County of Orange

&

Orange County Fire Authority

Local Hazard Mitigation Plan November 2015

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Record of Changes

Date of Revision	Revision Description	Section/Component	Revision Completed By

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Board of Supervisors Resolution

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State OES Formal Review Letter

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FEMA Letter of Acceptance

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Chapter 1 Introduction

Introduction

The County of Orange operates a comprehensive emergency management program of which mitigation is a key component. Responsibility for mitigation planning and implementation rests with multiple agencies and departments. The mitigation theory postulates that money spent reducing a community's exposure to hazards is more cost effective than the money spent to respond to and recover from the impacts of those hazards.

The Disaster Mitigation Act of 2000 (Public Law 106-390) amended the Robert T. Stafford Disaster and Emergency Assistance Act (42 USC 5121 et seq.) to describe a set of requirements for local mitigation planning. Local jurisdictions are required to maintain a Local Hazard Mitigation Plan (LHMP) under the Disaster Mitigation Act of 2000 to be eligible to receive FEMA mitigation project grants (42 USC 5165).

The mission of the County of Orange and Orange County Fire Authority Hazard Mitigation Plan is to promote sound public policy designed to protect residents, critical facilities, infrastructure, key resources, private property, and the environment from natural hazards in County unincorporated area, fire hazards in the Fire Authority service area, and County and Fire Authority owned facilities.

Hazard mitigation will result in increased public awareness, documentation of resources for risk reduction and loss-prevention, and identifying activities to guide the County toward building a safer, more sustainable community.

Scope

This Local Hazard Mitigation Plan (LHMP) is a multi-jurisdiction plan developed jointly between the County of Orange, a local government, and the Orange County Fire Authority, a Joint Powers Authority. This collaborative plan was developed to ensure that each participating agency has met the requirements of 44 CFR §201.6. The plan is also written to meet requirements of Activity 510 – Floodplain Management Planning under the National Insurance Program Community Rating System. The current approved Local Hazard Mitigation Plan is adopted as an element of The County of Orange General Plan under Chapter IX – Safety Element as required under California Government Code §8685.9 and §65302.6.

As a multi-jurisdiction plan, the document focuses on mitigating all natural hazards impacting unincorporated areas of the County as well as County and Orange County Fire Authority owned facilities. The Orange County Fire Authority provides fire suppression and prevention services to the County unincorporated areas, as well as a variety of other jurisdictions and contracts under their Joint Powers Authority. As a result, fire mitigation strategies in this plan are inclusive of all areas served by the Fire Authority.

Planning Process

Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process* ***shall*** *include:*

(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;

(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and

Requirement §201.6(c)(1): *[The plan **shall** document] the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.*

In order to develop a comprehensive Local Hazard Mitigation Plan (LHMP) it was necessary to enlist participation from County agencies as well as the Fire Authority. This plan was developed through the work of the Orange County Hazard Mitigation Planning Task Force (Task Force), the County Emergency Management Council, the County Emergency Management Council Subcommittee, and the Orange County Emergency Management Organization. The Task Force consisted of representatives from the following agencies, departments, and jurisdictions:

County of Orange	
Sheriff's Department, Emergency Management Division	
Michelle Anderson	Deputy Director of Emergency Management
Donna Boston	Director of Emergency Management
Ethan Brown	Senior Emergency Management Program Coordinator
Raymond Cheung	Assistant Emergency Manager
Bryan Hovde	Senior Emergency Management Program Coordinator
Victoria Osborn	Assistant Emergency Manager
Public Works Department	
Brian Anderson	Supervising Engineering Technician II, GIS Applications
Mike Granada	Civil Engineering Assistant, Capital Programs
Penny Lew	Senior Civil Engineer, Flood Plain Management
Ruby Maldonado	Manager, Planning, Land Use Development
Mehdi Sobhani	Manager, Infrastructure Programs, Flood Program Support
Health Care Agency	
Michele Cheung	Public Health Medical Officer
Lydia Mikhail	Manager, Health Disaster Management
Mike Steinkraus	Emergency Medical Services Coordinator
Social Services Agency	
Diana LaRusso	Emergency Services Support Manager
Sheriff's Department	
Robert Beaver	Director, Research and Development Division
Delia Kraft	Emergency Communications Manager, Communications Division

John Wayne Airport	
Jim Ellis	Emergency Preparedness Manager
Andrew Harsh	Emergency Preparedness Manager
Dana Point Harbor	
David Rocha, P.E.	Engineering Manager
Orange County Community Resources	
Janet Hamlin-Clinkscales	Administrative Manager, Organizational Development
Orange County Fire Authority	
Randy Black	Battalion Chief, Emergency Planning and Coordination
Brian Norton	Battalion Chief, Community Risk Reduction

The Task Force was responsible for leading the plan update process. During the revision, members reviewed and updated the County's mitigation strategy, evaluated changes to the threat landscape, updated disaster histories to reflect recent incidents, analyzed impacts to unincorporated areas and County owned infrastructure, and updated, added, and reprioritized mitigation action items. The County of Orange held responsibility for evaluating the majority of the hazards while the Orange County Fire Authority was responsible for evaluating fire threats, history, and mitigation action items across its service area. Both jurisdictions provided data on critical infrastructure to assist in evaluating risk.

In addition to the work done by the Task Force, additional agencies, jurisdictions, and organizations were provided an opportunity to provide comments, input, and feedback on the plan. Entities who were invited

to participate include:

County of Orange

- Assessor
- Auditor-Controller
- Board of Supervisors
- Child Support Services
- Clerk of the Board
- Clerk-Recorder
- County Counsel
- County Executive Office
- District Attorney
- Health Care Agency
- Human Resources
- John Wayne Airport
- OC Community Resources (OCCR)
- OCCR – Animal Care Services
- OCCR – Dana Point Harbor
- OC Public Works
- OC Waste & Recycling
- Orange County Sheriff's Department

(OCSD)

- OCSD – Communications
- Orange County Fire Authority
- Probation
- Public Defender
- Registrar of Voters
- Social Services Agency
- Superior Courts of California, County of

Orange

- Treasurer-Tax Collector

In addition to County agencies represented through the Emergency Management Council and the Emergency Management Council Subcommittee, comments on the plan were solicited from the Orange

County Emergency Management Organization (OCEMO). OCEMO is a standing subcommittee of the Orange County Operational Area Executive Board, tasked with developing and reviewing plans across the County to ensure consistency. Membership in the organization consists of representatives from each of the County's 34 cities along with members from special districts, school districts, and affiliated nongovernmental organizations. OCEMO meetings are also often attended by interested members of the public. OCEMO member agencies include:

OCEMO – Plan Participants

- County of Orange
- Orange County Fire Authority

OCEMO -- Cities

- Aliso Viejo
- Anaheim
- Brea
- Buena Park
- Costa Mesa
- Cypress
- Dana Point
- Fountain Valley
- Fullerton
- Garden Grove
- Huntington Beach
- Irvine
- La Habra
- La Palma
- Laguna Beach
- Laguna Hills
- Laguna Niguel
- Laguna Woods
- Lake Forest
- Los Alamitos
- Mission Viejo
- Newport Beach
- Orange
- Placentia
- Rancho Santa Margarita
- San Clemente
- San Juan Capistrano
- Santa Ana
- Seal Beach
- Stanton
- Tustin
- Villa Park

- Westminster
- Yorba Linda

OCEMO – School Districts

- Anaheim City School District
- Anaheim Union H.S. District
- Brea-Olinda Unified School District
- Capistrano Unified School District
- Centralia School District
- Coast Community College
- Cypress School District
- Fountain Valley School District
- Fullerton Joint Union High School District
- Fullerton School District
- Garden Grove Unified School District
- Huntington Beach School District
- Huntington Beach Union High School District
- Irvine Unified School District
- La Habra City School District
- Laguna Beach Unified School District
- Los Alamitos Unified School District
- Lowell Joint School District
- Magnolia School District
- Newport-Mesa Unified School District
- North Orange County Community College District
- Orange County Department of Education
- Ocean View School District
- Orange Unified School District
- Placentia-Yorba Linda Unified School District Rancho Santiago Community College District
- Saddleback Valley Unified School District
- Santa Ana Unified School District
- Savanna School District
- South Orange County Community College District
- Tustin Unified School District
- Westminster School District

OCEMO – Special Districts

- Buena Park Library District
- Capistrano Bay Community Services District
- Costa Mesa Sanitary District
- East Orange County Water District
- El Toro Water District
- Emerald Bay Community Services District
- Garden Grove Sanitary District
- Irvine Ranch Water District

- Laguna Beach County Water District
- Mesa Consolidated Water District
- Midway City Sanitary District
- Moulton Niguel Water District
- Municipal Water District of Orange County
- Orange County Transportation Authority
- Orange County Cemetery District
- Orange County Sanitation District
- Orange County Vector Control
- Orange County Water District
- Placentia Library District of Orange County
- Rossmoor Community Services District
- Santa Margarita Water District
- Serrano Water District
- South Coast Water District
- Sunset Beach Sanitary District
- Trabuco Canyon Water District
- Yorba Linda Water District

Disabilities and Access and Functional Needs Working Group

Members of the Orange County Disabilities, Access and Functional Needs Working Group were given an opportunity to review and comment on the plan. This working group is composed of people with disabilities, the organizations that serve them, emergency planners, and community advocates. The group works to ensure that all plan documents address the needs of the whole community.

Public Review

In addition to members of the public who reviewed the plan through other open meetings and committees, the Hazard Mitigation Plan was also distributed for public review on the Orange County Sheriff's Department Emergency Management Division's website and the County of Orange website. To publicize the plan's review, messages were sent through the Emergency Management Division's Twitter and Facebook accounts to more than 9,000 followers as well as through the Orange County Sheriff Department's Twitter account to more than 18,000 followers. On the website, visitors were also encouraged to participate in a survey regarding hazard and risk perception as well as steps they have taken to prepare themselves, their families, and their homes.

After closing the survey and public comment period, a Hazard Mitigation page is maintained on the Emergency Management Division website providing a resource for members of the public on the County's mitigation strategy, plan documents, and opportunities to provide feedback and comments for consideration during each annual plan review.

Online Survey Results

The online survey received 164 responses from Orange County residents. Survey-takers were asked a variety of questions, including which, if any, hazards had impacted them in the past, their level of concern on different hazards, their preparedness level, and their knowledge of hazards in their area. The complete text of the survey is available in Attachment A.

The most intriguing results of the survey included:

- Almost all respondents (or their families) had experienced a disaster. Of those, 85.71% were impacted by earthquake and 72.05% by drought.
- Respondents ranked earthquake as the natural disaster that poses the greatest threat to their neighborhood, with wildland/urban Fire, flood/storm and drought close behind. Nearly 50% of respondents ranked earthquake as the greatest natural threat.
- Only 26.50% of respondents ranked themselves as prepared or very prepared for a disaster. 73.49% of respondents ranked themselves as somewhat prepared or not prepared at all.
- Less than 50% of respondents reported they use social media as a source for emergency preparedness information, with most opting to use traditional sources like television, web sites and radio.
- Only 14.56% of respondents reported carrying flood insurance, while 41.14% of respondents reported carrying earthquake insurance.
- Almost 90% of respondents were signed up for AlertOC or another emergency mass notification system.

These survey results were used to validate the hazard risk assessment as well as the prioritization of mitigation action items.

Plan Meetings

As the planning process was executed, a number of in-person meetings were held to facilitate a thorough review and update of the plan (see Attachment A for planning meeting documentation). Between meeting dates, Task Force members were responsible for obtaining data, reviewing, and updating content. Below are the meetings and their purpose:

Date	Location	Purpose
September 9, 2014	Silverado, CA	Kick-off and task schedule
October 28, 2014	Santa Ana, CA	Hazard profile review and update assignment
March 18, 2015	Santa Ana, CA	Mitigation strategy review and project update
July 15, 2015	Santa Ana, CA	Mitigation action item final review (STAPLEE/prioritization)
August 6, 2015	Santa Ana, CA	OCEMO plan briefing
August 12, 2015	Santa Ana, CA	Agency capability and resource review/update
August 12, 2015	Santa Ana, CA	Emergency Management Council plan briefing
September 3, 2015	Remote	Draft plan review – internal
September 3, 2015	Orange, CA	OCEMO plan brief

October 1, 2015	Santa Ana, CA	OCEMO plan brief
October 13, 2015	Laguna Niguel, CA	Disabilities, Access, and Functional Needs Working Group review
November 5, 2015	Anaheim, CA	OCEMO plan brief and review
November 18, 2015	Santa Ana, CA	Emergency Management Council Plan Approval
November 19, 2015	Remote	Plan Submission to Cal OES/FEMA
January 2016 (Tentative)	Santa Ana, CA/ Irvine, CA	Plan adoption pending approval

Related Documents and Resources

Requirement §201.6(b): *In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process* ***shall*** *include:*

(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

During the plan review, update, and development, several other documents were reviewed to ensure consistency in planning efforts. Information from these documents has been incorporated throughout this plan. Both the County Emergency Operations Plan and the Urban Area Security Initiative Threat and Hazard Identification and Risk Assessment include hazard analysis of threats impacting the County. Reviewing the various methodologies used in these plans compared to the methodology in the Hazard Mitigation Plan was useful in evaluating the risk and impact associated with each hazard included. Other plans and documents provided base level data either for statistical purposes or based on scientific research surrounding potential hazard impacts in the County. Finally, State and Local Hazard Mitigation Plans were reviewed to evaluate format and content. Documents, reports, and studies reviewed included:

- County of Orange Emergency Operations Plan, 2015
- County of Orange General Plan, 2005
- County of Orange Comprehensive Annual Financial Report, 2014
- Orange County Essential Facilities Risk Assessment Project Report, 2009
- Anaheim/Santa Ana UASI THIRA, 2014
- California Multi-Hazard Mitigation Plan, 2013
- Southern California Catastrophic Earthquake Response Plan, 2010
- The ShakeOut Scenario (USGS Open File Report 2008-1150), 2008
- Overview of the ARkStorm Scenario (USGS Open File Report 210-1312), 2010
- City of Huntington Beach Hazard Mitigation Plan, 2012
- City of Berkeley Local Hazard Mitigation Plan, 2014
- City of Simi Valley Local Hazard Mitigation Plan, 2015
- National Flood Insurance Program Community Rating System Coordinator's Manual, 2013
- Local Mitigation Plan Review Guide, 2011
- Local Mitigation Planning Handbook, 2013

Chapter 2 Community Profile

History

The Formation and of Orange County

The State of California, created from a territory, was ceded to the United States by Mexico in 1848 and admitted into the Union as a free state in 1850. The population at that time was 92,597, located in a few small cities and mining camps scattered over grazing lands adjacent to watercourses. With the formation of the state, each principal town formed a county. The first counties were large with small populations, due to the vast amounts of territory between towns. As the county settled, additional centers of population formed. Efforts to form new counties by cutting off portions of the already established counties took place with some being successful, while others failed.

The growth of communities in the southeastern portion of Los Angeles County produced a desire for a smaller county with a county seat nearer home. The desire became reality with an appeal for autonomy to the legislature in 1889. The City of Santa Ana, which had outgrown the other cities in the proposed new county, took the lead in the struggle for county division. Throughout the winter, lobbyists remained in Sacramento at considerable expense, without success in overcoming the influence of Los Angeles against the bill for the new county. The bill, titled “An Act to Create the County of Orange,” selected Orange as its name. Late in the session, W.H. Spurgeon and James McFadden were successful in the legislature, skillfully handling various interests and antagonisms. The legislature passed the bill and Governor Waterman signed it on March 11, 1889.

The Formation of the Orange County Fire Authority

Prior to May, 1980, fire service for the cities of Cypress, Irvine, La Palma, Los Alamitos, Placentia, San Juan Capistrano, Tustin, Villa Park, and Yorba Linda along with the County unincorporated areas was provided by the California Department of Forestry (CDF)*. However, on May 16, 1980, the Orange County Fire Department (OCFD) was formed as a county department reporting to the Board of Supervisors. Fifty-two percent of the 518,483 residents served by the OCFD lived in unincorporated areas of the County.

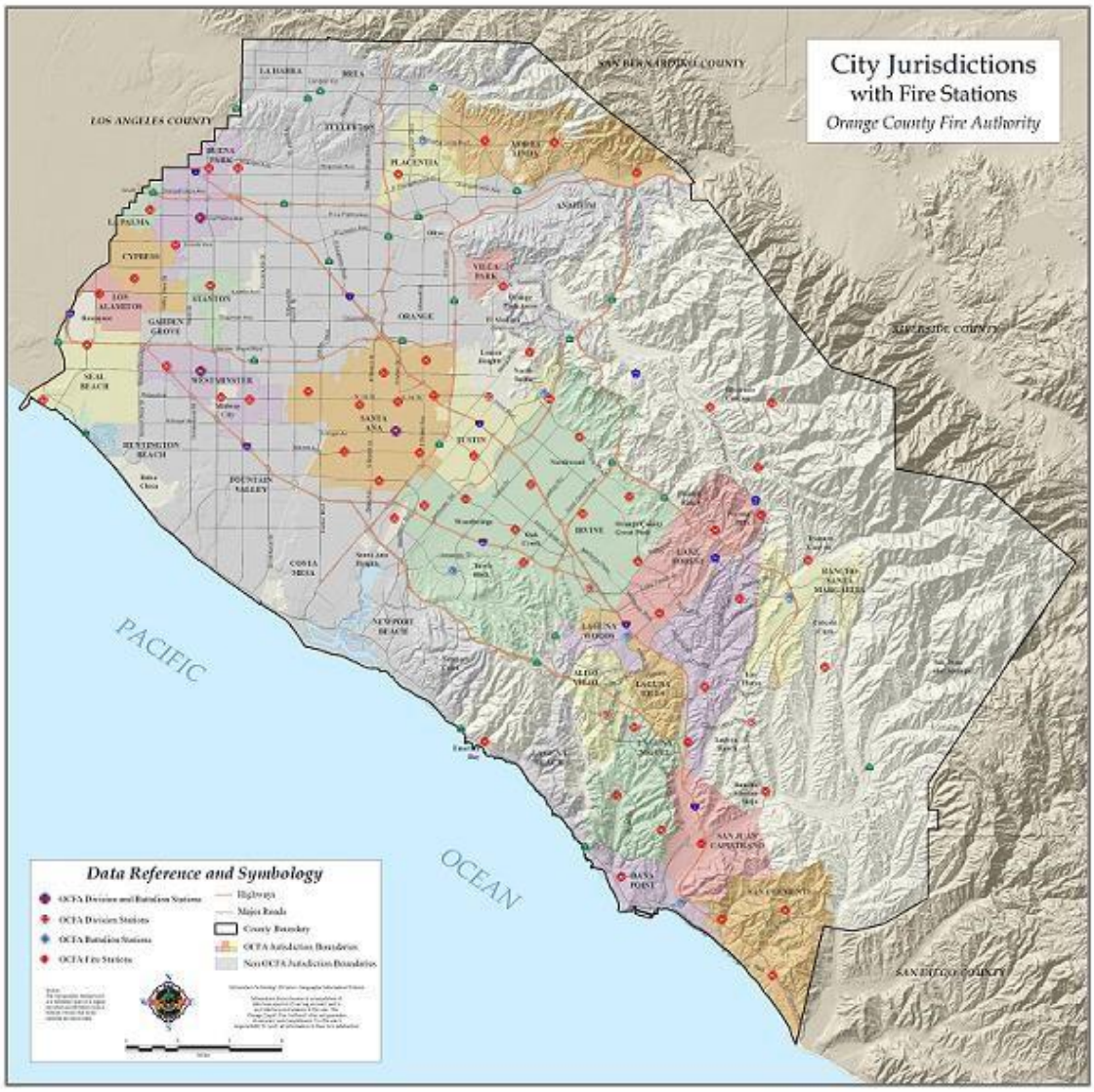
However, over the course of the next decade, five new cities were formed from unincorporated territory and two additional cities decided to contract with OCFD for fire service. As a result, by January 1, 1991, over 80% of OCFD's service population of 808,139 lived within these sixteen cities.

During 1991, the OCFD was on its way exploring the possibility of forming a special district as an independent entity governed by a board of directors representing the member cities and the County. The California Government Code dealing with special districts was studied, other fire protection districts were contacted, and services the new agency would need to provide were identified (i.e. investment services, employee benefits, payroll, and purchasing). Discussions had begun with the County about transferring title of the fire stations to the new organization.

A new governance structure, a Joint Powers Authority (JPA), was selected. Much of the previous work was used in this endeavor. By 1994 the plans and structure of the new agency were well underway. The County Board of Supervisors, the various City Councils, the OCFD labor groups, and management were

all pulling together to launch the new JPA. The Orange County Fire Authority (OCFA) was formed on March 1, 1995.

☐ **Map 1 - Orange County Base Map (Unincorporated Area in Gray)**



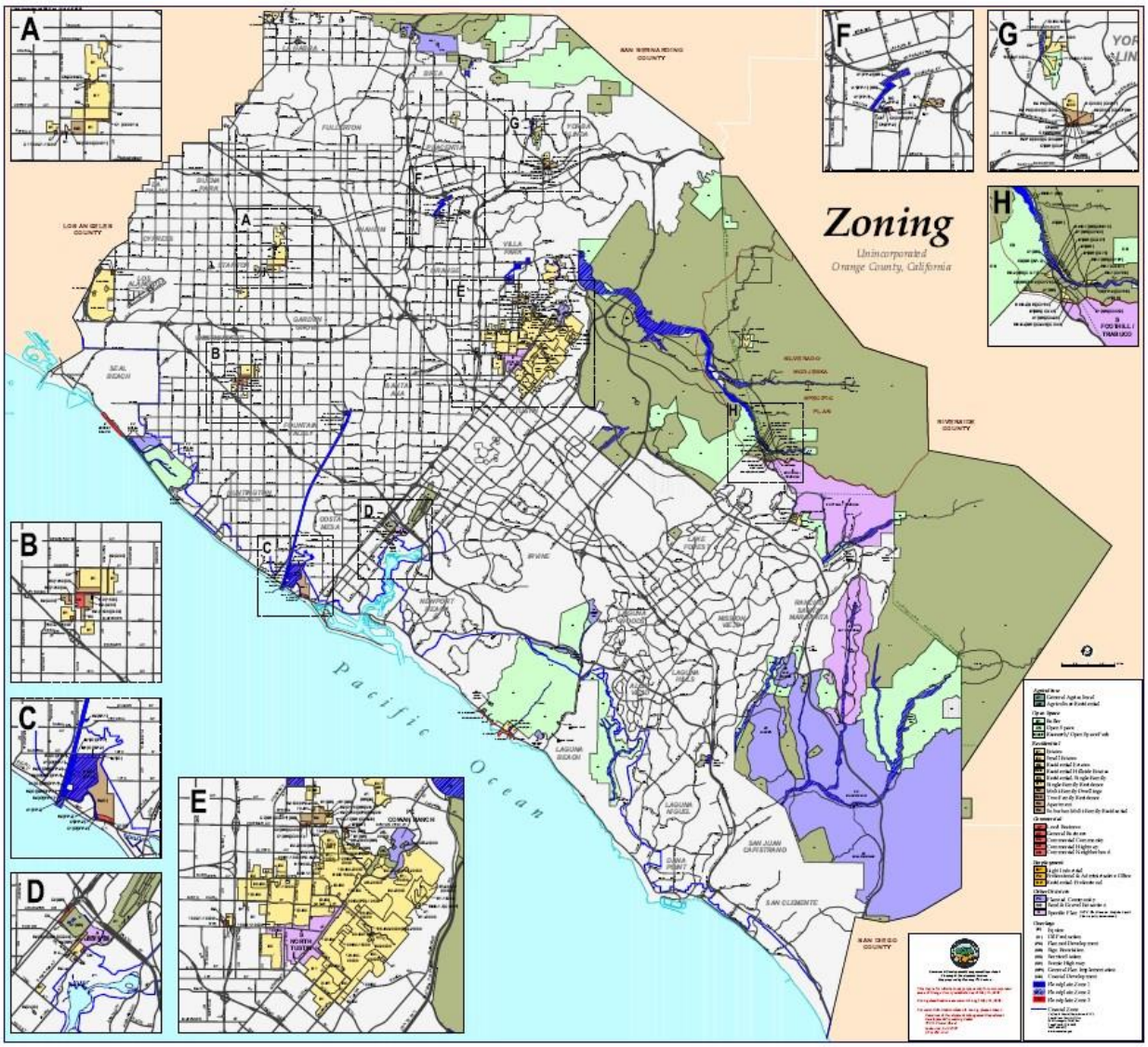
☐ **Map 2 – Orange County Fire Authority Service Area**

Geography and the Environment

Orange County has an area of 948 square miles, of which 791 square miles is land and 157 square miles is water. It is located in the southwestern portion of California and is bordered by Los Angeles County to the north, San Diego County to the south, Riverside and San Bernardino Counties to the east and the Pacific Ocean to the west. Orange County has 42 miles of coastline and three harbors. Thirty-four incorporated cities in the County are responsible for hazard mitigation planning within their jurisdictions. The County is responsible for hazard mitigation planning in the approximately 276 square miles of unincorporated area and all County owned facilities and properties.

The geography of Orange County is dominated by 3 major features: the vast coastal plain of the Los Angeles basin in the north and west, the Santa Ana Mountains and foothills in the south and east, and

the coastline of the Pacific Ocean to the southwest. Elevations in the County are as high as 5,689 feet at Santiago Peak down to sea level.



☐ **Map 3 - Zoning for Orange County**

Land Use

Requirement §201.6(c)(2)(ii)(C): *[The plan **should** describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.*

Requirement §201.6(d)(3)): *A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities.*

Residential housing comprises Twenty-five percent of the County's land area. Commercial, industrial, and public institutional uses account for thirteen percent of the County's land area. Twenty-five percent

of the County is classified as uncommitted, meaning it is either vacant or there is no data available for that land. Sixteen percent of the land is dedicated to open space and recreation.

Forty-six percent of the County unincorporated area is designated open space, with an additional twentyeight percent designated for agricultural use. Only four percent of the unincorporated area is zoned residential, but an additional fifteen percent is designated as planned communities. Less than one percent of the land is zoned for commercial use.

Orange County maintains approximately 60,000 acres of parkland, open space and shoreline. Orange County's city, state, and federal agencies also maintain local parks and open space, adding an additional 65,000 acres to the county total.

Housing growth in unincorporated Orange County includes both infill within existing neighborhoods and new construction on vacant land.

