-5
Reported Hazardous Material Incidents, 1990–2013

By Type of Incident		By Type of Material	
Type	**Number**	**Type**	**Number**
Aircraft	7	Oil, Misc.	114
Continuous	1	Oil, Diesel	107
Fixed	260	Oil, Fuel	56
Mobile	73	Ammonia	36
Pipeline	43	Oil, Crude	26
Railroad	31	Gasoline	39
Railroad Non-Release	57	Sewage	36
Storage Tank	17	Natural Gas	24
Unknown	181	Unknown	207
Vessel	227	Other	234
Total	**879**	**Total**	**879**

Source: National Response Center

In addition to the National Response Center, the EPA's Environmental Facts Multisystem Query contains information about facilities that are required to report activity (Superfund, water, waste, radiation, air, chemical, and toxic releases) to a state or federal system. 12 facilities have produced and released air pollutants, 20 facilities have permits and discharges to waters of the United States, 20 facilities have reported toxic releases, 458 facilities have reported hazardous waste activities, and 6 Superfund sites exist according to the query.

Location, Extent, and Probability of Future Events

In Monterey County, a hazardous materials event is most likely to occur along transportation corridors, oil fields, or in agricultural production areas. The trucks and trains that use these transportation corridors commonly carry a variety of hazardous materials, including gasoline, other crude oil derivatives, and other chemicals known to cause human health problems. The county's active oil fields are subject to fire or explosion. Monterey's agricultural industry is a heavy user of pesticides and fertilizers and the incorrect production and storage of these chemicals can not only contaminate the soil, air, and water, but can cause a fire or generate an explosion. In addition, there are an estimated 15 fixed hazardous materials sites within the planning area based on EPA Extremely Hazardous Substances (EHS) lists.

As such, as shown in Figure E-8 (Appendix E), a 1-mile buffer (½-mile on each side of the corridor) has been developed around the major transportation corridors: US 101, State Route 1 (Highway 1), State Route 156, State Route 183, State Route 68, State Route 198, and County Routes G14, G15, and G18. This buffer encompasses the majority of oil fields in Bradley and San Ardo and the majority of the agricultural pesticide and fertilizer storage facilities within Salinas Valley.

Comprehensive information on the probability and magnitude of a hazardous material event along the transportation corridor is not available. Wide variations among the characteristics of hazardous material sources and among the materials themselves make such an evaluation difficult. However, based on previous occurrences, Monterey County can expect a hazardous material event due to a railroad or mobile sources to occur five times a year. The probability of future hazardous material events due to oil fields and agricultural pesticides and fertilizers will be incorporated into future versions of the MJHMP as it becomes available.

4.3.8 Landslide

Nature

Landslide is a general term for the dislodgment and fall of a mass of soil or rocks along a sloped surface or for the dislodged mass itself. The term is used for varying phenomena, including mudflows, mudslides, debris flows, rock falls, rock slides, debris avalanches, debris slides, and slump-earth flows. Landslides may result from a wide range of combinations of natural rock, soil, or artificial fill. The susceptibility of hillside and mountainous areas to landslides depends on variations in geology, topography, vegetation, and weather. Landslides may also occur due to indiscriminate development of sloping ground or the creation of cut-and-fill slopes in areas of unstable or inadequately stable geologic conditions.

Debris flows are a particular threat to life and property in mountainous areas of Monterey County. These water-laden masses of soil and fragmented rock are most often triggered following heavy precipitation and can move very rapidly (20 miles per hour or more) and travel relatively long distances compared to other types of landslides, making them a particularly destructive hazard.

Landslides often occur together with other natural hazards, thereby exacerbating conditions, as described below:

- Shaking due to earthquakes can trigger events ranging from rock falls and topples to massive slides.
- Intense or prolonged precipitation that causes flooding can also saturate slopes and cause failures leading to landslides.
- Landslides into a reservoir can indirectly compromise dam safety, and a landslide can even affect the dam itself.
- Wildfires can remove vegetation from hillsides, significantly increasing runoff and the potential for fast-moving debris flows.