Since 2010, infill has consisted of construction of second units within residential areas and multi-unit developments on commercially zoned land. This has occurred mainly in the northern and central portions of the county. Also new single family unit construction is continuing and will soon complete the Ladera Ranch Planned Community. The net housing gain in unincorporated areas over the last five years is 214 units.

Recent new housing construction is now beginning on vacant undeveloped land in the southern and eastern parts of the county.

Over the last two years, construction has begun on the 14,000 unit Rancho Mission Viejo Planned Community (RMV PC) in unincorporated Orange County. Over one thousand units are completed and construction is ongoing. Over the next two decades, development will occur on 6,000 acres with 17,000 acres to remain as a permanent protected open space preserve. RMV PC follows the countywide trend toward higher density single family housing and more attached/multi-unit structures.

The 340 unit Esperanza Hills and 112 unit Rancho Cielo developments east of Yorba Linda and the 65 unit Saddle Crest development east of Santiago Canyon Road are in various planning approval/preconstruction stages. Construction within these single family home developments will likely begin within the 2015-2020 planning period.

Population and Demographics

As of January 2015, the California Department of Finance estimates Orange County's population as 3,114,209. Of those, about 121,458 live in the unincorporated areas of the County.[1]

[1] E-1 Current Population Estimates - California Department of Finance. Retrieved October 15, 2015, from http://www.dof.ca.gov/research/demographic/reports/estimates/e-1/view.php

The latest data depicts a diverse community, as shown in Table 1 below.

☐ **Table 1 – Orange County Population By Race**

Percentage of Total Orange County Population	
White alone, Not Hispanic or Latino	42%
Hispanic or Latino	35%
Asian, Not Hispanic or Latino	19%
Other	4%

Source: California Department of Finance

This diversity of the Orange County community emphasizes the need for effective communication during disasters for non-English speaking people. Roughly 45% of Orange County residents (over age 5) speak a language other than English at home, 20% speak English less than "very well" and 29.7% were born outside of the United States.[23] In 2012, widely spoken languages other than English spoken in Orange County households included Spanish, Vietnamese, Korean, Chinese, Tagalog, Persian, Arabic and Japanese.[4]

In 2014, the U.S. Census Bureau estimated that 8.6% of the noninstitutionalized population in Orange County was living with a disability. This percentage increases among the older population, with nearly 31% of the population 65 and older having some type of disability.

☐ **Table 2 – Orange County Disability Demographics**

Population	**0-4 years 191,517**		**5-17 years 529,348**		**18-64 years 2,000,063**		**65 + years 407,850**	
Disability	Count	Rate	Count	Rate	Count	Rate	Count	**Rate**
Hearing Difficulty	1,130	0.7%	2,625	0.5%	23,185	1.2%	50,483	12.4%
Vision Difficulty	723	0.4%	4,480	0.8%	24,639	1.2%	22,366	5.5%
Cognitive Difficulty	-	-	12,506	2.4%	49,374	2.5%	33,807	8.3%
Ambulatory Difficulty	-	-	2,336	0.4%	50,081	2.5%	78,443	19.2%
Self-Care Difficulty	-	-	4,504	0.9%	21,304	1.1%	33,886	8.3%
Independent Living Difficulty	-	-	-	-	62,606	2.2%	62,606	15.4%

[2] American Community Survey - SDC - Demographic Research - California Department of Finance. Retrieved August [3], 2015, from http://www.dof.ca.gov/research/demographic/state_census_data_center/american_community_survey/

[4] Languages Other Than English Spoken at Home (Orange County, 2012). Retrieved October 15, 2015, from http://cpehn.org/chart/languages-other-english-spoken-home-orange-county-2012

Source: U.S. Census Bureau, Disability Characteristics, 2014 American Community Survey 1-Year Estimates

Employment and Industry

As of February 2015, roughly 50% of the Orange County workforce was employed by service industries (including Information, Professional and Business Services, Educational and Health Services, Leisure and Hospitality, and Other Services). Approximately 10% of the workforce was employed by the manufacturing sector and 10% were employed in the retail trades. The top employers in Orange County were the Walt Disney Company, The University of California, the County of Orange, St. Joseph's Health, Kaiser
Permanente, and Boeing.[5] As of July [6], the unemployment rate in Orange County was 4.7%.[7]

Orange County hosts 42 million visitors annually.[8]

82% of the workforce commutes alone, 10% carpool and 3% use public transportation.[9] The high mobility of employees commuting from surrounding areas to industrial and business centers creates a greater dependency on roads, communications, accessibility and emergency plans.

History of Disasters

Since 1953 Orange County has received 29 federal disaster proclamations including 21 Presidential Disaster Declarations, 3 Presidential Emergency Proclamations, and 5 Fire Management Assistance declarations (shown in the table below). While the greatest recurring threat is flood and fire, the earthquake risk is ever-present.

[5] County of Orange Comprehensive Annual Financial Report - Principal Employers (2014). Retrieved October 15,
[6] , from http://ac.ocgov.com/civicax/filebank/blobdload.aspx?BlobID=41026

[7] Labor Market Information. Retrieved August 15, 2015, from http://www.labormarketinfo.edd.ca.gov/

[8] About OCVA. Retrieved September 15, 2015, from http://www.visittheoc.com/maps-and-information/about-ovca/

[9] County of Orange. (2015). OC Community Indicators: 2015. Retrieved October 15, 2015, from http://ocgov.com/civicax/filebank/blobdload.aspx?BlobID=45210

Federal Disaster Declarations for Orange County			
Disaster Number	**Year**	**Incident Type**	**Incident Title**
DR-1952	2011	Flood	SEVERE WINTER STORMS, FLOODING, AND DEBRIS AND MUD FLOWS
FM-2792	2008	Fire	FREEWAY FIRE COMPLEX
DR-1810	2008	Fire	WILDFIRES
FM-2737	2007	Fire	SANTIAGO FIRE
FM-2683	2007	Fire	241 FIRE
EM-3279	2007	Fire	WILDFIRES
DR-1731	2007	Fire	WILDFIRES, FLOODING, MUD FLOWS, AND DEBRIS FLOWS
FM-2630	2006	Fire	SIERRA FIRE
DR-1585	2005	Severe Storm	SEVERE STORMS, FLOODING, LANDSLIDES, AND MUD AND DEBRIS FLOWS
EM-3248	2005	Hurricane	HURRICANE KATRINA EVACUATION
DR-1577	2005	Severe Storm	SEVERE STORMS, FLOODING, DEBRIS FLOWS, AND MUDSLIDES
FS-2405	2002	Fire	ANTONIO FIRE
DR-1203	1998	Severe Storm	SEVERE WINTER STORMS AND FLOODING
EM-3120	1996	Fire	SEVERE FIRESTORMS
DR-1046	1995	Severe Storm	SEVERE WINTER STORMS, FLOODING LANDSLIDES, MUD FLOW
DR-1044	1995	Severe Storm	SEVERE WINTER STORMS, FLOODING, LANDSLIDES, MUD FLOWS
DR-1008	1994	Earthquake	NORTHRIDGE EARTHQUAKE
DR-1005	1993	Fire	FIRES, MUD/LANDSLIDES, FLOODING, SOIL EROSION
DR-979	1993	Flood	SEVERE WINTER STORM, MUD & LAND SLIDES, & FLOODING
DR-935	1992	Flood	RAIN/SNOW/WIND STORMS, FLOODING, MUDSLIDES
DR-812	1988	Flood	SEVERE STORMS, HIGH TIDES & FLOODING
DR-799	1987	Earthquake	EARTHQUAKE & AFTERSHOCKS
DR-677	1983	Coastal Storm	COASTAL STORMS, FLOODS, SLIDES & TORNADOES
DR-657	1982	Fire	URBAN FIRE
DR-635	1980	Fire	BRUSH & TIMBER FIRES
DR-615	1980	Flood	SEVERE STORMS, MUDSLIDES & FLOODING

DR-547	1978	Flood	COASTAL STORMS, MUDSLIDES & FLOODING
DR-566	1978	Flood	LANDSLIDES
DR-253	1969	Flood	SEVERE STORMS & FLOODING

Since the Local Hazard Mitigation Plan was last revised in 2010, the County of Orange received a disaster declaration for the 2011 winter storms and flooding. In March of 2014, the County of Orange proclaimed a local state of emergency following the 5.1 magnitude La Habra earthquake. Despite more than 10.5 million dollars in damage and costs related to this earthquake, no State Emergency Proclamation was received. On January 17, 2014 the Governor of California proclaimed a State of Emergency related to the State's extended drought. While the proclamation did not direct specific actions for counties, it was an important step in working towards reducing the overall impact of the drought across the state.

Chapter 3 Risk and Vulnerability Assessment

Overview of the Risk Assessment Process

A risk assessment provides information on the location of hazards, the value of existing land and property in hazard locations, and an analysis of risk to life, property, and the environment resulting from a natural hazard event. Specifically, the levels of a risk assessment are as follows:

1) Hazard Identification

Through an established hazard analysis process, the County of Orange regularly identifies its major hazards during the revision of its Emergency Operations Plan (complete list of identified hazards available in the "Hazard Identification" section below). In addition to its man-made hazards, Orange County has identified nine major natural hazards to be specifically addressed in its Hazard Mitigation plan: flood/storm, wildland/urban fire, earthquake, dam failure, landslide/mud flow/debris flow, tsunami, drought, climate change, and epidemic. Other natural hazards, such as high wind, extreme temperatures and tornado are not specifically described or assessed in this document as the related impacts to the County's unincorporated areas are minimal compared to the major hazards. Many agencies and jurisdictions worked together to identify these hazards, including the Orange County Emergency Management Organization, the Emergency Management Council Subcommittee, emergency management personnel from cities, special districts and school districts, and the Hazard Mitigation Planning Task Force. The process used the best available data to balance historical occurrence, probability and potential impact.

2) Profiling Hazard Events

This process describes the cause and characteristic of each hazard, the effect on the County in the past, and the historical vulnerability specific to Orange County's population, infrastructure, and environment. Each hazard section provides a profile for the hazards discussed in this plan.

3) Vulnerability Assessment/Inventorying Assets

This is a combination of hazard identification with an inventory of the existing (or planned) property development(s) owned by Orange County. Critical facilities are of particular concern. These entities provide essential products and services to the public, preserving the welfare and quality of life in the County and fulfill important public safety, emergency response, and/or disaster recovery functions. Map 4 of this section identifies critical facilities in the County with a description provided.

4) Risk Analysis

Estimating potential losses involves assessing the likely damage, injuries, and financial cost sustained in a geographic area over a given period. This analysis involves mathematical models with two measurable components of risk analysis: magnitude of the harm that may result expressed in monetary terms and the likelihood of the harm occurring. Describing vulnerability in terms of dollar loss provides the community and the state with a common framework to measure the effects of hazards on assets. At this time, quantitative estimates on losses have been calculated on flood, wildland fire, earthquake, dam failure, landslide, and tsunami hazards, and are available in the Quantitative Exposure Analysis section at the end of this chapter. The remaining hazards (drought, climate change, epidemic) lack an easily

definable spatial extent or are compounding factors for other hazards. In these situations, impact descriptions are qualitative in nature.

5) Assessing Vulnerability/Analyzing Development Trends

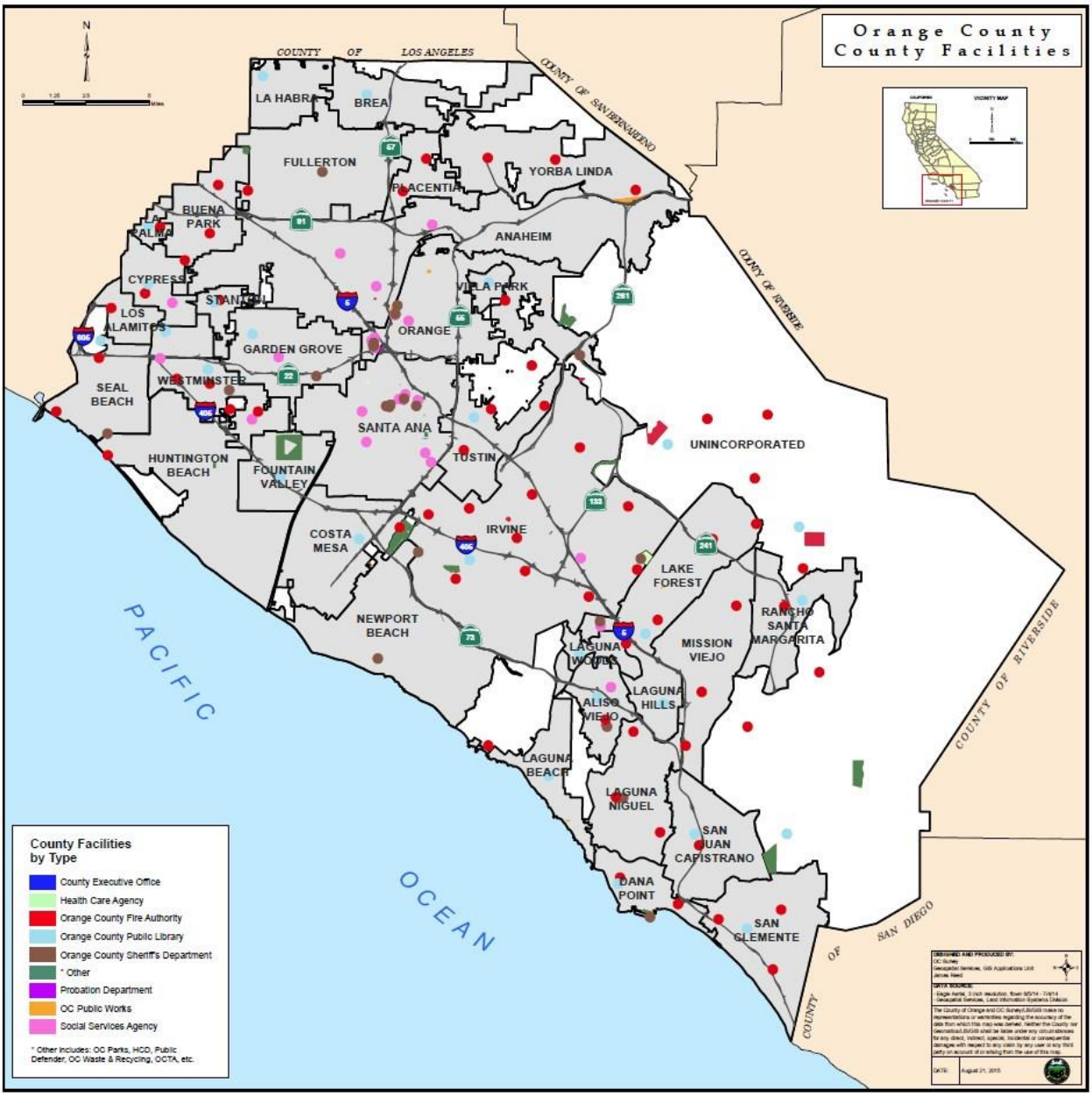
This step provides a general description of land uses and development trends within the community. This plan provides a comprehensive description of the character of the unincorporated area of Orange County in the Community Profile, Chapter 2. Analyzing the components of Orange County assists in identifying potential problem areas and serves as a guide for incorporating goals and ideas contained in this mitigation plan into other community development plans.

Hazard assessments are subject to the availability of hazard-specific data. Each hazard-specific section of the plan includes a section on hazard identification using data and information from the County or State agency sources.

Using the data available for hazard assessments, the County has numerous strategies available for reducing risk (described in Action Items, Chapter 4). Mitigation strategies further reduce disruption of critical services, risk to human life, and damage to personal and public property, and infrastructure. Action items throughout the hazard sections provide recommendations to improve data collection, hazard mapping and hazard assessments.

Critical Facilities and Infrastructure

Facilities critical to government response and recovery activities (i.e., life safety and property and environmental protection) include 911 centers, emergency operations centers, police and fire stations, public works facilities, communications centers, sewer and water facilities, hospitals, bridges and roads, and shelters. Critical and essential facilities are those facilities vital to the continued delivery of key government services or having significant impact on the public's ability to recover from an emergency. Map 4 below gives an overview of County-owned facilities. For a complete list, see Attachment C.



☐ **Map 4 – Orange County Critical Facilities**

Hospitals

The County of Orange does not own and/or operate hospitals. With the exception of the University of California, Irvine Medical Center, owned and operated by the University of California, all hospitals within Orange County are privately owned and operated. There are no hospitals in the unincorporated area of Orange County.

Hazard Identification

Requirement §201.6(c)(2)(i): *[The risk assessment **shall** include a] description of the type … of all natural hazards that can affect the jurisdiction.*

A hazard analysis has indicated that the County of Orange is at risk from numerous hazards associated with natural disasters and technological incidents. Many of the hazards that exist in or adjacent to Orange County have the potential for causing disasters exceeding any one jurisdiction's capabilities to successfully respond, making centralized command and control and the support of the County and its department's essential functions. The County will review and update the hazard analysis in conjunction with the review of the County of Orange Emergency Operations Plan (EOP). The hazard analysis in Figure 1 below was last approved in 2014.

Human-caused hazards listed in the table below are in County of Orange and Orange County Fire Authority Hazard Mitigation Plan documents such as the Orange County Emergency Operations Plan. Specifically, hazardous materials preparedness and mitigation measures addressed in the Orange County Operational Area Plan focus on hazardous materials throughout the County. The Orange County Emergency Operations Plan and the Orange County Sheriff's Department Policy Manual address issues related to riot and civil unrest. The Orange County Emergency Operations Plan Aviation Annex addresses aircraft incidents. The Office of Oil Spill Prevention and Response addresses oil spill mitigation. The Operational Area Rail Annex covers train and rail accidents. The Orange County Emergency Operations Plan addresses train accidents and other transportation issues. Although the San Onofre Nuclear Generating Station (SONGS) resides outside of Orange County, mitigation issues surrounding it are in the SONGS Plans, coordinated by the SONGS Interjurisdictional Planning Committee. Regarding terrorism, the Operational Area Executive Board manages the Terrorism Working Group, actively mitigating issues surrounding terrorism. The Orange County Intelligence Assessment Center addresses terrorism indicators and warnings issues. The Orange County Emergency Operations Plan addresses mitigation measures for Power Failures.

Climate change was not included as a hazard in the last County Emergency Operations Plan revision so it is not specifically called out in the table below, but it is evident that it will be a major component of Orange County's hazard analysis process moving forward. Since many of the effects of climate change will serve to worsen the severity and frequency of other hazards (wildfire, flood/storm, tsunami (through sea level rise)), the hazard analysis process will increase in complexity. The Hazard Mitigation Planning Task Force discussed this issue and decided the current hazard analysis did reflect the impact of climate change on other hazards, but will revisit the issue in 2020. In addition, other specific climate change hazards such as sea level rise may be added during future hazard analysis update cycles.

The following criteria were used to establish each potential hazard rating, based upon historical and recent events to validate frequency and impacts:

- What are the hazard threats facing the community.
    - Natural disaster
    - Manmade disasters
- What is the probability of occurrence?

- Likely ○
  Possible ○
  Unlikely

- What is the effect to lives and property?
  - High ○
    Average ○
    Low
- What are the hazard ratings – multiply probability of occurrence by the effects.

☐ **Figure 1 - Hazard Identification and Analysis**

HAZARD THREAT	PROBABILITY OF OCCURRENCE			EFFECT			HAZARD RATING (Probability x Effect)
	Likely 10	Possible 5	Unlikely 1	High 10	Average 5	Low 1	
Flood and Storm	X				X		50
Hazardous Materials	X				X		50
Wildland Fire	X				X		50
Earthquake		X		X			50
Civil Disturbance and Riot		X			X		25
Aircraft Incident		X			X		25
Oil Spill (Coastal)		X			X		25
Drought		X			X		25
Train Accident		X			X		25
Dam and Reservoir Failure			X	X			10
Epidemic			X	X			10
SONGS			X	X			10
Terrorism			X	X			10
High Wind (Santa Ana Winds)	X					X	10
Extreme Temperatures	X					X	10
Urban Fire		X				X	5
HAZARD THREAT	PROBABILITY OF OCCURRENCE			EFFECT			HAZARD RATING

	Likely 10	Possible 5	Unlikely 1	High 10	Average 5	Low 1	(Probability x Effect)
Landslide, Mud Flow and Debris Flow		X				X	5
Power Failure		X				X	5
Tornado		X				X	5
Tsunami			X			X	1

Profile of Hazard Events

Requirement §201.6(c)(2)(i): *[The risk assessment **shall** include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan **shall** include information on previous occurrences of hazard events and on the probability of future hazard events.*

The following information details each of the nine natural hazards addressed in the Hazard Mitigation Plan, their effect on Orange County in the past, and the portion of the County's population, infrastructure, and environment that has been historically vulnerable to each specific hazard, based on available data. Other natural hazards, such as high wind, extreme temperatures and tornado are not specifically described or assessed in this document as the related impacts to the County's unincorporated areas are minimal compared to the major hazards.

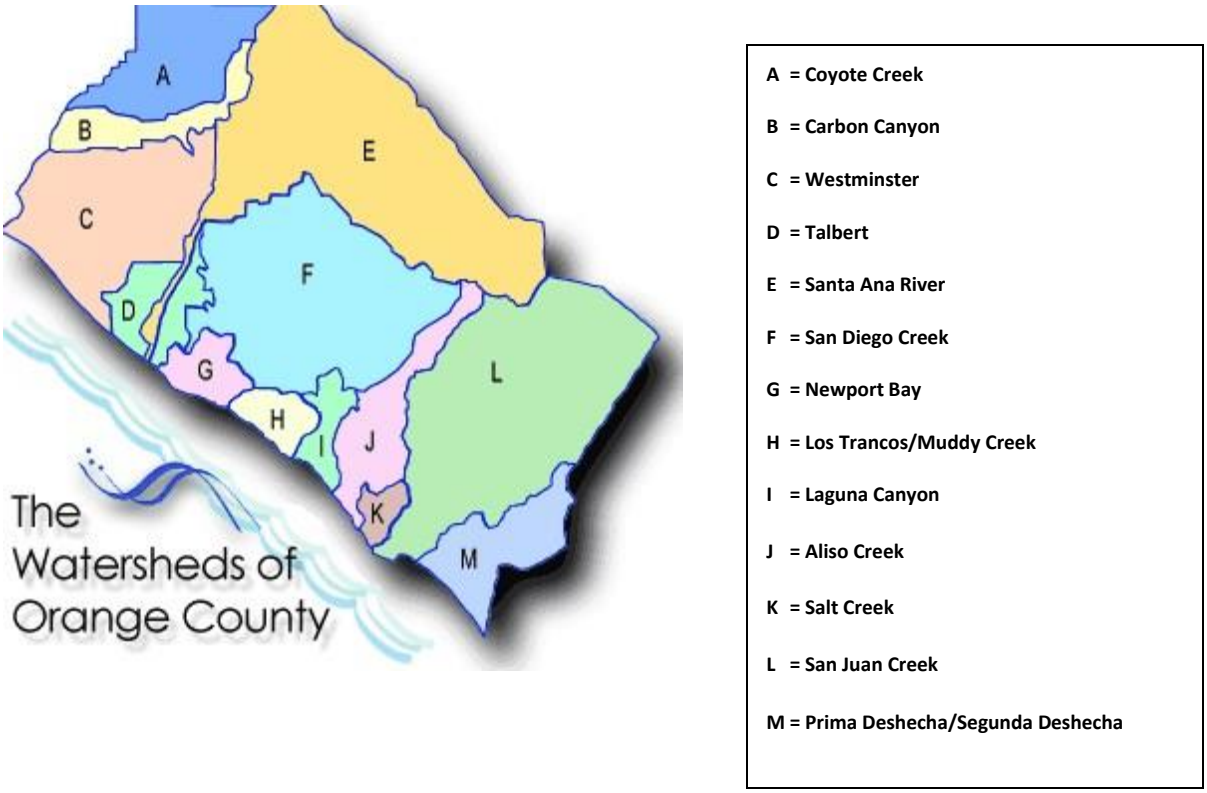
3.1 Flood/Storm

The following discussion addresses the threat of storm-related flooding updated from material found in the Safety Element of the County's General Plan.

Orange County's 510,000 acres are mainly mountainous terrain (on the northeast and southeast) and floodplain (in the central and western section). The County's rapid growth and transformation from an agricultural community to an urban community has changed flood control of large flows from mountains and hills to include control of additional runoff produced by development of the plains. Although there is a countywide system of flood control facilities, the majority of these are inadequate for conveying runoff from major storms, such as the Standard Project Flood or the 100-year flood.

The infrequency of very large floods further obscures the County's flood hazard. Storms labeled "severe" have occurred in less than 10 of the past 175 years. In particularly disastrous storms, a false sense of security prevailed following long periods of mild semi-arid years.

Map 5 provides locations of the various watersheds throughout Orange County. Orange County worked closely with Region IX in the FEMA Flood Map Modernization process which resulted in digital Federal Insurance Rate Maps (FIRM) dated December 3, 2009. The County facilitated FEMA to reach other cities within Orange County. The County is working with FEMA in transitioning the Flood Map Modernization (Map Mod) to Risk Mapping, Assessment, and Planning (Risk Map) for multi-hazard risk management.



☐ **Map 5 - Watersheds of Orange County**
(Source: Orange County Public Works, Watershed & Coastal Resources Division)

To provide quantitative information for flood warning and detection, Orange County began installing its ALERT (Automated Local Evaluation in Real Time) system in 1983. Operated by the Environmental Resources group at OC Public Works in cooperation with the National Weather Service, ALERT uses remote sensors located in rivers, channels and creeks to transmit environmental data to a central computer in real time. Sensors are installed along the Santa Ana River, San Juan Creek, Arroyo Trabuco Creek, Oso Creek, Aliso Creek, as well as flood control channels and basins. The field sensors transmit hydrologic and other data (e.g., precipitation data, water levels, temperature, wind speed, etc.) to base station computers for display and analysis. In addition, seven pump stations (Huntington Beach, Cypress, Seal Beach, Los Alamitos, Rossmoor, Harbor-Edinger, and South Park) regulating storm water discharge to flood control channels are also instrumented. Their monitoring system includes automated call-out of operations personnel in the event of a crisis.

Activation of the OC Public Works Department Operations Center (DOC) takes place when heavy rainfall occurs or is predicted, and/or when storm runoff conditions indicate probable flood damage. The DOC monitors the situation on a 24-hour basis. Response may include patrols of flood control channels and deployment of equipment and personnel to reinforce levees when needed. DOC activation and various emergency response actions are based on the following Emergency Readiness Stages:

- Stage I - Mild rainfall (watch stage).

- Stage II - Heavy rainfall or potential thereof. OC Public Works Department Operations Center activated and surveillance of flood control facilities in effect.
- Stage III - Continued heavy rainfall or deterioration of facilities. County Public Works Director in charge. County's personnel assume assigned emergency duties.
- Stage IV - Conditions are or are likely to be beyond County control. Board of Supervisors, or Director of Emergency Services when the Board is not in session, proclaims Local Emergency and assumes special powers. Mutual Aid requested.
- Stage V - Damage beyond control of all local resources. State forces are required. Governor requested to proclaim State of Emergency.
- Stage VI - Damage beyond control of local and State resources. Federal forces are required. President requested to declare Major Disaster. **References:**

Gold, Scott, "Disaster Prompted $1.3 billion Effort to Tame Santa River, Protect Basin," Los Angeles Times, October 3, 1999.

United States Army Corps of Engineers, Standard Project Flood Determinations, U.S. Army Corps of Engineers, Publication number EM 1110-2-141 (1965).

Floods as a Threat to Orange County

The Santa Ana River, flowing through the heart of Orange County to the Pacific Ocean, is the county's greatest flood threat. Research of flooding in Orange County illustrates these flood hazard issues, citing loss of life as well as damage to personal and public property.

One such flood occurred in 1938, wiping out roads, bridges, and railroads near the river when an 8-foot wall of water swept out of the Santa Ana Canyon. Anaheim, Santa Ana, and Garden Grove were hardest hit and 34 lives were lost because of the flood. The flood and its damage were a catalyst for construction of Prado Dam, developed as part of the Army Corps of Engineers flood control protection plan. Government officials estimate that today without the protection of Prado Dam, a flood of this magnitude would cause as many as 3,000 deaths and top $40 billion in damages.

The Army Corps of Engineers, tasked with the project of increasing the level of protection at Prado Dam from the current 70-year level to a 190-year level of protection, started the final phase of construction in 2012 for the area of the River downstream of Prado Dam (called Reach 9). It is anticipated that the construction of all phases of Reach 9 will be completed in 2018. Overall completion of the Prado Dam project, which includes dikes within the Prado Basin and raising of the spillway, is anticipated to be completed in 2021. Further, portions of the County not inundated by river overflow during a 100-year event could be subject to flooding from overflow of water drainage facilities currently inadequate for carrying the 100-year discharge.

Other areas subject to flooding during severe storms include areas adjacent to Bolsa Chica Channel, Anaheim-Barber, Stanton Storm Channel, Santa Ana-Santa Fe, Cañada, Paularino, Westminster, Trabuco, Borrego, Serrano, Laguna Canyon, Atwood Channel, Brea Creek Channel, Fullerton Creek Channel,

Carbon Creek Channel, San Juan Creek Channel, and East Garden Grove-Wintersburg Channel. Areas adjacent to Santiago Creek and Collins Channel in the central portion of the County and large portions of the San Diego Creek watershed in the City of Irvine and unincorporated areas of the County are also subject to inundation. In the southern portion of the county, canyon areas are subject to flooding. However, with increased development in these areas the flood hazard becomes even greater.

Flood damages within the Westminster-East Garden Grove Watershed, along the East Garden GroveWintersburg Channel and Westminster Channel affect residential, commercial, and industrial development within the cities of Westminster, Garden Grove, Santa Ana, Huntington Beach, Seal Beach, and Fountain Valley. The East Garden Grove-Wintersburg Channel was originally constructed in the early 1960s as a mixture of earthen, riprap, and concrete-lined trapezoidal section with short reaches of concrete rectangular and covered box facilities. It was designed to carry 25-year peak discharge which was the design standard at the time the channels were constructed. With urbanization growth throughout Orange County and congressional approval of the 1968 National Flood Insurance Program and 1973 amendment, the existing capacity has become deficient and needs to be improved to convey a 100-year peak discharge. The hundreds of homes in the downstream segment of the channel system would be subjected to an estimated 8-foot depth of flooding if a 100-year storm event occurred today. The winter storms of 2005 in this area severely eroded the maintenance roads and levee banks. Constructing this channel system to its ultimate condition will alleviate the floodplain and mitigate 100-year storm events to containment within the channel thus relieving mandatory flood insurance and will create potential environmental enhancements for the watershed.

Portions of the downstream channel have been improved; however continuing work on portions of the channel includes, but is not limited to: removing and hauling existing riprap lining, excavating material from the channel sides, constructing and improving maintenance roadways, and reinforcing the levee with soil-cement mixed columns in combination with sheet pile installations.

San Juan Creek and Trabuco Creek Channels over the years have sustained numerous damages caused by heavy storms, with the most recent damage occurring in January 2005 and December 2010. The damaged portions of the creek's levees were promptly repaired following the storms. However, despite these repairs, significant portions of the levees remain vulnerable to failure during major storm events while the creek's capacity remained deficient to convey the 100-year storm. OC Public Works focused its resources on devising an eight phase levee fortification program which will install steel sheet pile walls behind existing deficient channel lining. This multi-phase program will provide immediate protection against catastrophic levee failure once completed. The levee reinforcement program includes creek improvements on San Juan Creek Channel from Stonehill Drive to the I-5 Freeway and on Trabuco Creek Channel from its confluence with San Juan Creek Channel to 1,600 feet upstream of the Del Obispo Bridge. To date, four of the eight phases have been completed. The remaining segments, to be constructed in the next few years, have been prioritized based on the District's funding allocation. Following these improvements, another phase will begin which includes additional construction needed to raise the level of protection to the desired 100-year level including improvements between Pacific Coast Highway and Stonehill Drive and remove adjacent areas out of the Federal Emergency Management Agency's (FEMA) floodplain designation.

Historic Data for Orange County

Residents reported damaging floods caused by the Santa Ana River, known as "Great Floods," as early as 1770. A massive flood recorded on January 7, 1770 is in the Notes of Father John Crespi. Major floods in Orange County on the Santa Ana River have occurred in 1810, 1815, 1825, 1884, 1891, 1916, 1927, 1938, 1969, 1983, 1993 and 1997. The greatest flood in terms of water flow was in 1862 with an estimated flow rate of 317,000 cubic feet per second (cfs). This was three times greater than the Great Flood of 1938 estimated at 110,000 cfs. The most damaging flood in terms of cost was the Great Flood of 1969. The County's population had significantly increased by this time creating greater potential for loss.

Great Flood of 1862- The storm and flood of January 1862, called the Noachian deluge of California, were unusual in two ways: 1) the storm occurred during the very severe drought of 1856-1864 and 2) the flooding was extremely long, lasting 20 days. Under normal circumstances, major floods last no longer than a few days. The only structure left standing was a chapel called Aqua Mansa on high ground above the river. The priest rang the chapel bell and the settlers fled the rising waters. Small villages along the Santa Ana River were completely destroyed. Miraculously, there were no recorded deaths.

Great Flood of 1916 – The flood on January 27, 1916 inundated a large area in Santa Ana, flooding Main Street with water 3 feet deep. The farming area, today known as City of Westminster, was also flooded.

A total of six bridges, three traffic bridges and three railroad bridges washed away and four people drowned.

Great Flood of 1938 – The flood of 1938 considered the most devastating of all County floods in the 20th Century, affected all of Southern California. The storm began on February 27 and lasted until March 3. In the Santa Ana Basin, 34 people died and 182,300 acres were flooded. All buildings in Anaheim were damaged or destroyed. Two major railroad bridges, seven traffic bridges, and the little town of Atwood were completely destroyed. As the Santa Ana River inundated the northwestern portion of Orange County, train service to and from Santa Ana was cancelled and communication with the outside world was essentially nonexistent. Damage exceeded $50 million.

Great Flood of 1969 – The floods of January and February were the most destructive on record in Orange County. Previous floods had greater potential for destruction, but the County was then relatively undeveloped. The intensity of the 1938 flood was greater, but of shorter duration. A drought that began in 1945 was relieved by only two wet years until the floods in 1969. An annual overdraft of 100,000 acrefeet brought the average groundwater level to 15 feet below sea level, and ocean water moved into the aquifers. Some wells along the coast began producing brackish water and had to be abandoned. http://www.ocwd.com/html/history.htm Rainfall was continuous from January 18-25 resulting in widespread flooding January 25-26. Orange County was declared a national disaster area on February 5. A storm on February 21-25 once again brought rain to the already saturated ground, culminating in a disastrous flood on February 25. The largest peak outflow from Santiago Reservoir since its inception in 1933 occurred in February. On February 25, the reservoir at Villa Park Dam reached its capacity. This was the first time since its construction in 1963 with a maximum outlet inflow of 11,000 cfs. Even though the outlet conduit was discharging up to 4,000 cfs, spillway overflow occurred at 1:30 p.m. on February 25

and continued 36 hours. The maximum peak outflow from the dam reached 6,000 cfs. The safety of the dam was never threatened. However, the outflow caused serious erosion downstream in Orange and Santa Ana and in portions of parks and golf courses. Trees and debris inundated the streambed. Houses, apartments, gardens, swimming pools, and bridges eroded away. Numerous residents and volunteers, worked around the clock to remove debris, sandbag eroding embankments, cordon off danger zones, issue warnings, and make temporary repairs. U.S. Marine Corps helicopters dropped junked cars along the banks of the creek below Bristol Street in an effort to prevent further undermining of homes. A Southern Pacific Railroad bridge, water and sewer lines, a pedestrian overcrossing, and three roads washed out. Approximately 2,000 Orange and Santa Ana residents were evacuated from houses bordering Santiago Creek.

Great Flood of 1983 – The presence of El Nino spawned the flood of 1983. The intense downpour concentrated in a local area and also resulted in the highest waves to crest onshore in 10 years. Meanwhile, the Santa Ana River crested at the mouth of the ocean, creating a disaster for the low-lying areas of Huntington Beach with floodwaters three to five feet deep. In addition, the pounding surf destroyed a section of the Huntington Beach Pier, resulting in a complete renovation of the pier.

Great Floods of 1993 – In 1993, El Nino spawned a storm and flood. This storm was concentrated in the Laguna Canyon Channel area from Lake Forest to downtown Laguna Beach. In spite of a valiant effort to save downtown merchants by sandbagging, the stores were flooded anyway. Laguna Canyon Road was damaged extensively as well as homes and small businesses in the Laguna Canyon Channel. There were no fatalities reported.

☐ **Figure 2 - Great Floods in the past in Orange County**

▪ 1770, Jan.	▪ Information regarding this flood is gathered from Father Juan Crespi's diary
▪ 1780, Dec.	▪ Information regarding gathered from Father Junipero Serra's diary.
▪ 1825	▪ Greatest flood of previous 100 years. ▪ Santa Ana River changed main course from Anaheim Bay to Newport Bay.
▪ 1862, Jan.	▪ The greatest flood in California's history. ▪ The rain began on Christmas Eve 1861 continuing for 30 days. The sun shone a total of 45 minutes in that thirty day period. ▪ Fifty inches of rain fell during December and January. ▪ Water ran four feet deep through downtown Anaheim.

▪ 1862	Agua Mansa Story ▪ The entire population of Agua Mansa survived the great flood in a small church. Granite monuments were placed on the steps of the church to mark the place where waters stopped rising. ▪ In 1967, archeologists and the Riverside County Surveyor located the ruined foundation of the Agua Mansa Mission near the present day Route 60 bridge in Riverside. ▪ The water surface established by the mission monuments and other data from old irrigation works enabled the calculation of flow at Agua Mansa to be 315,000 CFS. Nearly 700 square miles are tributary to Prado Dam downstream of Agua Mansa, estimated flow in the Santa Ana Canyon was 400,000 CFS. ▪ Current Santa Ana River capacity in Orange County is 20,000 to 40,000 CFS. ▪ NOTE: the enormous magnitude of the 1862 flood was unknown in 1939-1941 at the time of the design and building of Prado Dam. ▪ Santa Ana River Basin parameters. ▪ 2253 square miles tributary to Prado (768 square miles behind Lake Elsinore). ▪ The fall of the Santa Ana River from Orange County line to the Pacific Ocean (30 miles) is greater than the fall in the Mississippi River from Cairo, Illinois to the Gulf of Mexico (600 miles). The steep watercourse makes hydraulic design difficult. The rapid response of the watershed to rainfall makes warning of over bank flow difficult. ▪ Computer based radio telemetry is used to gather data for flood warnings. ▪ Sediment deposits near the ocean chokes channel capacity. ▪ Scour around bridges and channel lining caused by high velocity flows. ▪ Drop structures (small dams) are required to slow the water and stabilize the soft bottom portions of the channel. ▪ Villa Park Dam impounds the flow from 81 square miles.
▪ 1884 Feb.	▪ The Santa Ana River created a new ocean outlet
▪ 1888-1891	▪ Annual floods
▪ 1914	▪ Heavy flooding
▪ 1916	▪ Hundreds of square miles inundated Orange County. The flow in the Santa Ana River was about 75,000 cfs., overflowing into Anaheim Bay. ▪ Santiago Creek overflowed into El Modena and Tustin.
▪ 1921	▪ Flooding
▪ 1927	▪ Moderate flood
▪ 1938 Mar	Devastation to all of Orange County. ▪ Greatest flood since 1862 – about 100,000 cfs in Santa Ana River. ▪ 22" of rain fell in 5 days in the San Bernardino Mountains. ▪ Santa Ana River levees failed in many places and waters flowed into Anaheim Bay. ▪ 34 lives lost in Orange County. ▪ Damage reached $14 million (1938).

▪ 1969	Great damage, especially to governmental infrastructure. ▪ The January storm was the greatest since 1938. There was one heavy flood after 9 day storm and another moderate flood. ▪ February storm greater than January but both were moderate intensity, long duration (i.e., large volume) events. 1-hour intensity and 24-hour volume. ▪ Prado Dam inflow : 77,000 cfs, outflow 6,000 cfs. ▪ Maximum Santa Ana river capacity is 40,000 cfs. ▪ 1 ½ million cubic yards of sediment carried by Santa Ana River nearly caused levee failure due to the invert rising over five feet near the river mouth. ▪ Prado Dam was 60% filled. ▪ Villa Park Dam inflow – 11,000 cfs, outflow – 6,000 cfs. ▪ $5 million – private property damage. ▪ $2.6 million – district property damage. ▪ $9 million – other public property damage (roads and parks). ▪ Federal Dams in and near Orange County cost $640 million over a 30 year period. ▪ The Federal dams prevented $1 million in damage during one week in February 1969. Smaller but more numerous local facilities by district, cities and county had a comparable cost-benefit effect. ▪ 1969 was a wakeup call to flood protection engineers from the Corps of Engineers to City Engineer level in Orange County.
▪ 1974	▪ 100-year rainfall along the coast of Orange County. Damage limited by substantial flood control improvements and 3-hour duration of high intensity rainfall.
▪ 1983	A very damaging record-breaking storm. ▪ 6-hours in duration covering about 100 square miles of western Orange County. ▪ Severe property damage in Huntington Beach, Fountain Valley, and Costa Mesa. ▪ The storm influenced the criteria published in the 1986 Orange County Hydrology Manual.
▪ 1995	▪ A very damaging storm with record breaking intensities for 2 and 3 hour duration. Flooded homes in Los Alamitos, Seal Beach, and Garden Grove.
▪ 1997	The most severe storm ever measured in Orange County. ▪ New records set for 30 minutes, 1 hour, 2 hour, 3 hour, 6 hour, 12 hour, and 24-hour rainfall. ▪ There was severe damage to Laguna Beach, Lake Forest, Irvine, and to the I-5 Freeway. ▪ 100-year rainfall covered over 200 square miles of our 800 square mile county. ▪ This storm and the similar, but slightly less severe 1983 and 1995 events, revealed vulnerability of older flood control facilities built. It was thought this type of intense storm was too rare to consider protective measures. ▪ Too many record-breaking storms hit in too short a period.
▪ 2005	▪ A series of “Pineapple Express” storms in January and February were the most significant since El Nino of 1998 causing mud flows and flooding throughout Orange County. Both state proclamations and federal declarations of disaster were made for these storms.
▪ 2010	▪ Significant storms occurring in January and December resulted in damage from flooding and mud flows in Laguna Beach. Levee damage occurred in San Juan Capistrano along Trabuco Creek.
Sources: Santa Ana River Mainstream Project – OC Public Works/Santa Ana River Division	

Flooding during the 1997/1998 El Niño Storm Season affected Orange County. Extensive storm damage to private property and public infrastructure (County and cities) reached approximately $50 million.

Storm conditions caused numerous countywide mud flows, road closures, and channel erosion. Hillside erosion and mud flows forced continual clearing of County roads of fallen trees and debris. Protective measures, such as stabilizing hillside road slopes with rock or K-rail at the toe of slopes, were taken to keep the normal flow of transportation on the County's road system. County harbors, beaches, parks, and trails also sustained substantial storm damage.

High ocean waves and storm activity forced the closure of Aliso Beach Pier when it was declared unsafe to the public and as a result, eventually required demolition. The high ocean waves also severely damaged the Laguna Beach boardwalk. Flooding occurred in the city, causing injuries and two deaths as a result of water and mud flow. Lateral erosion occurred to the natural banks of Serrano Creek and Aliso Creek. Storm flows destroyed portions of San Juan Creek and Trabuco Creek levees and channel linings. The U.S. Army Corps of Engineers assumed responsibility for the channel restoration following initial emergency response repairs made by the County. Substantial silt and sedimentation deposits at Santa Ana-Delhi and San Diego Creek Channels contributed to severe dredging problems at the Upper Newport Bay Regional Park, with costs estimated in excess of $2 million. Major landslides in Laguna Niguel caused millions of dollars in damage. Deterioration and collapse of a culvert 25 feet beneath the asphalt forced closure of Santiago Canyon Road for three weeks.

Assistance from resources such as the Army Corps of Engineers and the Federal Highway Administration minimized the overall reimbursement from FEMA (P.L. 93-288, Stafford Act for Public Assistance). Still, the reimbursement to the County unincorporated area alone still reached approximately $4 million.

Although the 1997/1998 floods resulted in substantial damage to Orange County, it was not unprecedented. In January 1995, a disaster was declared in the County as extremely heavy and intense rains quickly exceeded the storm runoff capacity of local drainage systems in many Orange County cities and regional Flood Control District systems. As a result, widespread flooding of homes and businesses occurred throughout these cities. There were approximately 1000 people evacuated and extensive damage sustained to both private and public property. Unincorporated areas of the county received $12.5 million in reimbursement through Public Assistance programs.

A series of storms battered Southern California in January and February 2005. These storms were the most significant to hit Southern California since the El Niño of 1998 and caused mud flows and flooding throughout Orange County. Both state proclamations and federal declarations of disaster were made for these storms.

Orange County is in close proximity to Los Angeles, San Bernardino, Riverside, and San Diego Counties. Heavy rain affecting any one of these counties can easily affect Orange County. In addition, the towering mountains trap eastern-moving winter storms and draw out the rain. The rainwater moves rapidly down the steep slopes and across the coastal plains on its way to the ocean. Orange County averages about thirteen inches of rain a year, yet some mountain peaks in the County receive more than forty inches of precipitation annually.

Naturally, this rainfall moves rapidly downstream, often with severe consequences for anything in its path. Flood-generated debris flows roared down canyons at speeds near 40 miles per hour carrying with them walls of mud, debris, and water many feet high.

Factors Creating Flood Risk

Flooding occurs when climate, geology, and hydrology combine to create conditions of water flow outside its usual course.

Seasonal Rainfall

Over the last 100 years, the average annual rainfall in Orange County is 13.03 inches. However, the term "average" means very little as the annual rainfall during this period has ranged from 2.19 inches in 20062007 to 38.2 inches in 1883-1884. This makes Orange County a land of extremes in terms of annual precipitation. Orange County is in the southern section of the Los Angeles Basin fringing the border of the Saddleback Range on the east, increasing the possibility of collection of rainwater within the county.

Another relatively regular source for heavy rainfall, particularly in the mountains and adjoining cities, is from summer tropical storms. Figure 3 lists tropical storms with significant rainfall in the past century, and the general areas affected by these storms. These tropical storms usually coincide with El Niño years.

El Niño

Like many weather patterns, El Niño is one of those systems that nearly everyone has heard of, but whose origins are not so widely known. An elixir of unusual trade wind patterns and warming waters, the weather event can dominate climatic conditions across the world. El Nino is a disruption of the ocean-atmosphere system in the tropical Pacific having important consequences for weather around the globe.

Nineteenth century anglers coined the name "El Niño." Anglers plying the waters off the coast of Peru in the late 1800s were the first to notice an occasional seasonal invasion of warm, southward ocean current that displaced the north-flowing, cold stream in which they normally fished. Typically, it happened around Christmas, or the first of the year – hence the name "El Niño," which means "little boy" or "Christ child" in Spanish.

An El Niño occurs when the ocean-atmosphere system in the tropical Pacific Ocean is disrupted. Normally, trade winds blow toward the west across the tropical Pacific Ocean, piling up warm surface water in the western Pacific. In a classic El Niño, the trade winds relax in the central and western Pacific, leaving warm water in the eastern Pacific. Heavy rainfall follows the warm water eastward, leading to flooding in Peru and California. Meanwhile, areas farther west, such as Indonesia and Australia, suffer droughts.

An El Niño event occurred in 1997-98 and mild occurrences in 2004-2005 and 2009-2010. The 1983-84 El Niño is considered the strongest and most devastating on record, responsible for more than 1,000 deaths, causing weather-related disasters on nearly every continent and totaling $10 billion in damages to property and livestock. El Niño conditions typically last one or two years, and are followed by "La Niña," or "little girl," in which a cooling of the same mid-Pacific waters triggers a reverse in climate impacts.

☐ **Figure 3 – Select Tropical storms or cyclones that affected Southern California**

Month-Year	Date(s)	Area(s) Affected	Rainfall
July 1902	20th & 21st	Deserts & Southern Mountains	up to 2"
Aug. 1906	18th & 19th	Deserts & Southern Mountains	up to 5"
Sept. 1910	15th	Mountains of Santa Barbara County	2"
Aug. 1921	20th & 21st	Deserts & Southern Mountains	up to 2"
Sept. 1921	30th	Deserts	up to 4"
Sept. 1929	18th	Southern Mountains & Deserts	up to 4"
Sept. 1932	28th to Oct 1st	Mountains & Deserts, 15 Fatalities	up to 7
Aug. 1935	25th	Southern Valleys, Mountains & Deserts	up to 2"
Sept. 1939	4th - 7th	Southern Mountains, Southern & Eastern Deserts	up to 7
	11th & 12th	Deserts, Central & Southern Mountains	up to 4"
	19th - 21st	Deserts, Central & Southern Mountains	up to 3"
	25th	Long Beach, W/ Sustained Winds of 50 Mph	5"
		Surrounding Mountains	6 to 12"
Sept. 1945	9th & 10th	Central & Southern Mountains	up to 2”
Sept. 1946	30th - Oct 1st	Southern Mountains	up to 4"
Aug. 1951	27th - 29th	Southern Mountains & Deserts	2 to 5"
Sept. 1952	19th - 21st	Central & Southern Mountains	up to 2"
July 1954	17th - 19th	Deserts & Southern Mountains	up to 2"
July 1958	28th & 29th	Deserts & Southern Mountains	up to 2"
Sept. 1960	9th & 10th	Julian	3.40"
Sept. 1963	17th - 19th	Central & Southern Mountains	up to 7"

Sept. 1967	1st - 3rd	Southern Mountains & Deserts	2"
Oct. 1972	6th	Southeast Deserts	up to 2"
Sept. 1976	10th & 11th	In Central and Southern Mountains. Ocotillo, CA was destroyed and there were 3 fatalities	6 to 12"
Aug. 1977	n/a	Los Angeles	2"
		Mountains	up to 8"
Oct. 1977	6th & 7th	Southern Mountains & Deserts	up to 2
Month-Year	**Date(s)**	**Area(s) Affected**	**Rainfall**
Sept. 1978	5th & 6th	Mountains	3"
Sept. 1982	24th - 26th	Mountains	up to 4"
Sept. 1983	20th & 21st	Southern Mountains & Deserts	up to 3"
Oct. 1987	5th-12th	Southern California	2.14”
June 1990	5th – 7th	Southern California and Western U.S.	Up to 3.28”
Sept. 2001	3rd	Southern California, Strong Thunderstorm Activity	Less than 1”
Oct. 2009	14th	Southern and Central California, High winds	Up to 10”
Sept. 2014	8th	Southern Deserts	Up to 3”
July 2015	18th – 20th	Southern California	Up to 4”
http://www.fema.gov/nwz97/eln_scal.shtm & other sources			

Geography and Geology

Southern California is the product of rainstorms and erosion for millennia. Most of the mountains surrounding the valleys and coastal plain are deeply fractured faults. As the mountains grew taller, their brittle slopes eroded. Rivers and streams carried boulders, rocks, gravel, sand, and silt down these slopes to the valleys and coastal plain. Today, much of the coastal plain rests on the ancient rock debris and sediment washed down from the mountains.

This sediment acts like a sponge, absorbing vast quantities of rain in years when heavy rains follow a dry period. Like a sponge near saturation, the same soil fills up rapidly when heavy rain follows a period of relatively wet weather. Even so, in some years of heavy rain, flooding is minimal because the ground is relatively dry, yet the same amount of rain following a wet period can cause extensive flooding.

Essentially all of Orange County is built out leaving little open land to absorb rainfall. The lack of open land forces water to remain on the surface rapidly accumulating. If it were not for the massive flood control system with its concrete lined river and streambeds, flooding would be a much more common occurrence. In addition, the tendency is toward less and less open land. In-fill building is becoming a much more common practice in many areas. Developers tear down an older home, typically covering up to 40% of the lot, replacing the single home with three or four town homes or apartments covering 90-95% of the lot.

Another potential source of flooding is "asphalt creep." The street space between the curbs of a street is a part of the flood control system. When water leaves property and accumulates in the street, it is directed toward the underground portion of the flood control system. The carrying capacity of the street is determined by the width of the street and the height of the curbs along the street. Often, when resurfacing streets, a one to two inch layer of asphalt is laid over the existing asphalt. This added layer of asphalt subtracts from the rated capacity of the street to carry water. Thus, the original engineered capacity of the entire storm drain system is marginally reduced over time. Subsequent re-paving of the street will further reduce the engineered capacity even more.

Bridges

In flood events, bridges are key points of concern because of their importance in the transportation network for the movement of goods, travel, and emergency services. During flood events, scouring of bed material supporting their foundation can occur. Historically, this is the most common cause of bridge failures. Bridges in and of themselves may also be obstructions in a watercourse, restrict flows, and cause stream instability.