History

As shown in Figure E-9 (Appendix E), the USGS has mapped over 1,500 large landslides along the Big Sur coast. Some of these notable landslides include the Willow Creek, Wild Cattle Creek, Gray Slip, Duck Ponds, Tree Bones, Hurricane Point, and Straight Down landslides. Historically, landslide activity has increased during severe El Niño years. During the 1972–1973 El Niño season, a landslide along the Big Sur coast resulted in one death. Throughout the 1997–1998 El Niño season, a series of debris slides failed along the northern flank of Saddle Mountain in Carmel Valley and impacted Saddle Mountain Recreation Area. A landslide in Las Lomas in rural north Monterey County caused several homes to be destroyed and resulted in a Hazard Mitigation Grant Program (HMGP) project that involved buying out the affected homes and preserving the land where the slide occurred as perpetual open space. Failures were typically 50 to 100 feet in length, 30 to 50 feet in width, and 3 to 6 feet deep. Also, several landslides blocked Highway 1 at Hurricane Point.

In more recent years numerous landslide events have been recorded in Big Sur, damaging structures and forcing the closure of Highway 1. Many of these incidents occurred following intense rainfall in areas that had been recently burned by wildfire and were described as debris flows by the National Weather Service. Since 2007 there have been a total of nine landslide events recorded in Monterey County causing an estimated $4 million in property damages, but no reported fatalities or injuries.

Location, Extent, and Probability of Future Events

Several types of landslides occur in Monterey County, including shallow rock falls, debris flows, and steep slope failures. However, the most common type of landslide in this area is a large slow-moving or creeping landslide. Typically, these deep-seated landslides, which are hundreds to thousands of feet in length or width, only move fractions of an inch per year. However, during heavy rainfall or seismic events, a landslide can move several yards a minute or faster.

As shown in Figure E-10 (Appendix E), the areas of highest susceptibility to earthquake-induced large landslides include Carmel Valley, the southern Big Sur coast, the Arroyo Seco district, and the foothills of southern Salinas Valley. In this area, rocks have been weakened through faulting and fracturing, uplift, and saturated soils due to heavy or prolonged rainfall. Shallow landslides such as debris flows and rock falls are strongly dependent on local site conditions and therefore are not included on this figure. However, these geologic hazards are most common in the northern part, along the steep slopes of the northern Big Sur coast.

The potential for debris flows increases significantly for areas recently burned by large wildfires. Wildfires can greatly reduce the amount of vegetation, which in turn reduces the ability for the ground to absorb rainwater, allowing excessive water runoff that often includes large amounts of debris. An area of current particular concern is the vicinity of Pfeiffer Ridge in Big Sur that was impacted by the Pfeiffer Fire in December 2013. While post-fire assessment data and detailed mapping on vulnerability to debris flow is not available, structures located anywhere near the burn area should be considered potentially at risk during and following high intensity rainfall events until the vegetation is restored.

In general Monterey County can expect to experience significant landsliding events during strong El Niño years (every 5 to 7 years) or during a large earthquake event. Overall, the probability of occurrence of this hazard is therefore considered to be possible.

4.3.9 Sea Level Rise

Nature

Sea level rise refers to an increase in mean sea level over time. There is strong scientific evidence that global sea level is now rising at an increased rate and will continue to rise during this century. In its most recent assessment report (2013), the Intergovernmental Panel on Climate Change (IPCC) estimates that the global average sea level will rise between 0.9 and 3.2 feet (0.28 to 0.98 meters) in the next century. However, climate models, satellite data, and hydrographic observations demonstrate that sea level is not rising uniformly around the world. Depending on the region, sea level might be projected to rise several times the global mean rise or can actually fall.