Bridges in the County are Federal, State, County, Flood Control District, City, or privately owned property. County owned bridges that are on the public roadway system are inspected by the California Department of Transportation (CalTrans) in accordance with National Bridge Inspection Standards. Inspections are performed at regular intervals not to exceed two years unless justification to do otherwise is approved by the Federal Highway Administration. Bridges that are not a part of the public roadway system or listed in the States Inventory of Bridges will not be subject to inspection and are consequently a reason for concern.

The following bridges owned and maintained by the County have been retrofitted to address scour and/or seismic concerns:

- Hamilton Street-Victoria Street at Santa Ana River Channel (Bridge No. 55C-0103)
- Adams Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0344)
- Edinger Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0154) ▪ Warner Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0148)

- Harbor Boulevard Bridge at Santa Ana River Channel (Bridge No. 55C-0631)
- Lincoln Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0017)
- Glassell Street Bridge at Santa Ana River Channel (Bridge No. 55C-0130)
- Santiago Canyon Road Bridge at Santiago Creek (Bridge No. 55C-0038)
- Santiago Canyon Road Bridge at Santiago Creek (Bridge No. 55C-0049)
- Island Way Bridge at Harbor Waterway (Bridge No. 55C-0561)
- Brea Boulevard Bridge at Brea Creek (Bridge No. 55C-0122)
- Brea Boulevard Bridge at Brea Creek (Bridge No. 55C-0123)
- Santa Margarita Parkway Bridge at Arroyo Trabuco (Bridge No. 55C-0520)
- Slater Avenue-Segerstrom Avenue Bridge at Santa Ana River Channel (Bridge No. 55C-0371)

The County plans to replace Edinger Bridge at Bolsa Chica Channel (Bridge No. 55C-0400) in Fiscal Year 2017/2018. The new bridge is designed to current seismic design standards.

Flood Terminology

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, stores excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

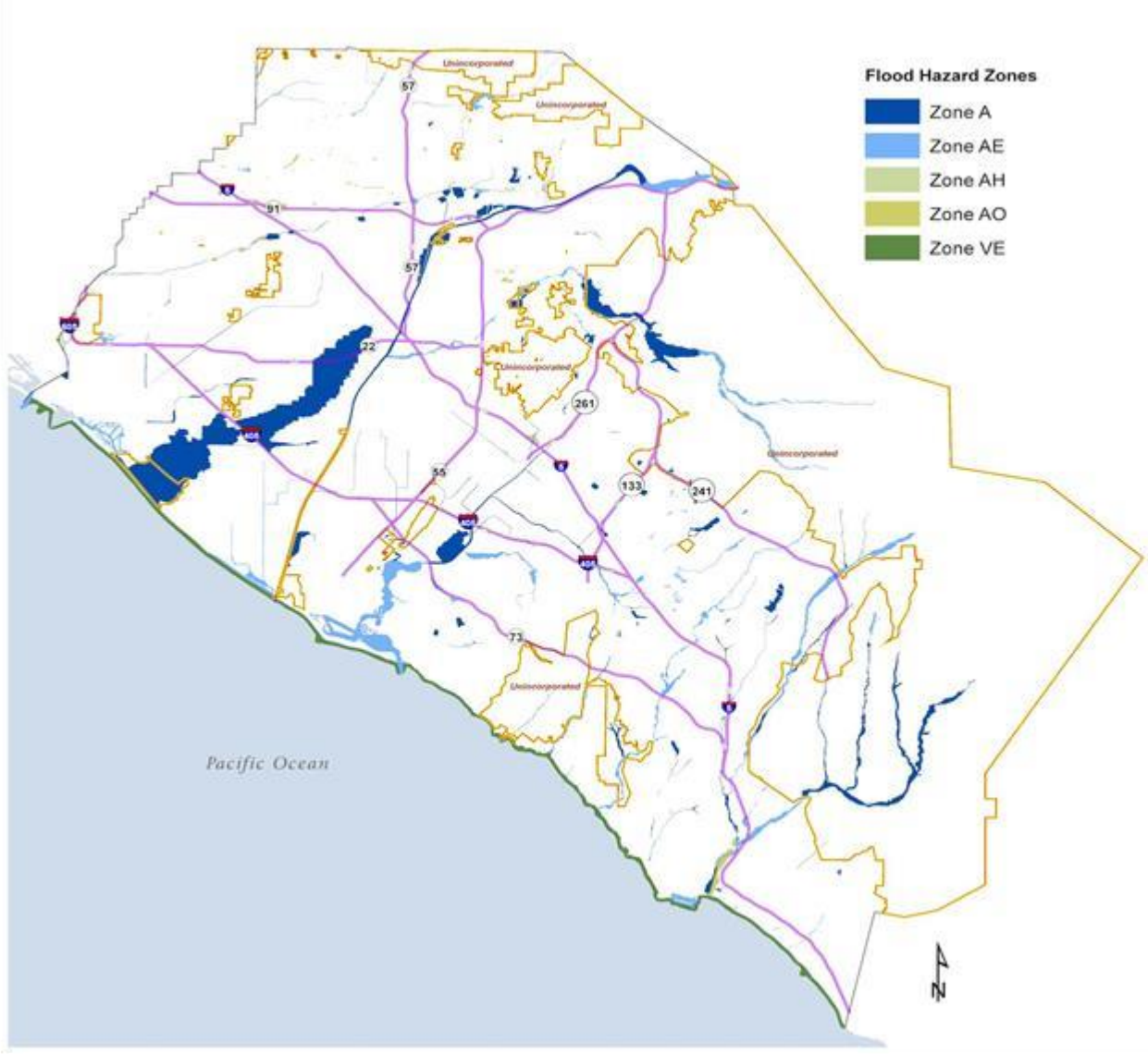
100-Year Flood

A 100-year flooding event is a flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood. Map 6 illustrates the 100-year floodplain in Orange County.

Floodway

The floodway is one of two main sections creating the floodplain. Regulatory purposes require floodways be defined. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For National Flood Insurance Program (NFIP) purposes, floodways are defined as the channel of a river or stream, and the over bank areas adjacent to the channel. The Orange County Zoning Code defines a "Floodway" as "the channel of a river or other watercourse and that part of the floodplain reasonably required to discharge the base flood without cumulatively increasing the water surface elevation more than one (1) foot." In the Orange County Zoning Code, the "FP-1" Zoning District is intended to be applied to areas shown as "floodway" on the December 3, 2009 or most current federal Flood Insurance Rate Maps and Flood Boundary and Floodway Maps and areas in which the County has determined that a floodway exists.

The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require the floodway be open and free from development or other structures that can obstruct or divert flood flows onto other properties.



☐ **Map 6 - 100-Year Floodplain in Orange County**

Flood Fringe

The flood fringe refers to outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. It is generally defined as "the land area, which is outside of the stream floodway, but is subject to periodic inundation by regular flooding." This is the area where development is most likely to occur, and where precautions to protect life and property must be taken. In Section 7-9-113-1 of the Orange County Zoning Code (Zoning Ordinance), the flood fringe encompasses the FP-2 and FP-3 Districts.

The FP-2 is intended to be applied to areas shown as "A," "A1", "AO," "AE," "AH," and "A99" on the December 3, 2009 or most current federal Flood Insurance Rate Maps and areas in which the County has determined to be a "Special Flood Hazard Area" (SFHA).

The FP-3 is intended to be applied to areas shown as "V", "VE," "AH," and "A99," on the December 3, 2009 or most current federal Flood Insurance Rate Maps and areas in which the County has determined to be a coastal high hazard area.

Development

For floodplain ordinance purposes, development is broadly defined as "any human caused change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard." The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

Uses permitted within the FP-1 District include agriculture, public flood control facilities and devices, public utility facilities, public parks and recreation areas. Specifically prohibited within all Floodplain Zones (FP-1, FP-2, and FP-3) are structures and uses increasing flood elevations during the course of a base flood discharge. Landfills, excavations and grading or the storage of materials and equipment resulting in the diversion or increase in erosion, flood elevations, or related hazards to people or property and storage or disposal of floatable substances and materials or of chemicals, explosives, and toxic materials are also prohibited. The "Base Flood" is defined in the Zoning Code as "the flood having a one percent chance of being equaled or exceeded in any given year, a.k.a. 100-year flood."

Base Flood Elevation (BFE)

The term "Base Flood Elevation" refers to the expected elevation (normally measured in feet above sea level) of a base flood. Base flood elevations can be set at levels other than a 100-year flood. Some communities choose to use higher frequency flood events as a base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation; while a 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Characteristics of Flooding

Two types of flooding primarily affect Orange County: riverine flooding and urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's capability to remove it.

Riverine Flooding

Riverine flooding is the over bank flooding of rivers and streams. The natural process of riverine flooding adds sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results

from large-scale weather systems generating prolonged rainfall over a wide geographic area. Flooding occurs in hundreds of smaller streams, which then drain into the major rivers.

Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low velocity sheet flows of water.

Urban Flooding

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds, to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly, peaking with violent force.

Dam Failure Flooding

Loss of life and damage to structures, roads, and utilities may be the result of a dam failure. Economic loss can result in a lowered tax base and lack of utility profits. The failure of one of the major dams in Orange County would certainly have this effect. FEMA requires all dam owners to develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions because dam failure can have severe consequences. Although there may be coordination with county officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner.

Since the 19th century, 45 dam failures have occurred in California. The two most significant dam failures are St. Francis Dam in 1928 and the Baldwin Hills Dam in 1963 that occurred in Los Angeles County.

For more detailed information regarding dam failure flooding, and potential flood inundation zones for a particular dam in the county, refer to the Orange County Emergency Action Plan. Also see Hazard Profile for Dam Failure in Chapter 3, Section 3.4 of this document.

Mud Flows

Another flood related hazard that can affect certain parts of the Southern California region are debris flows. Typically, debris flows occur in mountain canyons and the foothills. However, any hilly or mountainous area with intense rainfall and the proper geologic conditions may experience one of these very sudden and devastating events.

Mud flows, sometimes referred to as debris flows, lahars, or debris avalanches, are common types of fastmoving landslides. These flows generally occur during periods of intense rainfall or rapid snow melt. They usually start on steep hillsides as shallow landslides that liquefy, accelerating to speeds that are typically about 10 miles per hour, but can exceed 35 miles per hour. The consistency of debris flows ranges from watery mud to thick, rocky mud and can carry items as large as boulders, trees, and cars. Debris flows from many different sources can combine in channels, greatly increasing their destructive power. As the flow reaches flatter ground, debris spreads causing damage in developed areas.

The canyon areas within Orange County are susceptible to flooding and landslides following fire events.

The 2007 Santiago Fire, torching more than 28,000 acres, and the 2014 Silverado Canyon Fire, burning 960 acres, left burned trees and shrubs on steep slopes, exposing soil to be washed away by rain. It usually takes a few years for burned areas to recover vegetation.

Coastal Flooding

Low-lying coastal communities of Southern California also contend with coastal flooding. This occurs most often during storms with higher than normal tides. Storms, the time of year, and the tidal cycle can bring much higher than normal tides, causing flooding in low-lying coastal areas. This hazard however is limited to those areas.

Effect of Development on Floods

Development raises the river levels by forcing the river to compensate for the flow space obstructed by the inserted structures and/or fill. Serious problems arise with structures or a material added to floodways or floodplains and there is no removal of fill to compensate. Flood waters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience floodwaters that rise above historic levels. Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development occurring within the floodplain to ensure structures are prepared to withstand base flood events. In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Consideration taken in the development and the implementation of storm-water management systems ensures effective displacement of runoff waters.

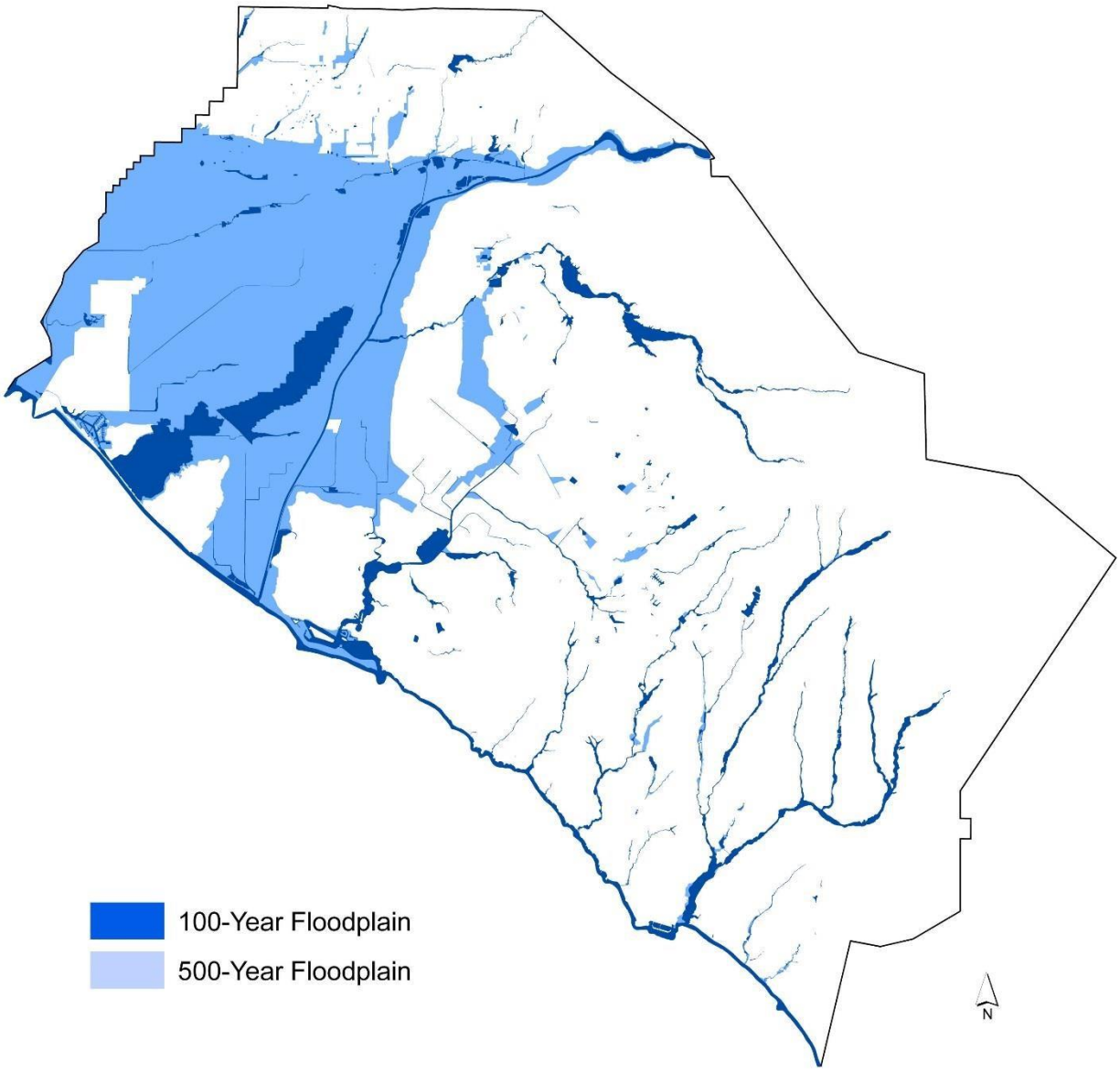
Identification of Flood-Prone Areas

Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas. The NFIP was established in 1968 to provide low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations focusing on building codes and sound floodplain management. Although NFIP regulations (44 Code of Federal Regulations (CFR) Chapter 1, Section 60, 3) require all new construction in floodplains be elevated at or above the base flood level, the Orange County Ordinance (09-008) requires that new construction be elevated at least one foot above the BFE.

Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS) Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by FEMA delineating Special Flood Hazard Areas (SFHA) in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine flood insurance requirements and applicable rates.

FIRMs are developed by combining water surface elevations with topographic data. Information derived through this process illustrates areas with the potential for inundation during a 100-year flood. They may also include base flood elevations (BFEs) and areas located within the 500-year floodplain. Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding in

a specific location. Flood Insurance Studies conducted in the late 1970's and early 1980's by FEMA show flood risk in specific areas. FEMA recently updated these floodplain maps during the Digital Flood Insurance Rate Map update. Human caused and natural changes to the environment continue to change the dynamics of storm water run-off.



☐ **Map 7 - FEMA 100 and 500-Year Floodplains (December 2009)**

Flood Mapping Methods and Techniques

Although many communities rely exclusively on FIRMs to characterize the risk of flooding in their area, some flood-prone areas are unmapped, but remain susceptible to flooding. These areas include locations next to small creeks, local drainage areas, and human-caused flooding.

To address this lack of data, Orange County, as well as other jurisdictions, has taken efforts to develop more localized flood hazard maps. One method includes using high water marks from flood events or aerial photos, in conjunction with the FEMA maps, to better reflect the true flood risk. The use of GIS (Geographic Information System) is becoming an important tool for flood hazard mapping. FIRM maps can be imported directly into GIS, which allows for GIS analysis of flood hazard areas.

Flood hazard areas on tax assessment parcel maps are particularly useful to communities, allowing evaluation of the flood hazard risk for specific parcels during review of a development request. Coordination between FEMA and local planning jurisdictions is key to making a strong connection with GIS technology for flood hazard mapping.

FEMA and the Environmental Systems Research Institute (ESRI), a private company, have formed a partnership providing multi-hazard maps and information to the public via the Internet. The online FEMA GeoPlatform site assists communities in evaluating geospatial information regarding natural hazards. The hazard maps provided on the site are available at http://fema.maps.arcgis.com. The FEMA Map Service Center (MSC) is the official public source for flood hazard information providing centralized GIS downloadable data and maps at http://www.msc.fema.gov.

Hazard Assessment

Hazard Identification

Hazard identification is the first phase of flood-hazard assessment. Identification is the process of estimating: (1) the geographic extent of the floodplain (i.e., the area at risk from flooding), (2) the intensity of the flooding that can be expected in specific areas of the floodplain, and (3) the probability of occurrence of flood events. This process results in the creation of a floodplain map providing detailed information to assist jurisdictions when making policies and land-use decisions.

Data Sources

FEMA mapped the 100-year and 500-year floodplains through the Flood Insurance Study (FIS) in conjunction with the United States Army Corps of Engineers (USACE) in August of 1987. A map of the floodplain completed in March of 1978 included the Housing and Urban Development (HUD) study when Orange County entered into the NFIP. The county has updated smaller drainage studies on the USACE and FEMA maps since this time and has access to the latest updated DFIRM (Digital Flood Insurance Rate Map) maps that followed the December 2009 FIRMs from FEMA. Map changes are expected from the upcoming Risk Map updates.

Community Flood Issues

Susceptibility to Damage during a Flood Event

The largest impact to communities in a flood event is the loss of life and property to both private and public entities. Development in the floodplains of Orange County increases the risk of extensive property loss resulting in flooding and flood damage.

Property Loss Resulting from Flooding Events

The type of property damage resulting from flood events is dependent upon the depth and velocity of the floodwaters. Fast moving floodwaters can wash buildings off their foundations and sweep cars downstream. High waters combined with flood debris can damage infrastructure, pipelines, and bridges. Landslide damage related to soil saturation can cause extensive damage. Water saturation of materials susceptible to loss (i.e., wood, insulation, wallboard, fabric, furnishings, floor coverings, and appliances), in many cases, renders a home unlivable.

Mobile Homes

The 1996 floods destroyed 156 housing units in the State. Of those units, 61% were mobile or manufactured homes. Many older manufactured home parks are located in floodplain areas. A manufactured home has a lower level of structural stability during a flood event. Because of confusion in the late 1980's resulting from multiple changes in NFIP regulations, some communities do not actively enforce anchoring requirements. The lack of enforcement of manufactured home construction standards in floodplains contributes to severe damage. In the unincorporated area of Orange County, the Orange County Zoning Code specifies that each mobile home installed on its own building site shall comply with the requirements of Section7-9-149.5 (et. al.). Each mobile home installation shall comply with the site development standards for a single-family dwelling in the applicable zoning district and be placed on a foundation system.

The Orange County Planning Division states there are currently no mobile home parks within the unincorporated area that have some portion of their property in the 100-year floodplain. However, the Orange County Zoning Code does permit "Manufactured Homes" within the FP-2 and FP-3 "Floodplain" district subject to a site development permit per Section 7-9-113.5 of the Zoning Code. Such uses may also be subject to appropriate approvals from FEMA if a subject property is also included within a floodplain on a Flood Insurance Rate Map or a Flood Boundary and Floodway Map.

Business/Industry

Flooding impacts businesses when damaged property interrupts operation, forcing closure for repairs, and customer access is cut off. A community maintains economic vitality in the face of flood damage with quick response to the needs of businesses affected by the flood. Response to business damages can include funding to assist owners in elevating or relocating flood-prone business structures.

Public Infrastructure

Publicly owned facilities are a key component of the daily lives of all residents in the county. Damage to public water and sewer systems, transportation networks, flood control facilities, emergency facilities, and offices hinder the government in delivering services. By taking action to create public policy, government can reduce risk to public infrastructure and private property resulting from flood events.

Roads

During a natural hazard event, or any type of emergency or disaster, dependable road connections are critical for providing emergency services. Orange County road systems often traverse floodplain and floodway areas. Federal, state, county, and city governments all have a stake in protecting roads from flood damage. Transportation agencies responsible for road maintenance are typically aware of roads at risk from flooding.

Bridges

Bridges are key points of concern during flood events. They are important links in road networks and river crossings and can be obstructions in watercourses, inhibiting the flow of water. A state-designated inspector must inspect all public bridges every two years, looking at everything from seismic capability to erosion and scour. Private bridges, not inspected, can be very dangerous. Five of the highest priority bridges in Orange County are currently being upgraded by replacing earthquake resistant bearing pads.

Storm Water Systems

Local drainage problems are common throughout the County and most of the local systems are owned and operated by the cities. A drainage master plan of the county is updated as needed. The staff of Orange County Public Works is aware of local drainage threats. The problems are often present where storm water runoff enters culverts or goes underground into storm sewers. Inadequate maintenance also contributes to the flood hazard in urban areas.

Water/Wastewater Treatment Facilities

There are ten utilities in Orange County with facilities located in local jurisdictions. There are 28 retail water utilities and 2 regional water utilities within the county.

Water Quality

Environmental quality problems include bacteria, toxins, and pollution. In 1990, the California Regional Water Quality Control Board, Santa Ana, and San Diego Regions issued municipal separate storm sewer system (MS4) permits under the National Pollution Discharge and Elimination System (NPDES) regulating the discharge of urban storm water runoff. Fourth term MS4 permits for Orange County were issued in 2009 and fifth term permits will be adopted in 2015. Each jurisdiction, including Orange County must comply with the MS4 permit provision, which have increased in complexity each time they have been reissued. Procedures established assist OC Public Works staff in implementing NPDES requirements designed for reducing and eliminating the discharge of pollutants into the waters of Orange County from urban sources. Orange County has invested heavily in efforts to implement a watershed approach to address water quality as well as habitat restoration, recreation, and flood control.

Existing Flood Mitigation Activities

Flood mitigation activities include current mitigation programs and activities that are being implemented by Orange County agencies or organizations.

Orange County Codes

Orange County uses building codes, zoning codes, and various planning strategies to address the goals aimed at restricting development in areas of known hazards, and applying the appropriate safeguards.

Acquisition and Protection of Open Space in the Floodplain

Current efforts to increase public open space in Orange County coupled with the need to restore and preserve natural systems providing a wildlife habitat also help to mitigate flood events. Publicly owned parks and open spaces provide a buffer linking flood hazards and private property.

Riparian Areas

Riparian areas are important transitional areas linking water and land ecosystems. Vegetation in riparian areas is dependent on stream processes and is composed of plants requiring large amounts of water, such as willows and cottonwood trees. Healthy vegetation in riparian buffers can reduce streamside erosion during flood events normally affected by the high water. The community has supported various improvement projects addressing issues caused by population growth and development and strained by land and water resources.

Wetlands

Many floodplain and stream-associated wetlands absorb and store storm water flows, reducing flood velocities and stream bank erosion. Preserving the wetlands reduces flood damage and the need for expensive flood control devices such as levees. When the storms are over, many wetlands augment summer stream flows by slowly releasing the stored water back to the stream system. Wetlands are highly effective in removing nitrogen, phosphorous, heavy metals, and other pollutants from the water. For this reason, artificial wetlands are often constructed for cleaning storm water runoff and for tertiary treatment (polishing) of wastewater.

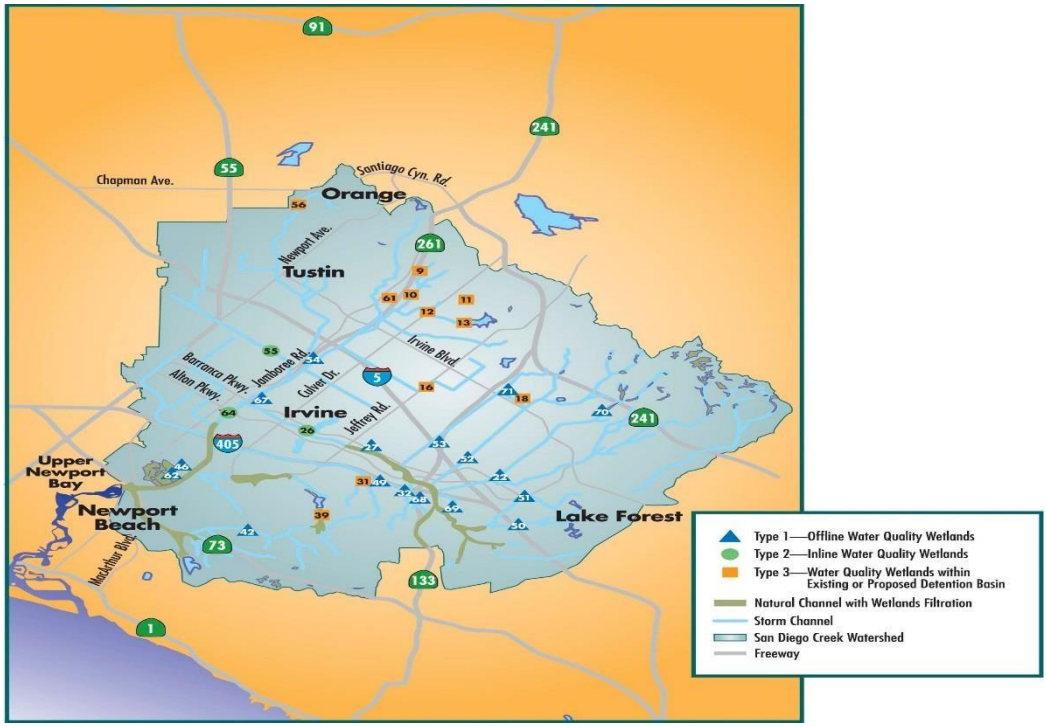
The only wetlands located in Orange County are listed below. These areas are under the jurisdictions noted with each site.

- **Bolsa Chica** – Responsible Party: California State Fish & Game.
- **Upper Newport Bay** – Responsible Party: California State Fish & Game (Orange County Public Works, Harbors, Parks & Beaches operates a regional facility adjacent to the bay).
- **Seal Beach Wetlands** – Responsible Party: Federal Government/ Seal Beach Weapons Station.
- **Huntington Beach Wetlands** – Responsible Party: Huntington Beach Conservancy.

The Natural Treatment System is a wetlands project initiated by the Irvine Ranch Water District. With the support of Orange County and the Cities of Irvine, Lake Forest, Orange, Newport Beach and Tustin, construction of 31 water quality wetlands to clean urban runoff within the San Diego Creek Watershed and to improve water quality in Upper Newport Bay is underway.

The Natural Treatment System (NTS) is a cost effective, environmentally sound alternative for handling dry weather runoff. Low-flow natural and urban run-off is diverted into manmade wetlands throughout

the San Diego Creek Watershed. Contaminants are removed preventing them from reaching the Upper Newport Bay. As the system provides a natural resource, riparian habitat, wildlife and water quality benefits throughout the watershed.



☐ **Map 8 - Irvine Ranch Water District's Natural Treatment System (NTS)**

Storm Water Systems

Orange County, the Orange County Flood Control District, and the Cities of Orange County (collectively referred to as Permittees) received their first National Pollutant Discharge Elimination System (NPDES) MS4 permits in 1990 from the Santa Ana Regional Water Quality Control Board. These permits authorize the discharge of runoff from the municipally owned and operated storm drain system provided pollutants be prevented or minimized to the Maximum Extent Practicable (MEP). MS4 permits for Orange County Permittees were renewed in 1996, 2002, 2009 and 2015. Each subsequent MS4 permit renewal has increased the responsibility of Orange County Permittees to manage storm water runoff discharged to receiving waters from the municipal storm drain system.

To achieve compliance with MS4 permit requirements, Orange County Permittees drafted a Drainage Area Management Plan (DAMP) in 1993. The DAMP was updated in 2000, 2003 and again in 2011, reflecting the increased requirements of the MS4 permits. The main objectives of the DAMP are to present a plan that satisfies NPDES permit requirements and to reduce and prevent the impacts of urban storm water discharges on receiving waters.

The DAMP is the principal policy document for Orange County Permittees, with each jurisdiction documenting how they are implementing the DAMP in a document called the Local Implementation Plan (LIP).

The DAMP describes the programs that serve to:

1. Provide the framework for the program management activities and plan development (**Section 2.0** and **Section 3.0**);

2. Provide the legal authority for prohibiting unpermitted discharges into the storm drain system and for requiring Best Management Practices (BMP) in new development and significant redevelopment (**Section 4.0**);

3. Improve existing municipal pollution prevention and removal BMPs to further reduce the amount of pollutants entering the storm drain system. (**Section 5.0**);

4. Educate the public about the issue of urban storm water and non-storm water pollution and obtain their support in implementing pollution prevention BMPs (**Section 6.0**);

5. Ensure all new development and significant redevelopment incorporates appropriate Site Design, Source Control and Treatment Control BMPs to address specific water quality issues. (**Section 7.0**);

6. Ensure construction sites implement control practices that address control of construction related pollutants discharges including erosion and sediment control and on-site hazardous materials and waste management (**Section 8.0**);

7. Ensure existing development will address discharges from industrial facilities, selected commercial businesses, residential development and common interest areas/homeowner associations. (**Section 9.0**);

8. Detect and eliminate illegal discharges/illicit connections to the municipal storm drain system (**Section 10.0**);

9. Conduct a storm water monitoring program to identify impacted receiving waters to assist in the prioritization of watersheds for analysis and planning, and to assist in the prioritization of pollutants to facilitate the development of specific controls to address these problems (**Section 11.0**); and

10. Assess watersheds and manage urban runoff on a watershed basis (**Section 12.0**).

Flood Management Projects

Flood management structures assist in regulating flood levels by adjusting water flows upstream of floodprone areas. There are 32 dams in Orange County holding millions of gallons of water in reservoirs. The County of Orange/Orange County Flood Control District owns three of these dams, while the U.S. Army Corps of Engineers (USACE), water districts and other entities own the majority. Release of reservoir water from flood control dams is designed to protect the County from floods. Projects by the

County of Orange/OCFCD focus on the removal of large floodplains and are included in its Capital Improvement
Program. These floodplains are located in the watersheds referred to by USACE as the Westminster Watershed (Huntington Beach, Westminster, Fountain Valley, Garden Grove, Unincorporated Orange County and Santa Ana) and the San Juan Creek Watershed (San Juan Capistrano and Dana Point). Also, participation in the Community Rating System keeps the county active in implementing and maintaining mitigation measures to manage flood where possible.

Community Issues Summary

Orange County works to mitigate flood issues as they arise. However, funding, time, and resources are often challenging to obtain. Areas within the county are more susceptible to flooding issues than others are and have incurred repetitive loss. Orange County Public Works and the Orange County Sheriff's Department Emergency Management Division have documented the problem areas in the community.

The USACE is engaged in helping Orange County Public Works to identify problem areas and is partnered with property owners to mitigate flooding and associated stream bank issues. However, as the USACE moves away from in-stream stabilization projects, many projects are not maintained. The USACE will continue to assist Orange County in appropriate mitigation projects.

Source: Orange County Emergency Operations Plan, 2014.

Vulnerability Assessment

Vulnerability assessment is the second phase of flood-hazard assessment, combining the floodplain boundary, generated through hazard identification, with an inventory of the property in the floodplain. Understanding the population and property exposed to natural hazards assists in reducing risk and preventing loss from future events. FEMA provides a tool called HAZUS which uses Geographic Information Systems (GIS) technology to estimate physical, economic and social impacts of disasters. Sitespecific inventory data for a particular flood event (10-year, 25-year, 50-year, 100-year, and 500-year) are generally available within HAZUS to calculate a community's vulnerability to flood events. The amount of property in the floodplain, as well as the type and value of structures on those properties, are calculated within HAZUS to provide a working estimate for potential flood losses.

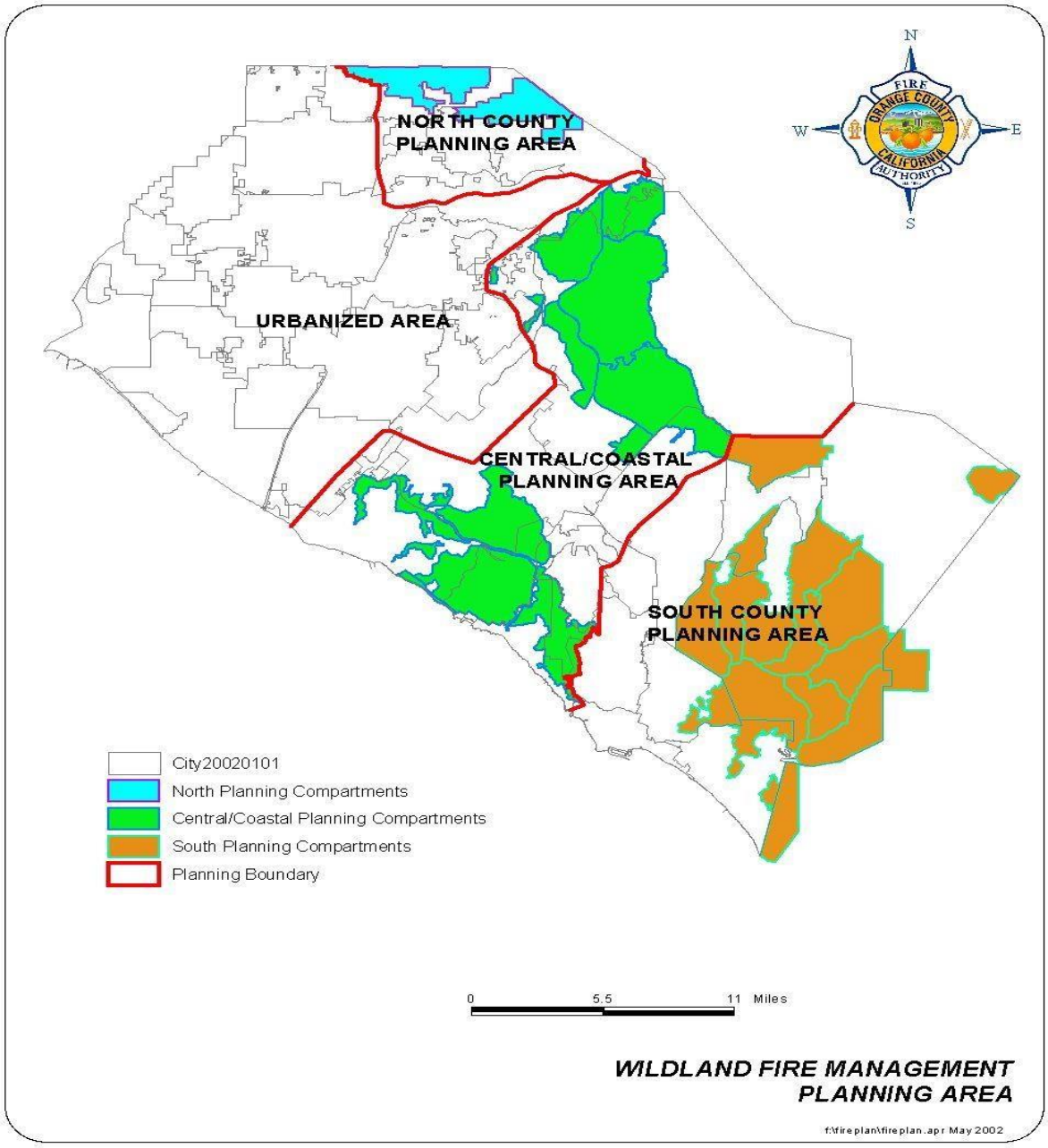
Risk Analysis

Risk analysis is the third and most advanced phase of a hazard assessment. It builds upon the hazard identification and vulnerability assessment. A flood risk analysis for Orange County includes two components: (1) the life and value of property that may incur losses from a flood event (defined through the vulnerability assessment), and (2) the number and type of flood events expected to occur over time. Within the broad components of a risk analysis, it is possible to predict the severity of damage from a range of events. Flow velocity models can assist in predicting the amount of damage expected from different magnitudes of flood events. The data used to develop these models is based on hydrological analysis of landscape features. Changes in the landscape, often associated with human development, can alter the flow velocity and the severity of damage that can be expected from a flood event.

The Orange County Essential Facilities Risk Assessment project ran detailed models for three flood scenarios (1% Annual Chance Flood Event (with levees), 100 Year Flood (without levees), and 500 Year Flood) in Orange County. That data can be found in Attachment B – OCEFRA HAZUS Report. In addition, assessments were performed using updated data in ArcGIS and are available at the end of this chapter in the Quantitative Exposure Analysis section.

3.2 Wildland/Urban Fire

A variety of fire protection challenges exist within Orange County, including structure, urban fires, wildland fires, and fires in the Wildland Urban Interface (WUI). This hazard analysis focuses on wildland fires, but also addresses issues specifically related to the Wildland Urban Interface and structure issues. Map 9 shows the Wildland Fire Management Planning Areas for Orange County.



☐ **Map 9 - Wildland Fire Management Planning Areas**

Wildland Urban Interface

In an effort to alleviate the dangers from wildland fires in or near the interface with urban development (Wildland Urban Interface or WUI), the construction of fuel modification zones (firebreak, fuel break, or greenbelt) are required in unincorporated County areas. The application of this method does have limitations and is therefore only a part of the solution. Fire prevention measures that reduce the level of risk to the structures located in the WUI must be further studied and developed in order to "harden the structure/home" and prevent the spread of wildland fire due to flying embers and radiant heat.

Much of the following, which addresses the threat of fire to urban areas, wildlands and the Wildland Urban Interface, has been extracted from the information prepared by the Orange County Fire Authority (OCFA) for the Safety Element of the County's General Plan.

Some of the most difficult fire protection problems in the urban area are:

- Multiple story, wood frame, high-density developments.
- Large contiguous built up areas with combustible roof covering materials.
- Transportation of hazardous materials by air, rail, road, water and pipeline. Natural disasters.

Other factors contributing to major fire losses are:

- Delayed detection of emergencies.
- Delayed notification to the fire agency.
- Response time of emergency equipment.
- Street structure – private, curvilinear and dead-end, street widths.
- Inadequate water supply for wildland fire suppression.
- Inadequate code enforcement and code revisions, which lag behind fire prevention knowledge.

Fire Prevention is the major fire department activity in urban areas; the objective is to prevent fires from starting. Once a fire starts, the objective is to minimize the damage to life and property. Urban fire prevention programs that are designed to achieve this fire prevention objective are:

- Adoption and aggressive enforcement of the most recent Fire and Building Codes with state and local amendment addressing wildland fire hazards.
- Development of a comprehensive master plan to ensure that staffing and facilities keep pace with growth.
- Enforcement of Hazardous Materials Disclosure Ordinance.
- Active participation in planning committees and other planning activities.

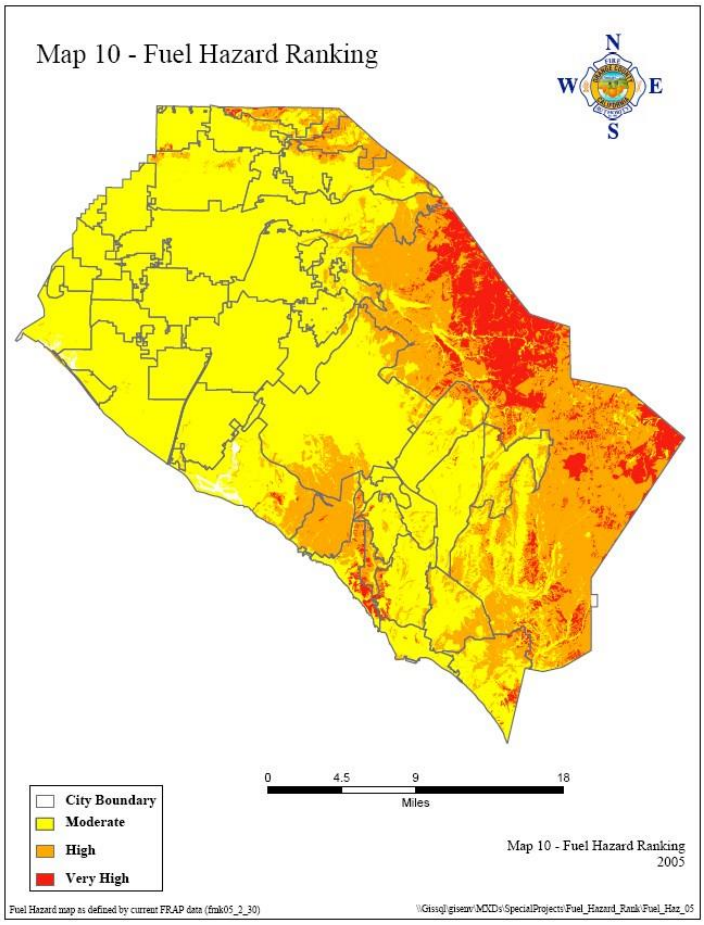
The character of the existing built-up area and future land use determines the location of fire stations, the number of fire companies, staffing of such companies, and future fire protection facility needs. Structural conditions also influence the quantity of water needed for fire protection (fire flow) and hydrant distribution.

Features of structural conditions that affect fire control are:

- Type of construction, construction features, and use of buildings.
- Area of building (ground floor area).
- Number of stories.
- Type of roof covering material.
- Exposures to the building.

Wildland Fires

California experiences large, destructive wildland fires almost every year and Orange County is no exception. Wildland fires have occurred within the county, particularly in the fall of the year, ranging from small, localized fires to disastrous fires covering thousands of acres. The most severe fire protection problem in the unincorporated areas is wildland fire during Santa Ana wind conditions. Map 10 shows the current fuel hazard ranking as of 2015 for the County.



☐ **Map 10 - Fuel Hazard Ranking, 2005 (Current as of 2015)**

Reasons for control difficulty associated with wildland fires are:

- Adverse weather conditions.

- Large quantities of contiguous combustible fuelbeds.
- Inaccessible terrain.
- Nonexistent or very limited water supply.
- Large fire fronts requiring dispersal of fire forces.

For these reasons, it is usually necessary for the firefighting force to meet the advancing fire front in an accessible area containing a minimum amount of combustible vegetation, and preferably located close to a water source.

The major objective of wildland fire defense planning is to prevent wildland fires from starting and, if unsuccessful, to minimize the damage to natural resources and structures. Some of the more successful programs currently in effect which contribute to the success of wildland fire prevention activities are:

- Closure of public access to land in hazardous fire areas.
- Building Code prohibition of most combustible roof covering materials (still allows Class C).
- Local amendments requiring “special construction features,” e.g. boxed eaves, Class A roof, dual paned or tempered glass windows.
- Construction and maintenance of community and private fuel modification zones.
- Vegetative Management Program (controlled burning).
- Weed Abatement Program.
- Fire Prevention Education Programs.

There are a number of natural conditions which dictate the severity of a wildland fire when it occurs. Three such conditions are weather elements, the topography of the area, and the type and condition of wildland vegetation.

Weather

Weather conditions have many complex and important effects on fire intensity and behavior. Wind is of prime importance; as wind increases in velocity, the rate of fire spread also increases. Relative humidity (i.e., relative dryness of the air) also has a direct effect; the drier the air, the drier the vegetation and the more likely the vegetation will ignite and burn. Precipitation (annual total, seasonal distribution and storm intensity) further affects the moisture content of both dead and living vegetation, which influences fire ignition and behavior.

Many wildland fires have been associated with adverse weather conditions. In recent years, Orange County has experienced numerous wildland fires that have destroyed, damaged or threatened an extensive number of homes and businesses that relates to millions of dollars in property damage and loss of business revenue. The Sierra Incident in CY2006 burned 10,584 acres; the Santiago Incident in CY2007 burned 28,476 acres and either damaged or destroyed 23 residences and the Freeway Complex in CY2008 that burned 30,305 acres and either damaged or destroyed 300+ residences; are just a few examples of the devastation caused by wildland fires. At the onset of these fires, the Santa Ana winds were exceeding 50 mph, making quick containment impossible.

Additionally, the extreme fire weather conditions of 1993, aided the devastating firestorms that swept the County during the period of October 24 through November 4. During this period, a total of 20 major fires in six Southern California counties burned out of control, of which three of these fires occurred in Orange County: the Stagecoach fire burned 750 acres and destroyed 9 buildings, the Laguna Beach fire burned 14,337 acres, destroyed 441 homes and caused approximately $528 million in damage, and the Ortega fire burned 21,384 acres and destroyed 19 buildings

In 1997, the Baker Canyon fire by Irvine Lake burned 6,317 acres of vegetation, followed by two additional fires in 1998: The Blackstar/Santiago Canyons fire destroyed 8,800 acres, and the Carbon Canyon fire burned 733 acres of brush.

In addition to winds, structural development exposures within or adjacent to wildland represents an extreme fire protection problem due to flying embers and the predominance of combustible roof coverings.

Topography

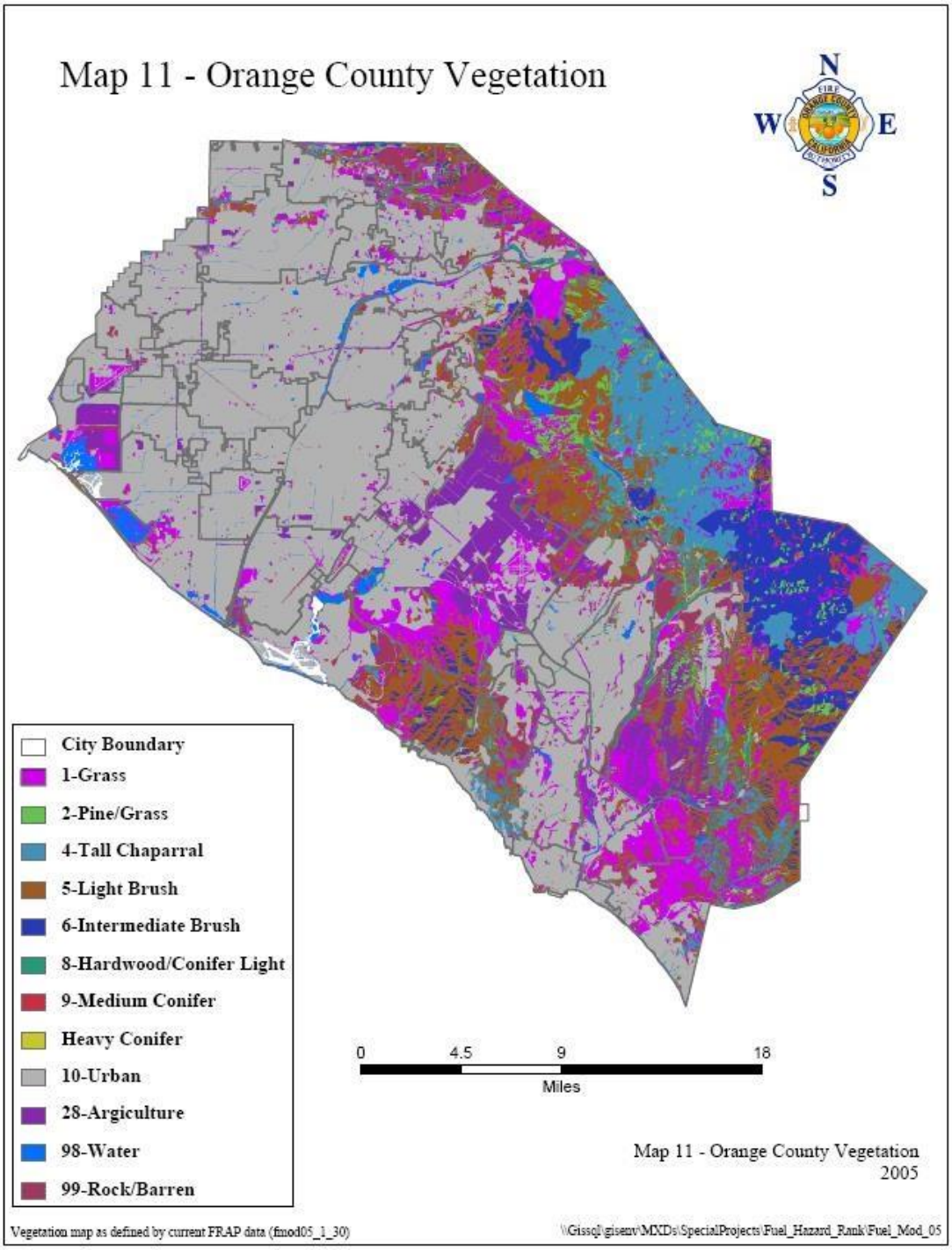
Topography has considerable effect on wildland fire behavior and, depending on the topography, may limit the ability of firefighters and their equipment to take adequate action to suppress or contain wildland fires. Simply said, a wildland fire starting in a canyon bottom will quickly spread to the ridge top before initial attack forces arrive. Rough topography greatly limits fireline construction, road construction, road standards, and accessibility by ground firefighting resources. Steep topography also channels airflow, creating extremely erratic winds on leeward slopes, canyons and passes. Water supply, intended for protecting structures located at higher elevations, is frequently dependent on water pump stations and utilities. The source of power for such stations is usually from overhead electrical power distribution lines, which are subject to destruction by wildland fires.

Vegetation

A key to effective fire control and the successful accommodation of fire in wildland management is the understanding of fire and its environment. The fire environment is the combination of combustible fuels, topography, and air mass and the complexity of these factors play an important role to influence the inception, growth, and behavior of a fire. The topography and weather components are, for all practical purposes, beyond human control, but it is a different story with fuels, which can be controlled before the outbreak of fires. In terms of future urban expansion, finding new ways to control and understand these fuels can lead to possible fire reduction.

A relatively large portion of the county is covered by natural (though modified) vegetation as indicated on the Composite Vegetation Map 11 provided by the Orange County Fire Authority. Of these different vegetation types, coastal sage scrub, chaparral, and grasslands become the most hazardous, with a high probability of ignition, during the dry summer months and, under certain conditions, during the winter months. For example, as chaparral gets older, twigs and branches within the plants die and are held in place. A stand of brush 10- to 20-years of age will contain dried and cured dead material that can produce a rate of spread comparable to grass fires. In severe drought years, additional plant material may die, contributing to the fuel load. There will normally be enough dead fuel accumulated in 20- to

30-year old brush to give rates of spread approximately twice as fast as in a grass fire. For example, under moderate weather conditions in a grass vegetation type a rate of spread of one-half foot per second can be expected. Conversely, a vegetation type of 20- to 30-year old stand of chaparral may have a rate of fire spread of about one foot per second. Fire spread in old brush (40 years or older) has been measured at eight times as fast as in grass, about four feet per second. Under extreme weather conditions, the fastest fire spread in grass is 12 feet per second or about eight miles per hour. Fuel Hazard Ranking for 2005 (Current as of 2015) is shown on Map 10 provided by OCFA.



☐ **Map 11 - Orange County Vegetation**

Wildland Fires as a Threat to Southern California

Wildland fire is a natural part of the ecosystem in Southern California. However, wildland fire presents a substantial hazard to life and property in communities built in or adjacent to the open spaces of Orange

County. There is a huge potential for losses due to Wildland Urban Interface fires in Southern California. The fall of 2007 marked one of the most destructive wildland fire season in California history. In a four day period from 10/20/07 thru 10/23/07, 20 separate fires started and raged across Southern California in Santa Barbara, Ventura, Los Angeles, San Bernardino, Riverside, Orange and San Diego counties. The massive Witch Incident in San Diego County alone consumed of 1,218 homes and burned over 197,990 acres.