The two driving processes causing global sea level rise are thermal expansion caused by the warming of the oceans (since water expands as it warms) and the loss of land-based ice (such as glaciers and polar ice caps) due to increased melting. Local sea level change is of more direct relevance and concern to coastal communities and distinct from global change. Local sea level change is affected by numerous processes that can alter the rate and extent of change, including a combination of the rise in sea level and the change in land elevation, and other locally influential variables such as wind and ocean currents, changes in ocean temperature and salinity, atmospheric pressure, and large-scale climate regimes. Areas experiencing coastal erosion and land subsidence accelerate the rate of sea level rise occurring locally. Coastal communities experiencing increases in mean sea level are at greater risk to the effects of coastal flood hazards as natural, protective buffers such as coastal wetlands and dunes are lost and property and infrastructure become more exposed to the frequency and severity of coastal flood and storm surge inundation. Such communities may also be at greater risk to increased coastal erosion and the intrusion of saltwater into groundwater aquifers which can lead to contamination of sources of freshwater for drinking or agricultural use, and other consequences including the loss of critically important habitat.

History

According to NOAA, while studies show that historic global sea levels changed little until 1900, sea levels began to climb in the 20th century. Records and research show that global sea level has been steadily rising at a rate of 1 to 2.5 millimeters (0.04 to 0.1 inches) per year since 1900, and this rate may be increasing. Since 1992, new methods of satellite altimetry indicate a rate of rise of 3 millimeters (0.12 inches) per year.

According to the California Climate Change Center's Third Assessment report (2012), sea levels along California's coast have increased a total of approximately 18 centimeters (7 inches) since 1900, for an average of 1.7 millimeters (0.07 inches) per year. The tide gauge station at Monterey County was installed in 1973, so more locally relevant and reliable long-term trend data on sea levels specific to Monterey County is not available. However the tide gauge data collected since 1973 suggests a sea level rise trend similar to the statewide average, at approximately 1.34 millimeters (0.05 inches) per year.

Location, Extent, and Probability of Future Events

Global sea level change is typically measured using satellite altimetry, and while these measurements are important, local measurements and projections for various scenarios are required for local vulnerability assessments and planning efforts. Figures E-16 (Appendix E) illustrate potential sea level rise inundation areas for Monterey County based on expected 2100 conditions assuming the following scenarios, which are consistent with the upper bound estimates of global sea level rise used by the State of California for coastal adaptation purposes under Executive Order S-13-08, and within the range of projections most recently recommended by the State's Climate Action Team for the Central Coast. These scenarios reflect an accelerated rate of sea level rise in comparison to historical measurements.

- Monterey County – Approximate 5-foot rise in sea level.
- Northern Monterey County (Moss Landing) **–** Approximate 5-foot rise in sea level.

Unlike most other natural hazards, sea level rise is a slow onset event, and the extent (severity or magnitude) of which is measurable only over long periods of time. Of greater immediate concern to Monterey County is the influence sea level rise will have on the severity of episodic hazard events such as coastal flooding and long-term coastal erosion. It is expected that sea level rise will be an amplifier of the magnitude for these other coastal hazards, which in all likelihood will require cost-effective hazard mitigation strategies that also take into account long-term adaptation to projected levels of gradual sea level rise inundation. Data and tools made available through Cal Adapt project an increase in land vulnerable to the 100-year coastal flood for Monterey County will increase by 11 percent by the year 2100.

4.3.10 Tsunami

Nature

One of the hazards with the potential to affect the Monterey County coast is a tsunami. A tsunami is a "wave or series of waves generated by an earthquake, landslide, volcanic eruption, or even large meteor hitting the ocean." What typically happens is a large, submarine earthquake (magnitude 8 or higher) creates a significant upward movement of the sea floor resulting in a rise or mounding of water at the ocean surface. The mound of water moves away from this center in all directions as a tsunami.