☐ **Figure 4 - October 2007 Firestorm Statistics**

County	Fire Name	Began	Acres Burned	Homes Lost	Homes Damaged	Lives Lost
San Diego	Ammo	10/23/07	21,004	0	0	0
San Diego	Harris	10/21/07	90,440	253	12	* 5
San Diego	Witch	10/21/07	69,894	1,141	77	* 2
San Diego	Rice	10/22/07	9,472	206	0	0
San Diego	Poomacha	10/23/07	49,410	138	5	0
Orange	Santiago	10/21/07	28,400	15	8	0
Riverside	Rosa	10/22/07	411	0	0	0
Riverside	Roca	10/21/07	270	1	0	0
San Diego	Coronado Hills	10/22/07	250	0	0	0
San Diego	McCoy	10/21/07	353	2	0	0
Santa Barbara	Cajon	10/22/07	250	0	0	0
Santa Barbara	Slide	10/22/07	12,759	271	43	0

Santa Barbara	Grass Valley	10/22/07	1,247	178	22	0
Los Angeles	October	10/21/07	20	0	0	0
Los Angeles	Canyon	10/21/07	4,521	6	9	0
Los Angeles	Magic	10/22/07	2,824	0	0	0
Los Angeles	Buckweed	10/21/07	38,356	21	13	0
Angeles NF	Ranch	10/20/07	58,401	1	0	0
Ventura	Nightsky	10/21/07	30	0	0	0
Los Padres NF	Sedgewick	10/21/07	710	0	0	0
County	**Fire Name**	**Began**	**Acres Burned**	**Homes Lost**	**Homes Damaged**	**Lives Lost**
Total Losses			517,122	2,233	189	

Source: http://www.fire.ca.gov/php/fire_er_content/downloads/2003LargeFires.pdf

***** Civilian Fatalities

Wildland Fire Characteristics

There are three categories of Wildland Urban Interface (WUI): (1) the classic WUI exists where welldefined urban and suburban development presses up against open expanses of wildland areas, (2) the mixed WUI is characterized by isolated homes, subdivisions and small communities situated predominantly in wildland settings, (3) and the occluded WUI existing where islands of wildland vegetation occur inside a largely urbanized area. Certain conditions must be present for significant interface fires to occur. The most common conditions include: hot, dry and windy weather, the inability of firefighting forces to contain or suppress the fire, the occurrence of multiple fires that overwhelm committed resources, and a large fuel load (dense vegetation). Once a fire has started, several conditions influence its behavior, including fuel, topography, weather, drought, and development.

Southern California has two distinct areas of risk for wildland fire. The foothills and lower mountain areas are most often covered with scrub brush or chaparral. The higher elevations of mountains also have heavily forested terrain.

The higher elevations of Southern California's mountains are typically heavily forested. The magnitude of the 2003, 2007 and 2008 fires is the result of three primary factors: (1) weather conditions including severe drought, a series of storms that produce thousands of lightning strikes and windy conditions; (2) infestations of a variety of beetles and other pests that has killed thousands of mature trees; and (3) the cumulative effects of wildland fire suppression over the past century that has resulted in an overabundance of brush and small diameter trees in the forests.

At the beginning of the 1900s, forests were relatively open, with 20 to 25 mature trees per acre. Periodically, lightning would start fires that would clear out underbrush and small trees, renewing the forests.

Today's forests are completely different, with as many as 400 trees crowded onto each acre, along with thick undergrowth. This density of growth makes forests susceptible to disease, drought and severe wildland fires. Instead of restoring forests, these wildland fires destroy them and it can take decades to recover. This radical change in our forests is the result of nearly a century of well-intentioned but misguided management[10].

The Interface

One challenge Southern California faces regarding the wildland fire hazard is from the increasing number of houses being built in the Wildland Urban Interface. Every year the growing population expands further and further into the hills and mountains, including forest lands. The increased "interface" between urban/suburban areas and the open spaces created by this expansion has produced a significant increase in threats to life and property from fires and has pushed existing fire protection systems beyond original or current design and capability. Many property owners in the interface are not aware of the problems and threats they face. Therefore, many owners must do more to manage or offset fire hazards or risks on their own property. Furthermore, human activities increase the incidence of fire ignition and potential damage.

Fuel

Fuel is the material that feeds a fire and is a key factor in wildland fire behavior. Fuel is classified by volume and by type.

Fuel volume is described in terms of "fuel loading," or the amount of available vegetative fuel.

Fuel type is an identifiable association of fuel elements of distinctive species, form, size, arrangement, or other characteristics that will cause a predictable rate of spread or resistance to control under specified

[10] "Overgrown Forests Require Prevention Measures" by Gale A. Norton, Secretary of the Interior, USA Today, Editorial, August 21, 2002.

weather conditions. Chaparral is a primary fuel type in Southern California and the basis of the extreme conditions associated with wildland fires. Chaparral habitat ranges in elevation from near sea level to over 5,000 feet in Southern California. Chaparral communities experience long dry summers and receive most of their annual precipitation from winter rains.

Fire has been important in the life cycle of chaparral communities for over 2 million years; however, the true nature of the "fire cycle" has been subject to interpretation. In a period of 750 years, it is generally thought that fire occurs once every 65 years in coastal drainages and once every 30 to 35 years inland.

The vegetation of chaparral communities has evolved to a point it requires fire to spawn regeneration. Many species invite fire through the production of plant materials with large surface-to-volume ratios, volatile oils and through periodic die-back of vegetation. These species have further adapted to possess special reproductive mechanisms following fire. Several species produce vast quantities of seeds which lie dormant until fire triggers germination. The parent plant which produces these seeds defends itself from fire by a thick layer of bark which allows enough of the plant to survive so that the plant can crown sprout following the blaze. In general, chaparral community plants have adapted to fire through the following methods: a) fire induced flowering, b) bud production and sprouting subsequent to fire, c) in-soil seed storage and fire stimulated germination, and d) on plant seed storage and fire stimulated dispersal.

An important element in understanding the danger of wildland fire is the availability of diverse fuels in the landscape, such as natural vegetation, manmade structures and combustible materials. A house surrounded by brushy growth rather than cleared space allows for greater continuity of fuel and increases the fire’s ability to spread. After decades of fire suppression, “dog-hair" thickets have accumulated, which enable high intensity fires to flare and spread rapidly.

Topography

Topography influences the movement of air, thereby directing a fire course. For example, if the percentage of uphill slope doubles, the rate of spread in wildland fire will likely double. Gulches and canyons can funnel air and act as chimneys, which intensify fire behavior and cause the fire to spread faster. Solar heating of dry, south-facing slopes produces up slope drafts that can complicate fire behavior. Unfortunately, hillsides with hazardous topographic characteristics are also desirable residential areas in many communities. This underscores the need for wildland fire hazard mitigation and increased education and outreach to homeowners living in interface areas.

Weather

Weather patterns combined with certain geographic locations can create a favorable climate for wildland fire activity. Areas where annual precipitation is less than 30 inches per year are extremely fire susceptible. High-risk areas in Southern California share a hot, dry season in late summer and early fall when high temperatures and low humidity favor fire activity. The so-called “Santa Ana” winds, which are heated by compression as they flow down to Southern California from the Great Basin Region, create a particularly high risk, as they can rapidly spread what might otherwise be a small fire.

Drought

Recent concerns about the effects of climate change, particularly drought, are contributing to concerns about wildland fire vulnerability. The term drought is applied to a period in which an unusual scarcity of rain causes a serious hydrological imbalance. Unusually dry winters, or significantly less rainfall than normal, can lead to relatively drier conditions and leave reservoirs and water tables lower. Drought leads to problems with irrigation and may contribute to additional fires, or additional difficulties in fighting fires. **Development**

Growth and development in scrubland and forested areas is increasing the number of human-made structures in Southern California interface areas. Wildland fire has an effect on development, yet development can also influence wildland fire. Owners often prefer homes that are private, have scenic views, are nestled in vegetation and use natural materials. A private setting may be far from public roads, or hidden behind a narrow, curving driveway. These conditions, however, make evacuation and firefighting difficult. The scenic views found along mountain ridges can also mean areas of dangerous topography. Natural vegetation contributes to scenic beauty, but it may also provide a ready trail of fuel leading a fire directly to the combustible fuels of the home itself.

Wildland Fire Hazard Assessment

Wildland Fire Hazard Identification

Wildland fire hazard areas are commonly identified in regions of the Wildland Urban Interface. Ranges of the wildland fire hazard are further determined by the ease of fire ignition due to natural or human conditions and the difficulty of fire suppression. The wildland fire hazard is also magnified by several factors related to fire suppression/control such as the surrounding fuel load, weather, and topography and property characteristics. Generally, hazard identification rating systems are based on weighted factors of fuels, weather and topography.

Figure 5 - Illustrates a rating system to identify wildland fire hazard risk (with a score of 3 equaling the most danger and a score of 1 equaling the least danger.

☐ **Figure 5 - Sample Hazard Identification Rating System**

Category	**Indicator**	**Rating**
Roads and Signage	Steep, narrow, poorly signed	3
	One or two of the above	2
	Meets all requirements	1
Water Supply	None, except domestic	3
	Hydrant, tank, or pool over 500 feet away	2

	Hydrant, tank, or pool within 500 feet	1
Structure Location	Top of steep slope with brush/grass below	3
	Mid-slope with clearance	2
	Level with lawn, or watered groundcover	1
Exterior Construction	Combustible roofing, open eaves, combustible siding	3
	One or two of the above	2
	Non-combustible roof, boxed eaves, non-combustible siding	1

In order to determine the "base hazard factor" of specific wildland fire hazard sites and interface regions, several factors must be taken into account. Categories used to assess the base hazard factor include:

Topographic location, characteristics and fuels
Site/building construction and design
Site/region fuel profile (landscaping)
Defensible space
Accessibility
Fire protection response
Water availability

The use of Geographic Information System (GIS) technology in recent years has been a great asset to fire hazard assessment, allowing further integration of fuels, weather and topography data for such ends as fire behavior prediction, watershed evaluation, mitigation strategies, and hazard mapping.

Vulnerability and Risk

Orange County residents are served by a variety of local fire departments as well as county, state and federal fire resources. Data that includes the location of interface areas in the county can be used to assess the population and total value of property at risk from wildland fire and direct these fire agencies in fire prevention and response.

Key factors included in assessing wildland fire risk include ignition sources, building materials and design, community design, structural density, slope, vegetative fuel, fire occurrence and weather, as well as occurrences of drought. An assessment of Orange County's exposure to high wildfire hazard areas is available in the Quantitative Exposure Analysis section at the end of this chapter.

The National Wildland Urban Fire Protection Program has developed the Wildland Urban Fire Hazard Assessment Methodology tool for communities to assess their risk to wildland fire. For more information on wildland fire hazard assessment refer to http://www.Firewise.org.

Community Wildland Fire Issues

Susceptibility to Wildland fire

Orange County has an extensive history with wildland fire, as described in Figure 6 below.

☐ Figure 6 - Large Fires in Orange County 1914-2015

Year	Fire Name	Acreage	Year	Fire Name	Acreage
1914	Unknown	18,754	1976	Pendleton	2,111
1915	Unknown	1,794	1977	Mine	4,956
1917	Unknown	3,164	1978	Soquel	5,428
1919	Unknown	2,225	1979	Paseo	3,644
1920	Unknown	2,724	1980	Owl	18,332
Year	**Fire Name**	**Acreage**	**Year**	**Fire Name**	**Acreage**
1923	Unknown	2,150	1980	Carbon Canyon	14,613
1925	Unknown	8,650	1980	Indian	28,938
1926	Unknown	9,934	1982	Gypsum	19,986
1927	Unknown	1,837	1985	Shell	1,635
1929	Unknown	1,085	1986	Bedford 1	2,956
1937	Unknown	4,916	1987	Bedford	4,070
1943	Unknown	1,930	1987	Silverado	6,018
1943	Unknown	2,727	1988	Ortega	2,471
1948	Green River	53,079	1989	Ortega	8,170
1952	Indian Potrero	5,604	1989	Assist 108	13,478
1954	Weigand	4,956	1990	Carbon Canyon	6,664
1954	Jameson	7,881	1990	Yorba	7,884

1955	Niger	1,606	1993	Laguna Fire	14,337
1956	Cornwall	3,173	1993	Ortega	21,010
1958	Unknown	11,774	1997	Baker	6,320
1958	Kelly	2,380	1998	Santiago Canyon	7,760
1958	Steward	69,444	2002	Green	2,234
1959	Talega	3,187	2002	Antonio	1,480
1961	Unknown	5,273	2006	Sierra Peak	10,505
1961	Outside Origin #2	5,019	2007	241	1,618
1966	Indian	1,405	2007	Santiago	28,517
1967	Paseo Grande	51,075	2008	Freeway Complex	30,305
1970	Nelson	3,586	2014	Silverado	968
1975	Grundy	1,915			

Growth and Development in the Interface The hills and mountainous areas of Southern California are considered to be interface areas. The development of homes and other structures is encroaching onto the wildlands and is expanding the Wildland Urban Interface. The interface neighborhoods are characterized by a diverse mixture of varying housing structures, development patterns, ornamental and natural vegetation and natural fuels.

In the event of a wildland fire, vegetation, structures and other flammables can merge into unwieldy and unpredictable events. Factors important to the fighting of such fires include access, fire and fuel breaks, proximity of water sources, distance from a fire station and available firefighting personnel and equipment. Reviewing past Wildland Urban Interface fires shows that many structures are destroyed or damaged for one or more of the following reasons:

- Combustible roofing material.
- Open eaves and vents.
- Combustible siding, window and door frames.
- Structures with no defensible space.
- Poor fire crew access to structures.
- Subdivisions located in heavy natural fuel types.
- Structures located on steep slopes covered with flammable vegetation.
- Limited water supply.

- Winds over 30 miles per hour.

Road Access

Road access is a major issue for all emergency service providers. As development encroached into the rural areas of the county, the number of houses without adequate turn-around space increased. In many older areas, there is not adequate space for emergency vehicle turnarounds in single-family residential neighborhoods, causing emergency workers to have difficulty accessing houses. As fire trucks are large, firefighters are challenged by narrow roads and limited access. When there is inadequate turn around space, the fire fighters can only work to remove the occupants, but cannot safely remain to save the threatened structures.

Water Supply

Firefighters in remote and rural areas are faced by limited water supply and lack of hydrant taps. Rural areas are characteristically outfitted with small diameter pipe water systems, inadequate for providing sustained firefighting flows.

Interface Fire Education Programs and Enforcement

Fire protection in Wildland Urban Interface areas may rely more heavily on the landowner's personal initiative to take measures to protect his or her own property. Therefore, public education and awareness may play a greater role in interface areas. In those areas with strict fire codes, property owners who resist maintaining the minimum brush clearances may be cited for failure to clear brush.

The Need for Mitigation Programs

Continued development into the interface areas will have growing impacts on the Wildland Urban Interface. Periodically, the historical losses from wildland fires in Southern California have been catastrophic, with deadly and expensive fires going back decades. The continued growth and development increases the public need for natural hazard mitigation planning in Southern California.

Wildland Fire Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

Local Programs

In Orange County there are independent local fire departments as well as a countywide consolidated fire district. Although each district or department is responsible for fire related issues in specific geographic areas, they work together to keep Orange County residents safe from fire. Although fire agencies work together to fight Wildland Urban Interface fires, each separate agency may have a somewhat different set of codes to enforce for mitigation activities.

The fire departments and districts provide essential public services in the communities they serve and their duties far surpass extinguishing fires. Most of the districts and departments provide other services

to their jurisdictions including Emergency Medical Services who can begin treatment and stabilize sick and injured patients in emergency situations. All of the fire service providers in the county are dedicated to fire prevention and use their resources to educate the public to reduce the threat of the fire hazard, especially in the Wildland Urban Interface. Fire prevention professionals throughout the county have taken the lead in providing many useful and educational services to Orange County residents, such as:

- Home fire safety inspection.
- Assistance developing home fire escape plans.
- Business Inspections.
- Community Emergency Response Team (CERT) training.
- Fire cause determination.
- Counseling for juvenile fire-setters.
- Teaching fire prevention in schools.
- Coordinating educational programs with other agencies, hospitals and schools.
- Answering residents' questions regarding fire hazards.

The Threat of Urban Conflagration

Although communities without Wildland Urban Interface are much less likely to experience a catastrophic fire, in Orange County there is a scenario where any community might be exposed to an urban conflagration similar to the fires that occurred following the 1906 San Francisco earthquake.

Large fires following an earthquake in an urban region are relatively rare phenomena, but have occasionally been of catastrophic proportions. The two largest peacetime urban fires in history, 1906 San Francisco and 1923 Tokyo, were both caused by earthquakes.

The fact that fire following earthquake has been little researched or considered in the United States is particularly surprising when one realizes that the conflagration in San Francisco after the 1906 earthquake was the single largest urban fire, and the single largest earthquake loss, in U.S. history. The loss over three days of more than 28,000 buildings within an area of nearly 5 square miles was staggering: $250 million in 1906 dollars, or about $5 billion at today's prices.

The 1989 Loma Prieta Earthquake, the 1991 Oakland Hills Fire, and Japan's recent Hokkaido Nansei-oki Earthquake all demonstrate the current, real possibility of a large fire, such as a fire following an earthquake, developing into a conflagration. In the United States, all the elements that would hamper firefighting capabilities are present: density of wooden structures, limited personnel and equipment to address multiple fires, debris blocking the access of fire-fighting equipment, and a limited water supply.

Finally, the April 21, 1982 Anaheim apartment fires in Anaheim illustrated the capability for urban conflagration in Orange County. The fire broke out shortly before dawn and, fueled by Santa Ana winds, quickly swept through a four-block area near Cerritos Avenue and Euclid Street, ultimately destroying 393 apartment units, one house and one business. This incident resulted in both a state proclamation of emergency and a federal disaster declaration. It also led many Orange County cities to enact ordinances restricting the use of flammable shake roofs.

These scenarios highlight the need for fire mitigation activity in all sectors of the region, Wildland Urban Interface or not.

Fire Codes

Local Fire and Building Codes

The State Fire and Building Codes currently contain few regulations for protection of structures from wildland fires. An Appendix to the California Fire Code, which must be locally adopted in order to have enforcement authority, contains extracts from the Public Resource Code relative to minimum brush clearances (30 to 100 feet) and safety in interface areas. Many local jurisdictions develop local amendments that more specifically address risks within their communities. The Orange County Fire Authority, through its partner cities and the County, adopt fuel modification standards (170 feet minimum) and building construction requirements (Class A roofs, boxed eaves, protected vents, dual paned windows, etc.) applicable in identified fire hazard areas.

County Fire Codes

Most of key sections of county codes are local amendments to the State Fire Code, including brush clearance (fuel modification) and construction features (roofs, eaves, etc.) that apply to Wildland Urban Interface areas are covered in the State Fire Code.

State Fire Codes

California Fire Code 2001

(For fuel modification and enforcement of hazardous fuels within populated areas.)

Section 27, Appendix 2-A-1

Article 11, Section 1103.2.4

CALIFORNIA PUBLIC RESOURCES CODE

DIVISION 4. FORESTS, FORESTRY AND RANGE AND FORAGE LANDS
PART 1. DEFINITIONS AND GENERAL PROVISIONS
CHAPTER 1. DEFINITIONS 4001-4004
CHAPTER 2. GENERAL PROVISIONS
Article 1. Penalties 4021-4022
Article 2. Purchase of Land 4031
PART 2. PROTECTION OF FOREST, RANGE AND FORAGE LANDS
CHAPTER 1. PREVENTION AND CONTROL OF FOREST FIRES
Article 1. Definitions 4101-4104
Article 2. General Provisions 4111-4123
Article 3. Responsibility for Fire Protection 4125-4136
Article 3.5. State Responsibility Area Fire Protection Benefit Fees 4138-4140.7
Article 4. Cooperative Agreements 4141-4145
Article 5. Firewardens and Firefighting Personnel 4151-4157

Federal Programs

The role of the federal land management agencies in the Wildland Urban Interface is to: reduce fuel hazards on the lands they administer, cooperating in prevention and education programs; providing technical and financial assistance; and developing agreements, partnerships and relationships with property owners, local protection agencies, states and other stakeholders in Wildland Urban Interface areas. These relationships focus on activities before a fire occurs, which render structures and communities safer and better able to survive a fire occurrence.

Federal Emergency Management Agency (FEMA) Programs

FEMA is directly responsible for providing fire suppression assistance grants and, in certain cases, major disaster assistance and hazard mitigation grants in response to fires. The role of FEMA in the Wildland Urban Interface is to encourage comprehensive disaster preparedness plans and programs, increase the capability of state and local governments and provide for a greater understanding of FEMA programs at the federal, state and local levels.

Fire Management Assistance Grants

This type of grant may be provided to a state with an approved hazard mitigation plan for the suppression of a forest or grassland fire that threatens to become a major disaster on public or private lands. These grants are provided to protect life and improved property, encourage the development and implementation of viable multi-hazard mitigation measures, and provide training to clarify FEMA's programs. The grant may include funds for equipment, supplies and personnel. A Fire Suppression

Assistance Grant is the form of assistance most often provided by FEMA to a state for a fire. The grants are cost-shared with states. FEMA's US Fire Administration (USFA) provides public education materials addressing Wildland Urban Interface issues and the USFA's National Fire Academy provides training programs.

Hazard Mitigation Grant Program

Following a major disaster declaration, the FEMA Hazard Mitigation Grant Program provides funding for long-term hazard mitigation projects and activities to reduce the possibility of damages from all future fire hazards and to reduce the costs to the nation for responding to and recovering from the disaster.

National Wildland Urban Interface Fire Protection Program

Federal agencies can use the National Wildland Urban Interface Fire Protection Program to focus on Wildland Urban Interface fire protection issues and actions. The Western Governors' Association (WGA) can act as a catalyst to involve state agencies, as well as local and private stakeholders. The objective is to develop an implementation plan to achieve a uniform, integrated national approach to hazard and risk assessment using fire prevention and protection in the Wildland Urban Interface. The program helps states develop viable and comprehensive wildland fire mitigation plans and performance-based partnerships.

U.S. Forest Service

The U. S. Forest Service (USFS) is involved in a fuel-loading program implemented to assess fuels and reduce hazardous buildup on National Forest lands. The USFS is a cooperating agency and, while it has little to no jurisdiction in the lower valleys, it has an interest in preventing fires in the forested lands in the interface, due to the likelihood that a wildland fire can spread from either jurisdiction onto the adjoining jurisdiction.

Other Mitigation Programs and Activities

Some areas of the country are facing Wildland Urban Interface issues collaboratively. These are model programs that include local solutions. Summit County, Colorado, has developed a hazard and risk assessment process that mitigates hazards through zoning requirements. In California, the Los Angeles County Fire Department and Orange County Fire Authority have retrofitted more than 150 fire engines with fire retardant foam capability and Orange County is developing a rating schedule specific to the Wildland Urban Interface to determine areas and structures susceptible to wildland fire. All are examples of successful programs that demonstrate the value of pre-suppression and prevention efforts when combined with property owner support to mitigate hazards within the Wildland Urban Interface.

Prescribed Burning

The health and condition of a forest will determine the magnitude of wildland fire. If fuels--slash, dry or dead vegetation, fallen limbs and branches--are allowed to accumulate over long periods of time without being methodically cleared, fire can move more quickly and destroy everything in its path. Prescribed burning is the most efficient method to get rid of these fuels. In California during 2003,

various fire agencies conducted over 200 prescribed fires and burned over 33,000 acres to reduce the wildland fire hazard.

Firewise

Firewise is a program developed within the National Wildland/ Urban Interface Fire Protection Program and it is the primary federal program addressing interface fire. It is administered through the National Wildfire Coordinating Group whose extensive list of participants includes a wide range of federal agencies. The program is intended to empower planners and decision makers at the local level. Through conferences and information dissemination, Firewise increases support for interface wildland fire mitigation by educating professionals and the general public about hazard evaluation and policy implementation techniques. Firewise offers online wildland fire protection information and checklists, as well as listings of other publications, videos and conferences. The interactive home page allows users to ask fire protection experts questions and to register for new information as it becomes available.

Wildland Fire Mitigation Action Items

As stated in the Federal Wildland Fire Policy, located at www.fs.fed.us **"The problem is not one of finding new solutions to an old problem but of implementing known solutions;** deferred decision making is as much a problem as the fires themselves. If history is to serve us in the resolution of the Wildland Urban Interface problem, we must take action on these issues now. To do anything less is to guarantee another review process in the aftermath of future catastrophic fires."

3.3 Earthquake

Earthquakes are considered a major threat to the County due to the proximity of several fault zones, notably including the San Andreas Fault Zone and the Newport-Inglewood Fault Zone. A significant earthquake along one of the major faults could cause substantial casualties, extensive damage to buildings, roads and bridges, fires, and other threats to life and property. The effects could be aggravated by aftershocks and by secondary effects such as fire, landslide and dam failure. A major earthquake could be catastrophic in its effect on the population, and could exceed the response capability of the local communities and even the State.

Following major earthquakes, extensive search and rescue operations may be required to assist trapped or injured persons. Emergency medical care, food and temporary shelter would be required for injured or displaced persons. In the event of a truly catastrophic earthquake, identification and burial of the dead would pose difficult problems. Mass evacuation may be essential to save lives, particularly in areas below dams. Many families could be separated, particularly if the earthquake should occur during working hours, and a personal inquiry or locator system would be essential to maintain morale. Emergency operations could be seriously hampered by the loss of communications and damage to transportation routes within, to and out of the disaster area and by the disruption of public utilities and services.

Extensive federal assistance could be required and could continue for an extended period. Efforts would be required to remove debris and clear roadways; demolish unsafe structures; assist in reestablishing public services and utilities; and provide continuing care and welfare for the affected population including temporary housing for displaced persons.

In general, the population is less at risk during non-work hours (if at home) as wood-frame structures are relatively less vulnerable to major structural damage than are typical commercial and industrial buildings. Transportation problems are intensified if an earthquake occurs during work hours, as significant numbers of Orange County residents commute to work in Los Angeles County. Similarly, a somewhat smaller number of Los Angeles residents commute to work in Orange County. An earthquake occurring during work hours would clearly create major transportation problems for those displaced workers.

Hazardous materials could present a major problem in the event of an earthquake. Orange County, one of the largest industrial and manufacturing areas in the state, has several thousand firms that handle hazardous materials, and are estimated to produce more than 100 million gallons of hazardous waste per year. The County's highways and railways serve as hazardous materials transportation corridors, and Interstate 5 is the third busiest highway corridor in the country. The Orange County Fire Authority coordinates the Hazardous Materials Area Plan which serves as a guide for emergency response and operations for hazardous materials incidents.