A tsunami can travel across the open ocean at about 500 miles per hour, the speed of a jet airliner. As the wave approaches land and as the ocean shallows, the wave slows down to about 30 miles per hour and has grown significantly in height (amplitude). A thrust-type earthquake (vertical displacement) is more likely to produce a tsunami than an earthquake from a lateral strike-slip fault, such as the San Andreas. Because of this, subduction zones, where dense oceanic crust burrows underneath less-dense continental crust, are more likely to produce a large tsunami. The Pacific coast of North America is a prime example of a subduction zone. The Cascadia Subduction Zone, off the coasts of British Columbia, Washington, Oregon, and Northern California is an area of concern for possible tsunami generation. The Aleutian Islands and Gulf of Alaska are also capable of producing very large offshore earthquakes that may produce large tsunamis.

A tsunami wave is NOT a tall breaking wave. A tsunami wave CAN NOT be surfed, they have no face for a surf board to dig into. It is NOT a tidal wave, although that term is a common misnomer for a tsunami. A tsunami actually resembles a flood or surge, consisting of several waves or surges. The first tsunami surge is often not the highest and the largest surge may occur hours after the first wave. It is not possible to predict how many surges or how much time will elapse between waves for a particular tsunami. This will become a major issue for public safety officials responding to a tsunami.

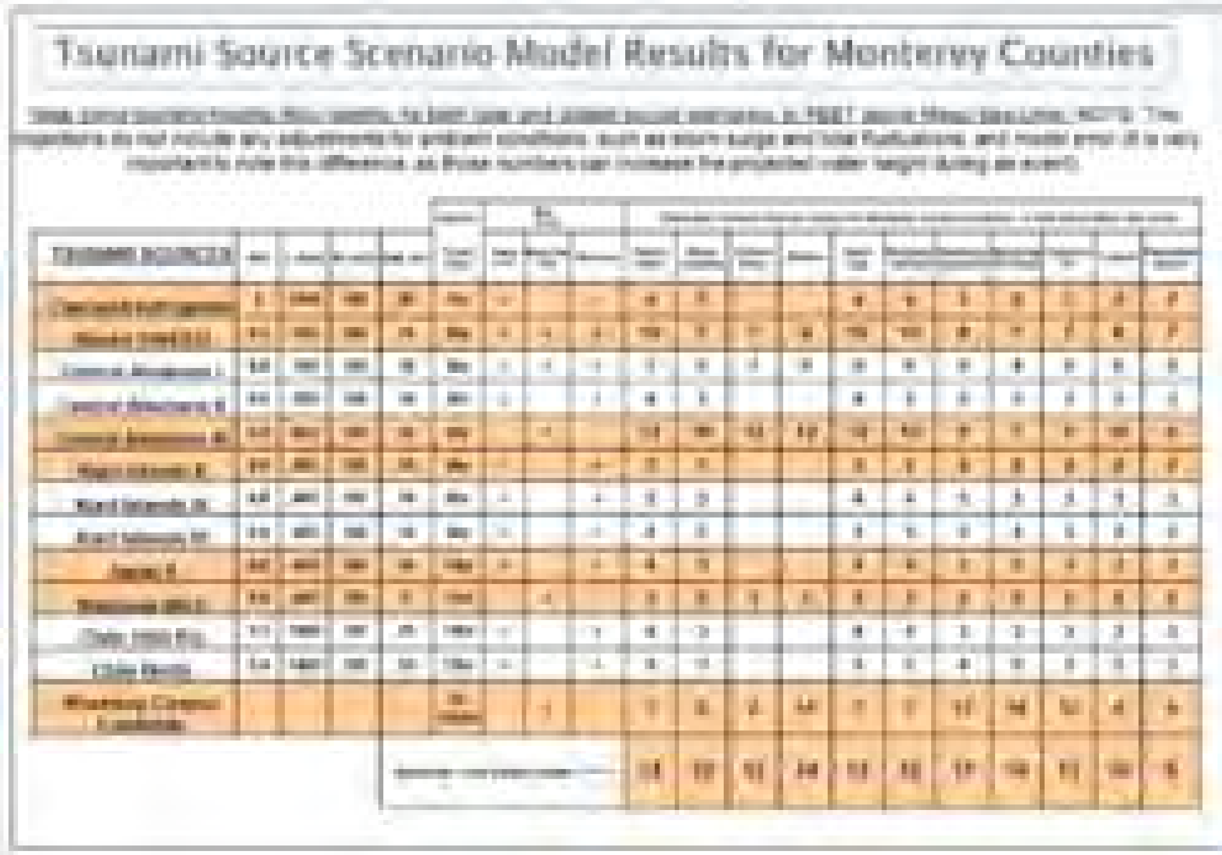
Visually, tsunamis differ from typical wind waves as well. A tsunami is virtually undetectable to the eye until it has nearly reached the shore. When people think of a tsunami, many will state that they expect to see a wave similar to a wind wave but much larger, perhaps similar to the giant wind waves in Hawaii and Australia that have made those places world class surfing destinations. However, a tsunami likely will not resemble a typical wind wave. A tsunami looks more like a storm surge experienced in a large hurricane than it does a wind wave. Similar to a hurricane's storm surge, a tsunami is capable of bringing in large amounts of water inland very quickly, and can inundate areas that are normally dry, even during highest tides. The surges are extremely strong and the currents uproot and carry everything within its path. These debris filled surges are deadly and destructive to anyone and everything in their path.[3]