Large faults as shown in Map 12 that could affect Orange County include the San Andreas Fault, the Newport-Inglewood Fault, the Whittier Fault, the Elsinore Fault, and the San Jacinto Fault. Smaller faults include the Norwalk Fault, and the El Modena and Peralta Hills Faults. In addition, newly studied thrust

faults, such as the San Joaquin Hills Fault and the Puente Hills Fault (not shown on map) could also have a significant impact on the County. Each of the major fault systems is described briefly below.

☐ **Map 12 - Earthquake Faults**

San Andreas Fault Zone: The dominant active fault in California, it is the main element of the boundary between the Pacific and North American tectonic plates. The longest and most publicized fault in California, it extends from Cape Mendocino in northern California to east of San Bernardino in southern California, and is approximately 35 miles northeast of Orange County. This fault was the source of the 1906 San Francisco earthquake, which resulted in some 700 deaths and millions of dollars in damage. It is the southern section of this fault that is currently of greatest concern to the scientific community. Geologists can demonstrate that at least eight major earthquakes (Richter magnitude 7.0 and larger) have occurred along the Southern San Andreas Fault in the past 1200 years with an average spacing in time of 140 years, plus or minus 30 years. The last such event on the Southern San Andreas occurred in 1857 (the Fort Tejon earthquake). Based on that evidence and other geophysical observations, the

Working Group on California Earthquake Probabilities (Southern California Earthquake Center (SCEC), 1995) has estimated the probability of a similar rupture (Magnitude 7.8) in the next 30 years (1994 through 2024) to be about 50%. The range of probable magnitudes on the San Andreas Fault Zone is reported to be 6.8 - 8.0.

Newport-Inglewood Fault Zone: Extends from the Santa Monica Mountains southeastward through the western part of Orange County to the offshore area near Newport Beach and was the source of the destructive 1933 Long Beach earthquake (magnitude 6.4), which caused 120 deaths and considerable property damage. During the past 60 years, numerous other shocks ranging from magnitude 3.0 to 5+ have been recorded. SCEC reports probable earthquake Magnitudes for the Newport-Inglewood fault to be in the range of 6.0 to 7.4.

Elsinore Fault Zone: Located in the northeast part of the county, this fault follows a general line east of the Santa Ana Mountains into Mexico. The main trace of the Elsinore Fault zone is about 112 miles long. The last major earthquake on this fault occurred in 1910 (M 6.0), and the interval between major ruptures is estimated to be about 250 years. SCEC reports probable earthquake magnitudes for the main trace of the Elsinore fault to be in the range of 6.5 to 7.5. At the northern end of the Elsinore Fault zone, the fault splits into two segments: the 25 mile long Whittier Fault (probable magnitudes between 6.0 and 7.2), and the 25 mile long Chino Fault (probable magnitudes between 6.0 and 7.0).

San Jacinto Fault Zone: Located approximately 30 miles north and east of the county. The interval between ruptures on this 130 mile long fault zone has been estimated by SCEC to be between 100 and 300 years, per segment. The most recent event (1968 M6.5) occurred on the southern half of the Coyote Creek segment. SCEC reports probable earthquake magnitudes for the San Jacinto fault zone to be in the range of 6.5 to 7.5.

San Joaquin Hills Fault: A recently discovered southwest-dipping blind thrust fault originating near the southern end of the Newport-Inglewood Fault close to Huntington Beach, at the western margins of the San Joaquin Hills. Rupture of the entire area of this blind thrust fault could generate an earthquake as large as M 7.3. In addition, a minimum average recurrence interval of between about 1650 and 3100 years has been estimated for moderate-sized earthquakes on this fault (Grant and others, 1999).

Puente Hills Thrust Fault: This is another recently discovered blind thrust fault that runs from northern Orange County to downtown Los Angeles. This fault is now known to be the source of the 1987 Whittier Narrows earthquake. Recent studies indicate that this fault has experienced four major earthquakes ranging in magnitude from 7.2 to 7.5 in the past 11,000 years, but that the recurrence interval for these large events is on the order of several thousand years.

In addition to the major faults described above, rupture of a number of smaller faults could potentially impact Orange County, including the Norwalk Fault (located in the north of the county in the Fullerton area), the El Modena Fault (located in the Orange area), and the Peralta Hills Fault in the Anaheim Hills area.

As indicated, there are a large variety of earthquake events that could affect Orange County. (The earliest recorded earthquake in California occurred in Orange County in 1769.) Predicted ground shaking patterns throughout Southern California for hypothetical scenario earthquakes are available

from the United States Geological Survey as part of their on-going "ShakeMap" program. These maps are provided in terms of Instrumental Intensity, which is essentially Modified Mercalli Intensity (see Figure 7 for the Modified Mercalli Intensity Scale) estimated from instrumental ground motion recordings.

Maps depicting strong ground shaking patterns for eight hypothetical scenario events potentially impacting Orange County are provided in Maps 13 through 20, as follows:

- M 7.8 repeat of the 1857 Fort Tejon Earthquake on the San Andreas Fault (Map 13)
- M 7.8 event on the Southern San Andreas Fault – "ShakeOut Scenario" (Map 14)
- M 6.9 earthquake on the Newport-Inglewood Fault (Map 15)
- M 6.8 earthquake on the Whittier Fault (Map 16)
- M 6.8 earthquake on the Elsinore Fault (Map 17)
- M 7.1 earthquake on the Palos Verdes Fault (Map 18)
- M 7.6 earthquake on the San Joaquin Hills Fault (Map 19)
- M 7.1 earthquake on the Puente Hills Fault (Map 20)

☐ **Figure 7 - Modified Mercalli Intensity (MMI) Scale (Richter, 1958)**

Value	Description
I	Not felt. Marginal and long period effects of large earthquakes.
II	Felt by persons at rest, on upper floors, or favorably placed.
III	Felt indoors. Hanging objects swing. Vibration like passing of light trucks. Duration estimated. May not be recognized as an earthquake.
IV	Hanging objects swing. Vibration like passing of heavy trucks; or sensation of a jolt like a heavy ball striking the walls. Standing motorcars rock. Windows, dishes, doors rattle. Glasses clink. Crockery clashes. In the upper range of IV, wooden walls and frame creak.
V	Felt outdoors; direction estimated. Sleepers wakened. Liquids disturbed, some spilled. Small unstable objects displaced or upset. Doors swing, close, open. Shutters, pictures move. Pendulum clocks stop, start, change rate.
VI	Felt by all. Many frightened and run outdoors. Persons walk unsteadily. Windows, dishes, glassware broken. Knickknacks, books, etc., off shelves. Pictures off walls. Furniture moved or overturned. Weak plaster and masonry D cracked. Small bells ring (church, school). Trees, bushes shaken (visibly, or heard to rustle)

VII	Difficult to stand. Noticed by drivers of motor cars. Hanging objects quiver. Furniture broken. Damage to masonry D, including cracks. Weak chimneys broken at roof line. Fall of plaster, loose bricks, stones, tiles, cornices (also unbraced parapets and architectural ornaments). Some cracks in masonry C. Waves on ponds; water turbid with mud. Small slides and caving in along sand or gravel banks. Large bells ring. Concrete irrigation ditches damaged.
VIII	Steering of motor cars affected. Damage to masonry C; partial collapse. Some damage to masonry B; none to masonry A. Fall of stucco and some masonry walls. Twisting, fall of chimneys, factory stacks, monuments, towers, elevated tanks. Frame houses moved on foundations if not bolted down; loose panel walls thrown out. Decayed piling broken off. Branches broken from trees. Changes in flow or temperature of springs and wells. Cracks in wet ground and on steep slopes.
Value	**Description**
IX	General panic. Masonry D destroyed; masonry C heavily damaged, sometimes with complete collapse; masonry B seriously damaged. (General damage to foundations.) Frame structures, if not bolted, shifted off foundations. Frames racked. Serious damage to reservoirs. Underground pipes broken. Conspicuous cracks in ground. In alluvial areas sand and mud ejected, earthquake fountains, sand craters.
X	Most masonry and frame structures destroyed with their foundations. Some well-built wooden structures and bridges destroyed. Serious damage to dams, dikes, embankments. Large landslides. Water thrown on banks of canals, rivers, lakes, etc. Sand and mud shifted horizontally on beaches and flat land. Rails bent slightly.
XI	Rails bent greatly. Underground pipelines completely out of service.
XII	Damage nearly total. Large rock masses displaced. Lines of sight and level distorted. Objects thrown into the air.

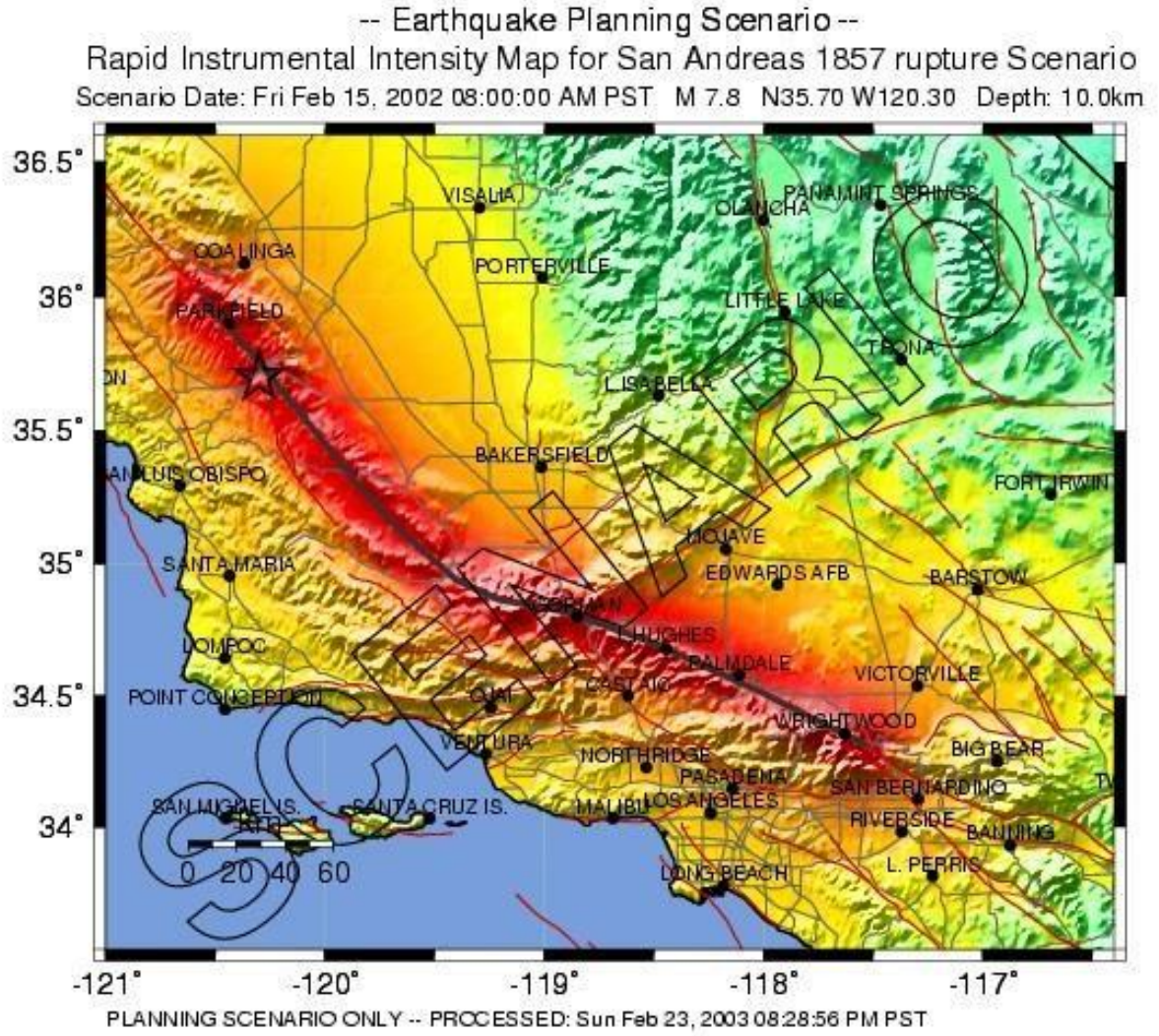
Masonry A: Good workmanship, mortar, and design; reinforced, especially laterally, and bound together by using steel, concrete, etc.; designed to resist lateral forces.

Masonry B: Good workmanship and mortar; reinforced, but not designed in detail to resist lateral forces.

Masonry C: Ordinary workmanship and mortar; no extreme weaknesses like failing to tie in at corners, but neither reinforced nor designed against horizontal forces.

Masonry D: Weak materials, such as adobe; poor mortar; low standards of workmanship; weak horizontally.

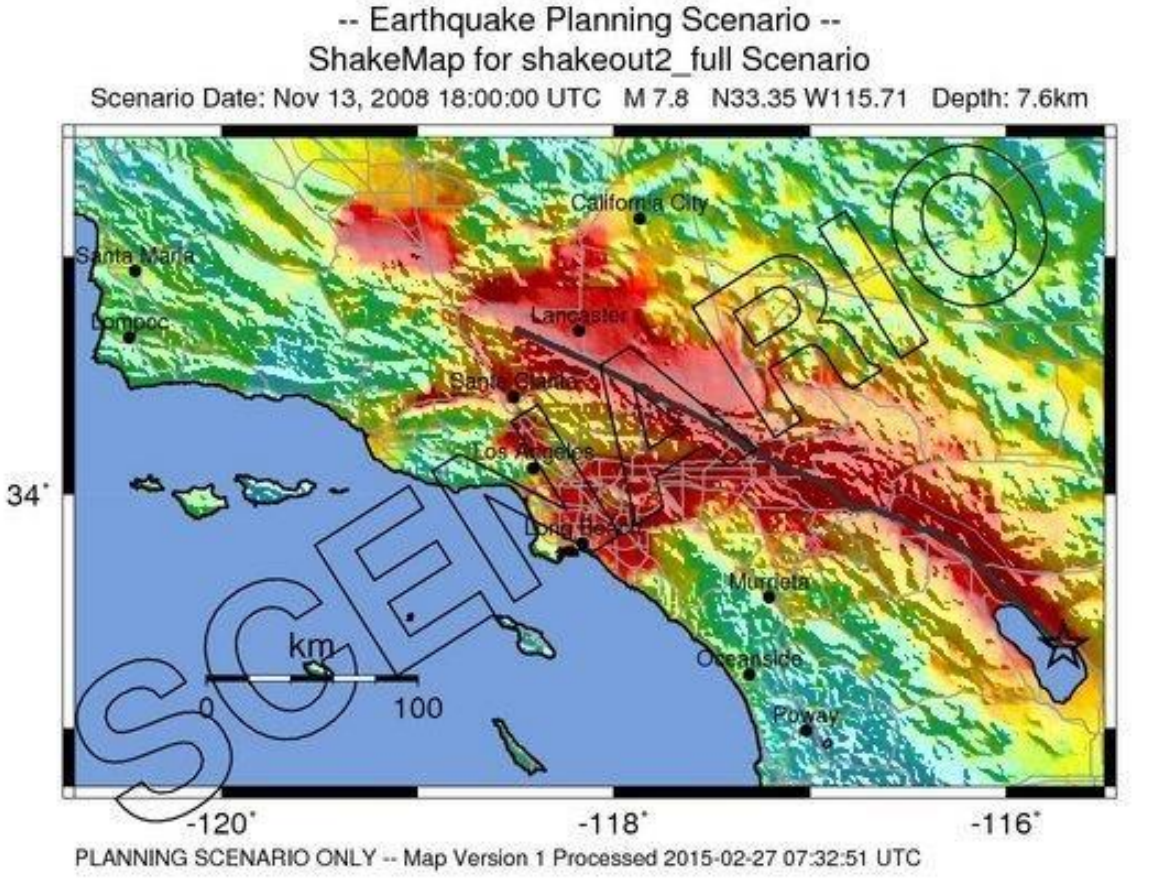
Map - 13 Scenario ShakeMap for a M 7.8 Earthquake on the San Andreas Fault: Repeat of 1857 Fort Tejon Earthquake (USGS)



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

14 Scenario ShakeMap for a M 7.8 Earthquake on the Southern San Andreas Fault – "ShakeOut" Scenario (USGS, 2008)

Map -

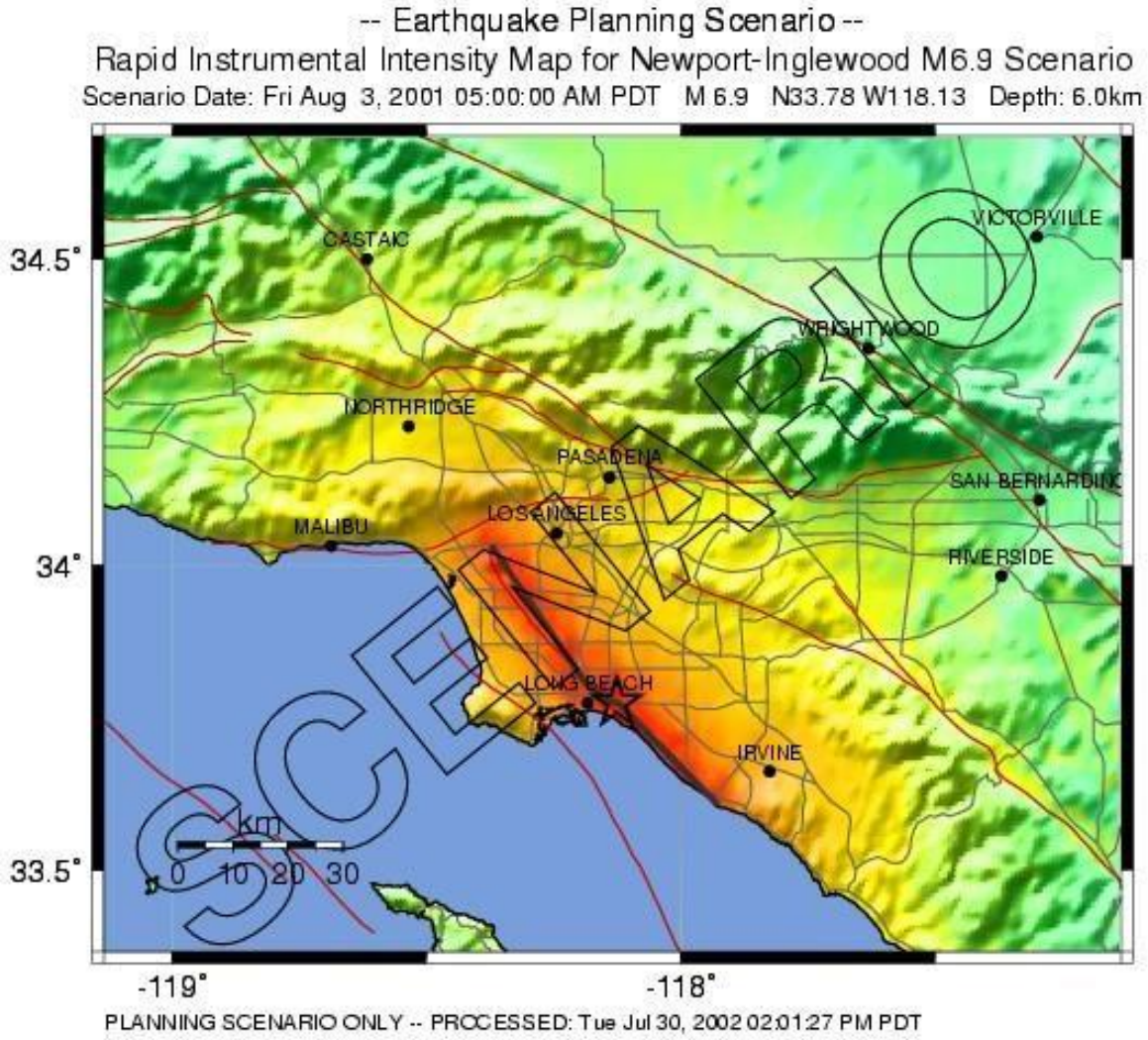


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Scale based upon Worden et al. (2012)

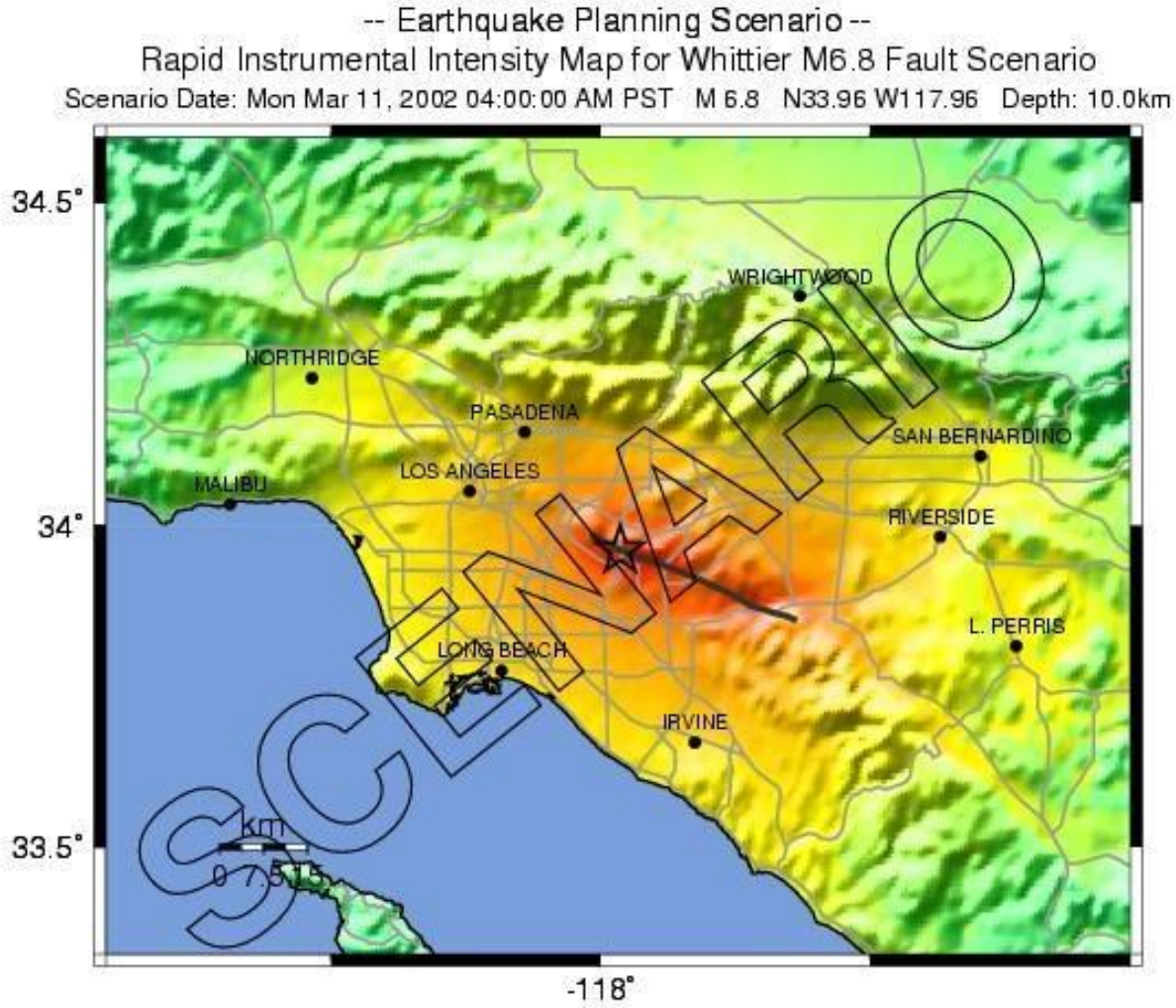
☐ **15 Scenario for a M 6.9 Earthquake on the Newport-Inglewood Fault (USGS, 2001)**

Map -



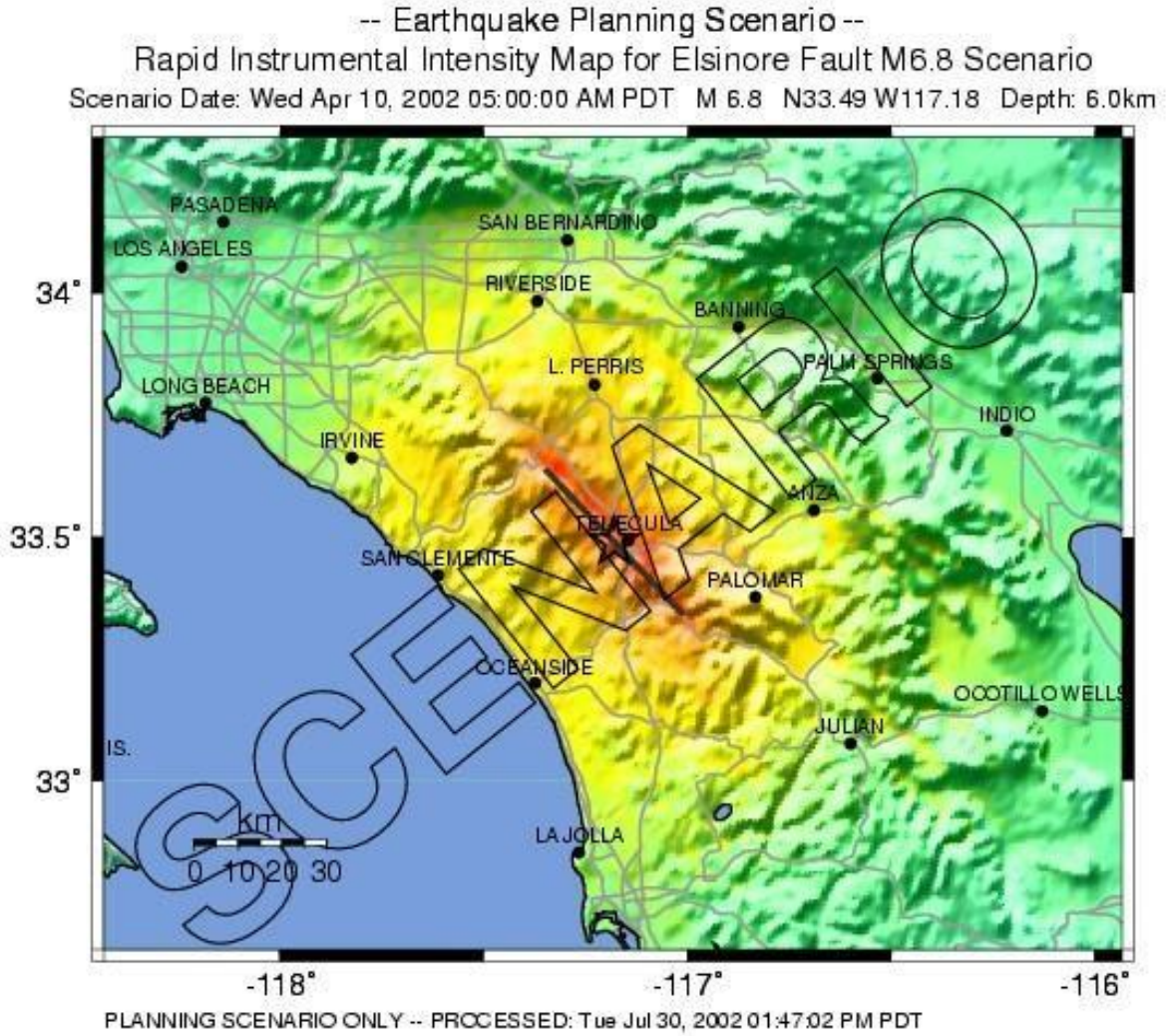
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