The chart shown in Figure 4-2 presents projected tsunami scenarios for areas in Monterey County.[4]

[3] *Monterey County Operational Area Tsunami Incident Response Plan*, Monterey County Office of Emergency Services, March 2014.

[4] *California Tsunami Evacuation Playbook, City of Monterey and Monterey County, Playbook No. 2014-Mont-01*, California Geological Survey, California Governor's Office of Emergency Services, and the National Oceanic and Atmospheric Administration, June 2014.

Figure 4-2
Tsunami Source Scenario Model Results



History

As shown in Table 4-6, eight observed tsunamis generated waves in Monterey County over the last 200 years. Almost all of the tsunamis were produced by earthquakes and resulted in wave run-ups of 1 meter or less. A tsunami in 1960 produced severe currents in Monterey, Moss Landing, and Pacific Grove and is blamed for one death.

More recently, in 2011, a tsunami caused by an earthquake off the coast of Japan created large and rapid changes in water level (up to 7 feet) at Moss Landing, causing large volumes of water to rush in and out of the north and south harbor areas. This ebbing and flowing combined with large sediment transport resulted in shear stresses on dock structures in the harbor, causing approximately $2.5 million in damages to 209 timber piles.

Table 4-6
Historic Monterey County Tsunami Events, 1806–2013

Date	Origin	Cause	Location of Effects	Wave Run-Up (Meters)
04/11/2011	Japan	Earthquake	Moss Landing	2.0 M
02/26/2010	Central Chile	Earthquake	Monterey	0.36 M
06/22/2001	Southern Peru	Earthquake	Monterey	0.15 M
04/25/1992	N. California	Earthquake	Monterey	<0.1 M
10/18/1989	N. California	Earthquake	Monterey, Moss Landing	0.4 – 1.0 M
03/28/1964	Gulf of Alaska	Earthquake	Monterey, Moss Landing, Pacific Grove	Observed – 1.4 M
05/22/1960	S. Central Chile	Earthquake	Monterey, Moss Landing, Pacific Grove	0.8 – 1.1 M
03/09/1957	Central Aleutian Islands	Earthquake	Monterey	0.6 M
04/01/1946	E. Aleutian Islands	Earthquake, Landslide	Monterey, Pacific Grove	Observed – 2.6 M
03/03/1901	N. California	Landslide	Monterey	Observed

Source: Humboldt State University, Monterey County Office of Emergency Services

Location, Extent, and Probability of Future Events

As shown in Figure 10 (Appendix E), the entire coastal area of Monterey County is susceptible to a tsunami. The Big Sur coast is less susceptible to significant tsunami run-up due to the rugged and steep cliffs of the coastal mountains. However, the coastal low-lying areas and riverine valleys to the north are highly susceptible to tsunamis. For example, areas as far inland as Castroville are susceptible to a moderate tsunami run-up (less than 21 feet. However, tsunami modeling by the State of California indicates that the maximum tsunami run-up height is expected to be only between 15-20 feet for the Monterey County coast.

As noted above, Monterey County has experienced 10 notable tsunamis over the past 100 years and has been impacted significantly by one. Although these numbers could be averaged to generate an expected occurrence rate, there have been as few as 1 and as many as 45 years in between events, and an averaged recurrence interval would not be meaningful. For the purposes of this plan, the probability that Monterey County will experience a tsunami has been estimated to be possible, averaging a 1-foot to 11-foot wave run-up for all coastal and low-lying areas within the county.

The San Gregorio Fault, which runs more or less parallel to the coastline, is the likeliest point of origin for a near-shore event. Although not generally considered a fault capable of producing a "mega-earthquake" (>8.0), it is capable of a large enough earthquake that could trigger an offshore landslide in a submarine canyon in the Monterey Bay. If an event such as this were to occur, any potentially resulting tsunami would reach shore in less than 30 minutes, and possibly as little as 10 minutes.

Strong currents could also be generated within harbors. During large tsunami events, primarily from the source area near the Alaska-Aleutian Islands region, tsunami currents could cause currents that could damage harbor docks, infrastructure, and other facilities.[5]

4.3.11 Wildland Fire

Nature

A wildland fire is a type of wildfire that spreads through consumption of vegetation. It often begins unnoticed, spreads quickly, and is usually signaled by dense smoke that may be visible from miles around. Wildland fires can be caused by human activities (such as arson or campfires) or by natural events such as lightning. Wildland fires often occur in forests or other areas with ample vegetation. In addition to wildland fires, wildfires can be classified as urban fires, interface or intermix fires, and prescribed fires.

The following three factors contribute significantly to wildland fire behavior and can be used to identify wildland fire hazard areas.

- **Topography:** As slope increases, the rate of wildland fire spread increases. South-facing slopes are also subject to more solar radiation, making them drier and thereby intensifying wildland fire behavior. However, ridgetops may mark the end of wildland fire spread, since fire spreads more slowly or may even be unable to spread downhill.
- **Fuel:** The type and condition of vegetation plays a significant role in the occurrence and spread of wildland fires. Certain types of plants are more susceptible to burning or will burn with greater intensity. Dense or overgrown vegetation increases the amount of combustible material available to fuel the fire (referred to as the "fuel load"). The ratio of living to dead plant matter is also important. The risk of fire is increased significantly during periods of prolonged drought as the moisture content of both living and dead plant matter decreases. The fuel's continuity, both horizontally and vertically, is also an important factor.
- **Weather:** The most variable factor affecting wildland fire behavior is weather. Temperature, humidity, wind, and lightning can affect chances for ignition and spread of fire. Extreme weather, such as high temperatures and low humidity, can lead to extreme wildland fire activity. By contrast, cooling and higher humidity often signal reduced wildland fire occurrence and easier containment.

The frequency and severity of wildland fires is also dependent on other hazards, such as lightning, drought, and infestations (such as the recent damage to Southern California alpine forests by the pine bark beetle). If not promptly controlled, wildland fires may grow into an emergency or disaster. Even small fires can threaten lives and resources and destroy improved properties. In addition to affecting people, wildland fires may severely affect livestock and pets. Such events may require emergency watering/feeding, evacuation, and shelter.

The indirect effects of wildland fires can be catastrophic. In addition to stripping the land of vegetation and destroying forest resources, large, intense fires can harm the soil, waterways, and the land itself. Soil exposed to intense heat may lose its capability to absorb moisture and support life. Exposed soils erode quickly and enhance siltation of rivers and streams, thereby enhancing

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[5] *California Tsunami Evacuation Playbook, City of Monterey and Monterey County, Playbook No. 2014-Mont-01*, California Geological Survey, California Governor's Office of Emergency Services, and the National Oceanic and Atmospheric Administration, June 2014.

flood potential, harming aquatic life, and degrading water quality. Lands stripped of vegetation are also subject to increased debris flow hazards.

History

The eighth largest wildland fire recorded in California since 1932 occurred in Monterey County. In July 1977 the Marble Cone fire burned almost 178,000 acres of land. Fortunately, no structures were lost and no deaths occurred. Lightning was determined to be the cause of this fire.

In more recent years the frequency, intensity, and impact of large wildland fires in Monterey County have increased, specifically in the Los Padres National Forest. In 2008, the Basin Complex Fire burned more than 162,000 acres, destroyed 58 structures, and damaged an additional 9 structures. The Indians Fire during this same event period burned an additional 81,000 acres, leaving 15 structures destroyed and one damaged. In December 2013, during the update to this plan, the Pfeiffer fire burned 917 acres near Big Sur and damaged or destroyed 38 structures, including 34 residential structures and 4 outbuildings.

As shown in Table 4-7, since 1999 Monterey County has experienced 18 large (300-acre or greater) wildland fires. These fires do not include the estimated 25,000 acres burned annually from wildland fires in Los Padres National Forest. Figure E-11 (Appendix E) shows total number of wildland fires from 1986 through 1996.

Table 4-7
Large Monterey County Wildland Fires, 1999-2013

Year	Fire Name	Dates	Acres Burned	Cause
2013	Pfeiffer	12/16 – 12/20	917	Under Investigation
2012	Turkey	7/9 – 7/10	2,529	Equipment
2011	Metz	5/12 – 5/14	832	Other
2011	Cattleman	5/29 – 5/30	382	Other
2009	Bryson	8/26 – 8/29	3,383	Structure
2009	Gloria	8/27 – 9/1	6,437	Equipment
2009	Ponderosa	8/1 – 8/7	458	Miscellaneous
2008	Indians	6/8 – 7/10	81,378	Campfire
2008	Basin Complex	6/21 – 7/27	162,818	Lightning
2008	Turkey	8/7 – 8/8	400	Power Equipment
2008	Chalk	9/25 – 10/29	16,269	Miscellaneous
2007	Mission	6/28 – 6/28	2,300	Powerlines
2006	Ricco	7/22 – 7/27	14,506	Lightning
2006	Stoney	7/26 – 7/26	500	Under Investigation
2005	Johnson	9/4 – 9/5	1,393	Vehicle
2004	Chular	6/30 – 7/1	300	Powerline
2002	Ft. Hunter Liggett	8/10 – 8/11	1,400	Under Investigation
1999	Metz Rd. #3	6/19 – 6/19	300	Undetermined

Source: CAL FIRE, U.S. Forest Service

Location, Extent, and Probability of Future Events
Figure E-12 (Appendix E) displays both the location and extent of wildland fire hazard areas for Monterey County. This map is based on the California Fire and Resource Assessment Program (FRAP) fuel rank model. This model ranks the fuel type, slope, and ladder and/or crown fuel present from 1911–2005 to determine potential exposure to wildfire hazard areas. As such, mountainous, highly combustible areas in and around the Los Padres National Forest have a FRAP fuel ranking of "very high" and therefore are most susceptible to wildland fires. The communities along the Big Sur coast, including Big Sur, Post, Lucia, Gorda, and Plaskett, are also at great risk to wildland fires. Sudden Oak Death is present and expanding in this area and its effects present a serious and growing wildland fire danger.

Generally, fire susceptibility throughout California dramatically increases in the late summer and early autumn as vegetation dries out, decreasing plant moisture content and increasing the ratio of dead fuel to living fuel. However, various other factors, including humidity, wind speed and direction, fuel load and fuel type, and topography, can contribute to the intensity and spread of wildland fires. The common causes of wildland fires in California include arson and negligence. Based on previous occurrences, Monterey County can expect a large wildland fire to occur about every 1 to 2 years, making the overall probability of occurrence likely.

It is anticipated that the effects of climate change will result in an increase in the frequency and magnitude of wildland fires for Monterey County. Data and tools made available through Cal Adapt project an increase in area burned of between 8-12 percent by 2020, between 10-15 percent by 2050, and between 19-28 percent by 2085 depending on low versus high emissions scenarios, respectively.

4.3.12 Windstorm

Nature
Winds are horizontal flows of air that blow from areas of high pressure to areas of low pressure. Wind strength depends on the difference between the high- and low-pressure systems and the distance between them. A steep pressure gradient results from a large pressure difference or short distance between these systems and causes strong winds. Windstorms associated with cyclonic systems and their cold fronts occur in the winter. These storms can damage trees and temporarily disrupt power and communication facilities, but usually cause only minor damage to structures.

Windstorms can also be created by thermally forced circulations during the spring to summer months. Known as sea breezes, these winds are strongest when the land becomes warmer than the adjacent ocean. Driven by the differential heating of land versus water, sea breeze formation is conducive under synoptic conditions that allow strong heating of land areas. The wind direction associated with the sea breeze is directed inland along the surface pressure gradient. Therefore, sea breeze fronts generally push inland for approximately 25 miles as the day progresses. The sea breeze circulation will intensify as the daytime solar heating reaches its maximum before diminishing and reversing to a land breeze circulation as the land cools.

History
According to the National Climatic Data Center, Monterey County has been affected by high windstorm events in January 2008, March 1995, and February 1993. The January 2008 event was the result of a very strong cyclone that slammed into the Monterey Bay area bringing flooding rains, high winds, record surf, and coastal flooding. A peak gust of 63 mph was recorded at Carmel Middle School and total estimated damages in Monterey County were estimated at nearly $1 million,

mainly due to falling trees hitting cars and buildings in the affected area. Monterey County has also recorded four tornadoes associated with cold-core upper-level lows centered off the Northern California coast. All four tornadoes occurred in the northeastern portion of Monterey County, with the largest tornado reaching a magnitude of F1 (maximum wind speeds of 73–112 mph) in Watsonville, just across the Pajaro River in Santa Cruz County, in December 2001.

In addition to winter windstorms, every year, between the months of March and October, when the Pacific High attains its greatest strength, prevailing northwest sustained surface winds in Salinas Valley reach average speeds of 10 to 15 mph with accompanying wind gusts up to 45 mph.

Location, Extent, and Probability of Future Events

All of Monterey County is subject to strong southeasterly winds associated with powerful cold fronts. These winds, which are usually part of a strong Pacific storm, generally occur during the winter months, from November through February. On the other hand, sea breezes generally occur in the central and southern Salinas Valley. As shown in Figure E-13 (Appendix E), the central and southern Salinas Valley is susceptible to both types of wind hazards. This area contains roughly all lands between the communities of Chualar in the north and San Lucas in the south. The San Benito County line forms the eastern boundary, and the boundary to the southwest is formed by the Hunter-Liggett Military Reservation and the Los Padres National Forest. As the wind passes through the narrowing valley, the wind velocity increases and moisture-holding capacity decreases. As such, this wind is relatively hot and dry in southern portions of the valley, such as Soledad. Sea breeze winds, with average winds speeds of 10–15 mph, can be expected annually from March through October. The overall probability of occurrence of this hazard is considered to be likely.