☐ **Map - 16 Scenario ShakeMap for a M 6.8 Earthquake on the Whittier Fault (USGS, 2002)**



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

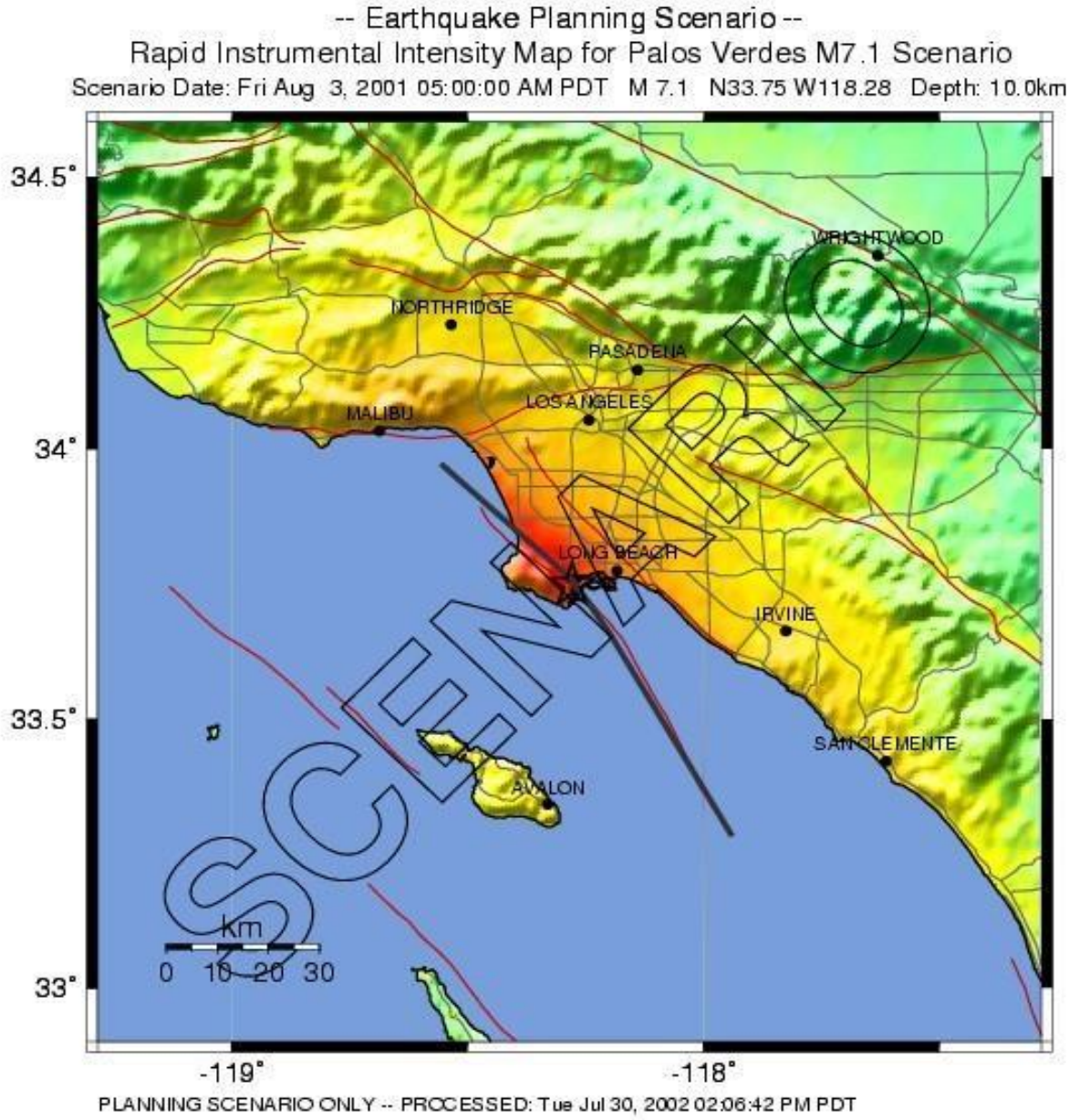
☐ **Map - 17 Scenario ShakeMap for a M 6.8 Earthquake on the Elsinore Fault (USGS, 2002)**



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	*8.1-16*	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

18- Scenario ShakeMap for a M 7.1 Earthquake on the Palos Verdes Fault (USGS, 2001)

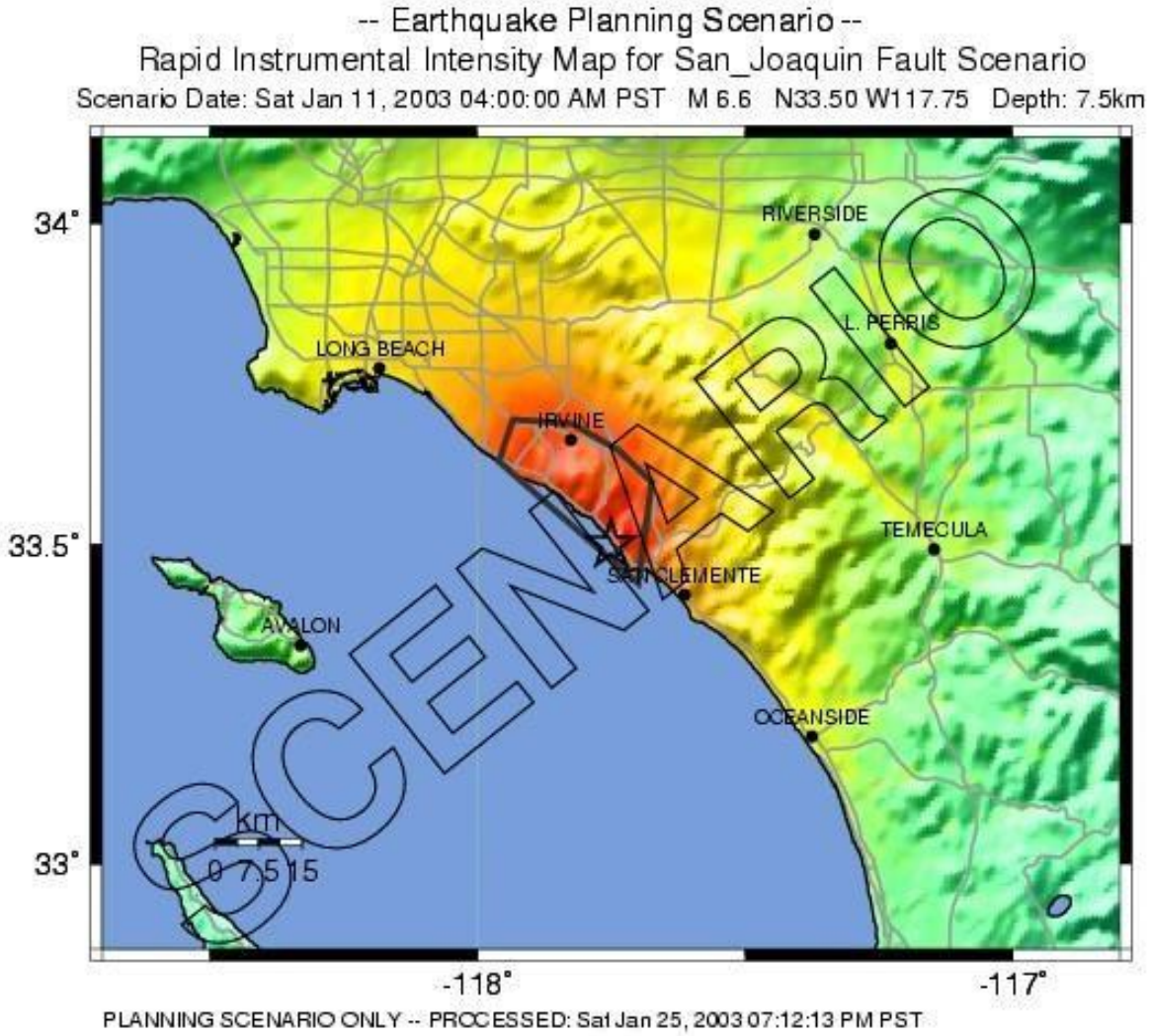
☐ **Map**



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

☐ **Map**

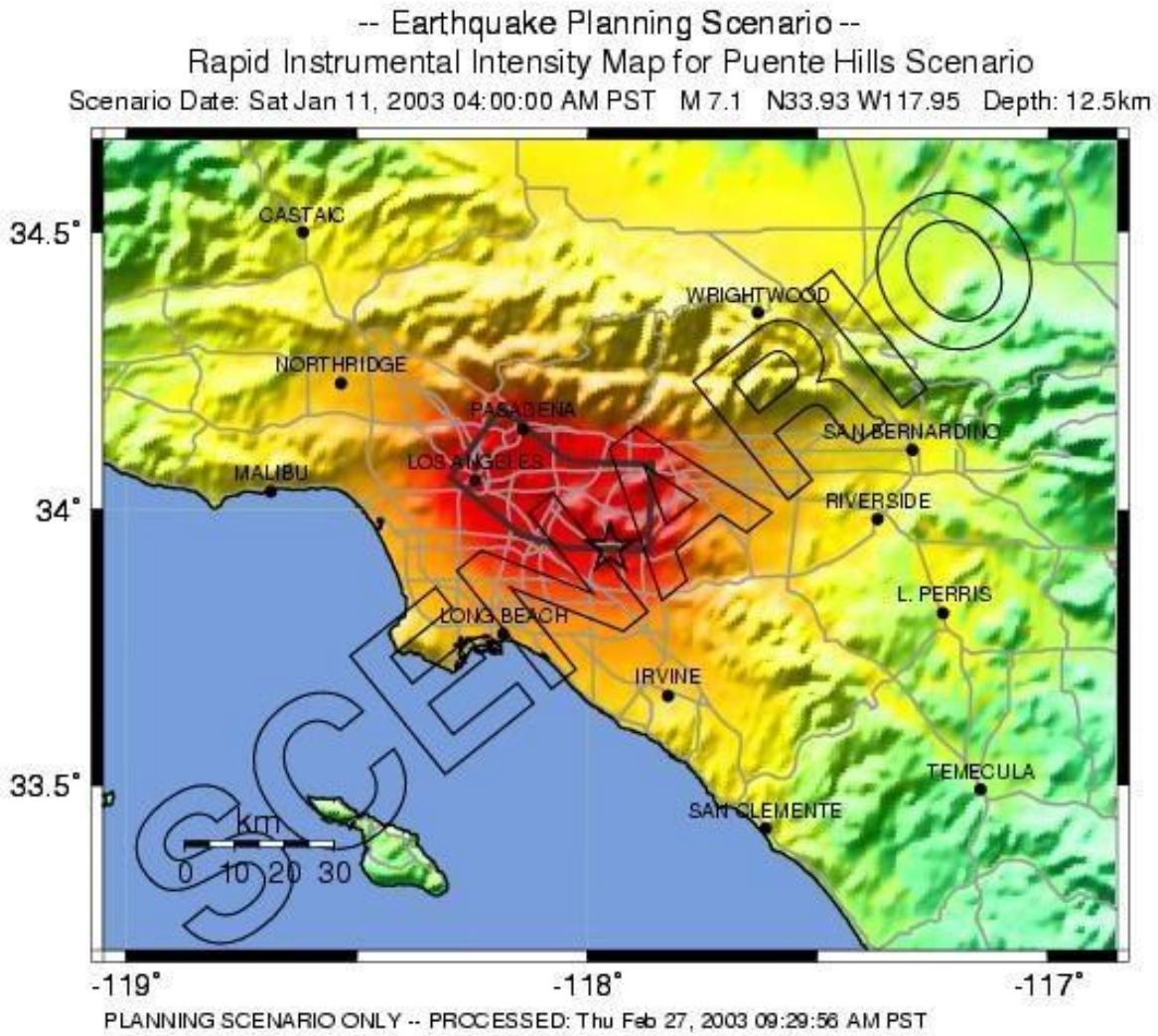
19- - Scenario ShakeMap for a M 6.6 Earthquake on the San Joaquin Hills Fault (USGS)



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

☐ **20 - Scenario ShakeMap for a M 7.1 Earthquake on the Puente Hills Fault (USGS, 2003)**

Map



PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	*<.17*	*.17-1.4*	*1.4-3.9*	*3.9-9.2*	*9.2-18*	18-34	34-65	65-124	>124
PEAK VEL.(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	*16-31*	*31-60*	*60-116*	*>116*
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

Earthquake as a Threat to Orange County

The most recent damaging earthquake event affecting Southern California was the 1994 Northridge Earthquake. At 4:31 A.M. on Monday, January 17, a moderate, but very damaging earthquake with a magnitude of 6.7 struck the San Fernando Valley. In the following days and weeks, thousands of aftershocks occurred, causing additional damage to affected structures.

Fifty-seven people were killed and more than 1,500 people seriously injured. For days afterward, thousands of homes and businesses were without electricity, tens of thousands had no gas, and nearly 50,000 had little or no water. Approximately 15,000 structures were moderately to severely damaged, which left thousands of people temporarily homeless. Of the 66,500 buildings were inspected, nearly 4,000 were severely damaged and over 11,000 were moderately damaged. Several collapsed bridges and overpasses created commuter havoc on the freeway system. Extensive damage was caused by ground shaking, but earthquake triggered liquefaction and dozens of fires also caused additional severe damage. This extremely strong ground motion felt in large portions of Los Angeles County resulted in record economic losses.

Historical and geological records show that California has a long history of seismic events. Southern California is probably best known for the San Andreas Fault, a fault running from the Mexican border to a point offshore, west of San Francisco. Geologic studies show that over the past 1,400 to 1,500 years large earthquakes have occurred at about 130 year intervals on the Southern San Andreas Fault. As the last large earthquake on the Southern San Andreas occurred in 1857, that section of the fault is considered a likely location for an earthquake within the next few decades according to www.data.scec.org/.

Yet, the San Andreas is only one of dozens of known earthquake faults that crisscross Southern California. Some of the better known faults include the Newport-Inglewood, Whittier, Chatsworth, Elsinore, Hollywood, Los Alamitos, and Palos Verdes faults. Beyond the known faults, there are a potentially large number of “blind” faults that underlie the surface of Southern California. One such blind fault was involved in the Whittier Narrows earthquake in October 1987.

Although the most famous of the faults, the San Andreas, is capable of producing an earthquake with a magnitude of 8+ on the Richter scale, some of the “lesser” faults have the potential to inflict greater damage on the urban core of the Los Angeles Basin which includes Orange County. Seismologists believe that a 6.0 earthquake on the Newport-Inglewood would result in far more death and destruction than a “great” quake on the San Andreas, because the San Andreas is relatively remote from the urban centers of Southern California.

For decades, partnerships have flourished between the USGS, Cal Tech, the California Geological Survey and universities to share research and educational efforts with Californians. Tremendous earthquake mapping and mitigation efforts have been made in California in the past two decades, and public awareness has risen remarkably during this time. Major federal, state, and local government agencies and private organizations support earthquake risk reduction. These partners have made significant contributions in reducing the adverse impacts of earthquakes. Despite the progress, the majority of

California communities remain unprepared because there is a general lack of understanding regarding earthquake hazards among Californians.

To better understand the earthquake hazard, the scientific community has looked at historical records and accelerated research on those faults that are the sources of the earthquakes occurring in the Southern California region. Historical earthquake records can generally be divided into records of the preinstrumental period and the instrumental period. In the absence of instrumentation, the detection of earthquakes is based on observations and felt reports, and is dependent upon population density and distribution. Since California was sparsely populated in the 1800s, the detection of pre-instrumental earthquakes is relatively difficult. However, two very large earthquakes, the Fort Tejon in 1857 (7.9) and the Owens Valley in 1872 (7.6) are evidence of the tremendously damaging potential of earthquakes in Southern California. In more recent times two 7.3 earthquakes struck Southern California, in Kern County (1952) and Landers (1992). The damage from these four large earthquakes was limited because they occurred in areas which were sparsely populated at the time they happened. The seismic risk is much more severe today than in the past because the population at risk is in the millions, rather than a few hundred or a few thousand persons.

History of Earthquake Events in Southern California

Since seismologists started recording and measuring earthquakes, there have been tens of thousands of recorded earthquakes in Southern California, most with a magnitude below three. No community in Southern California is beyond the reach of a damaging earthquake. Figure 8 describes the historical earthquake events that have affected Southern California.

☐ **Figure 8 - Earthquake Events in the Southern California Region**

Southern California Region Earthquakes with a Magnitude 5.0 or Greater	
1769 Los Angeles Basin	1918 San Jacinto
1800 San Diego Region	1923 San Bernardino Region
1812 Wrightwood	1925 Santa Barbara
1812 Santa Barbara Channel	1933 Long Beach
1827 Los Angeles Region	1941 Carpenteria
1855 Los Angeles Region	1952 Kern County
1857 Great Fort Tejon Earthquake	1954 W. of Wheeler Ridge
1858 San Bernardino Region	1971 San Fernando

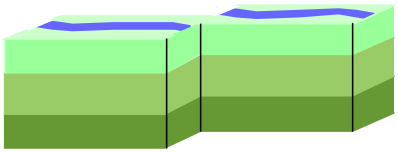
1862 San Diego Region	1973 Point Mugu
1892 San Jacinto or Elsinore Fault	1986 North Palm Springs
1893 Pico Canyon	1987 Whittier Narrows
1894 Lytle Creek Region	1992 Landers
1894 E. of San Diego	1992 Big Bear
1899 Lytle Creek Region	1994 Northridge
1899 San Jacinto and Hemet	1999 Hector Mine
1907 San Bernardino Region	2004 San Luis Obispo
1910 Glen Ivy Hot Springs	2008 Chino Hills
1916 Tejon Pass Region	2010 Baja California
	2014 La Habra

Source: US Geological Survey

Causes and Characteristics of Earthquakes in Southern California

Earthquake Faults

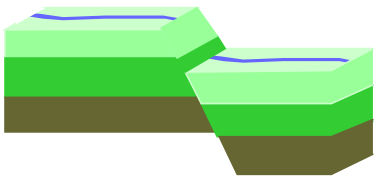
A fault is a fracture along between blocks of the earth's crust where either side moves relative to the other along a parallel plane to the fracture.



Strike Slip Fault

Strike-slip

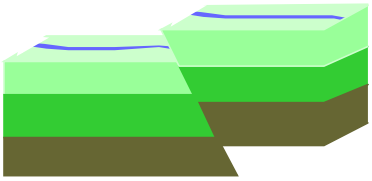
Strike-slip faults are vertical or almost vertical rifts where the earth's plates move mostly horizontally. From the observer's perspective, if the opposite block looking across the fault moves to the right, the slip style is called a right lateral fault; if the block moves left, the shift is called a left lateral fault.



Normal Fault

Dip-slip

Dip-slip faults are slanted fractures where the blocks mostly shift vertically. If the earth above an inclined fault moves down, the fault is called a normal fault, but when the rock above the fault moves up, the fault is called a reverse fault. Thrust faults have a reverse fault with a dip of 45 degrees or less.



Thrust Fault

Earthquake Related Hazards

Ground shaking, landslides, liquefaction, and amplification are the specific hazards associated with earthquakes. The severity of these hazards depends on several factors, including soil and slope conditions, proximity to the fault, earthquake magnitude, and the type of earthquake.

Ground Shaking

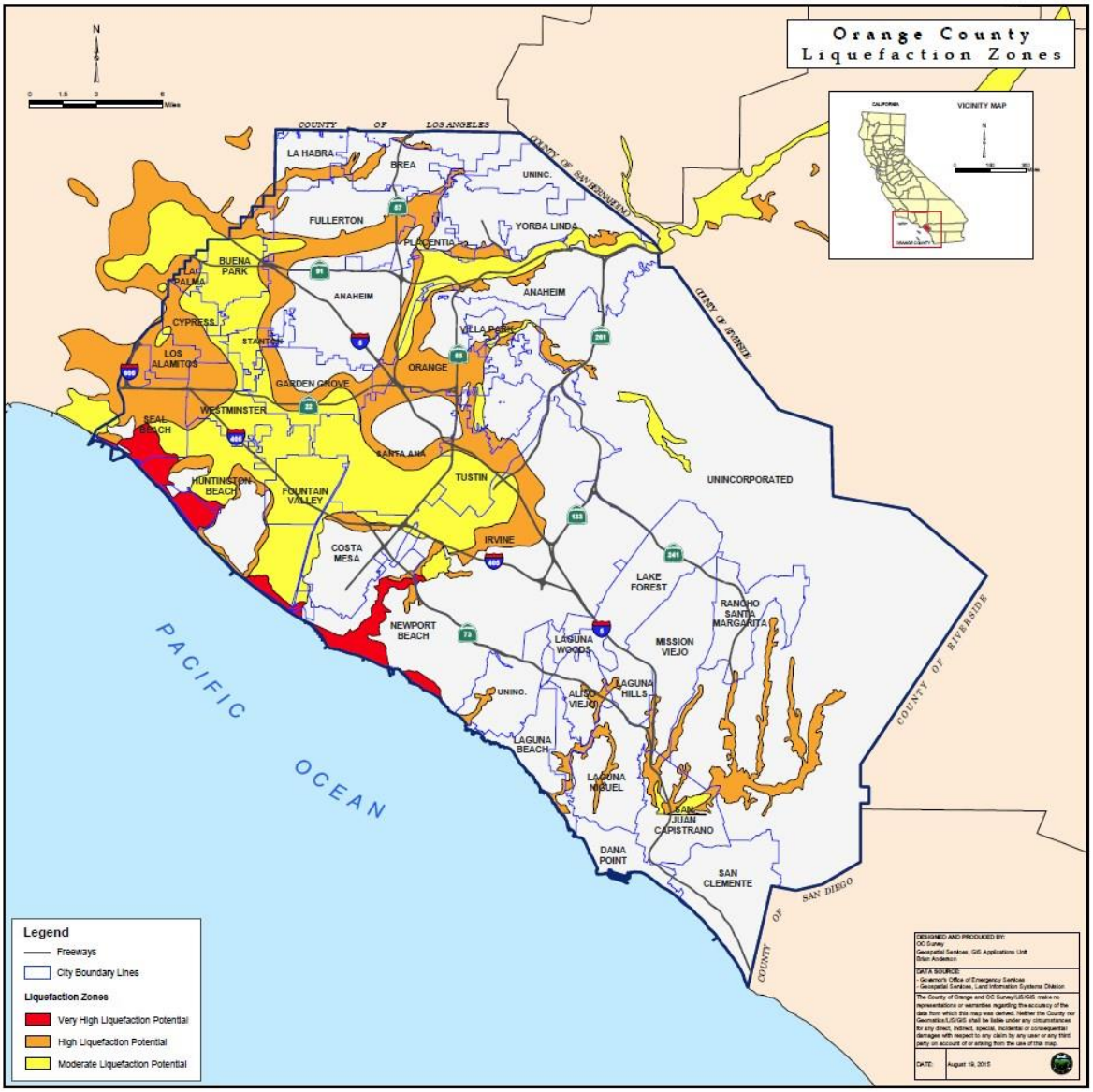
Ground shaking is the motion felt on the earth's surface caused by seismic waves generated by the earthquake. It is the primary cause of earthquake damage. The strength of ground shaking depends on the magnitude of the earthquake, the type of fault, and distance from the epicenter (where the earthquake originates). Buildings on poorly consolidated and thick soils will typically see more damage than buildings on consolidated soils and bedrock.

Earthquake Induced Landslides

Earthquake induced landslides are secondary earthquake hazards that occur from ground shaking. They can destroy the roads, buildings, utilities, and other critical facilities necessary to respond and recover from an earthquake. Many communities in Southern California have a high likelihood of encountering such risks, especially in areas with steep slopes.

Liquefaction

Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures. Many communities in Southern California are built on ancient river bottoms and have sandy soil. In some cases this ground may be subject to liquefaction, depending on the depth of the water table. Map 22 shows the areas of Orange County that may are susceptible to liquefaction. See also the California Geological Survey website at http://gmw.consrv.ca.gov/shmp/html/pdf_maps_so.html.



☐ **Map 21 - Liquefaction Map, Orange County**

Amplification

Soils and soft sedimentary rocks near the earth's surface can modify ground shaking caused by earthquakes. One of these modifications is amplification. Amplification increases the magnitude of the seismic waves generated by the earthquake. The amount of amplification is influenced by the thickness of geologic materials and their physical properties. Buildings and structures built on soft and unconsolidated soils can face greater risk. Amplification can also occur in areas with deep sediment filled basins and on ridge tops.

Earthquake Hazard Assessment

In California, many agencies are focused on seismic safety issues: the State's Seismic Safety Commission, the Applied Technology Council, California Office of Emergency Services, United States Geological Survey, Cal Tech, the California Geological Survey, as well as a number of universities and private foundations.

These organizations, in partnership with other state and federal agencies, have undertaken a rigorous program in California to identify seismic hazards and risks including active fault identification, bedrock shaking, tsunami inundation zones, ground motion amplification, liquefaction, and earthquake induced landslides. Seismic hazard maps have been published and are available for many communities in California through the State Division of Mines and Geology. Map 22 illustrates the known seismic zones in Southern California.

In California, each earthquake is followed by revisions and improvements in the Building Codes.

The 1933 Long Beach resulted in the Field Act, affecting school construction. The 1971 Sylmar earthquake brought another set of increased structural standards. Similar re-evaluations occurred after the 1989 Loma Prieta and 1994 Northridge earthquakes. These code changes have resulted in stronger and more earthquake resistant structures.

The Alquist-Priolo Earthquake Fault Zoning Act was passed in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. This state law was a direct result of the 1971 San Fernando Earthquake, which was associated with extensive surface fault ruptures that damaged numerous homes, commercial buildings, and other structures. Surface rupture is the most easily avoided seismic hazard.

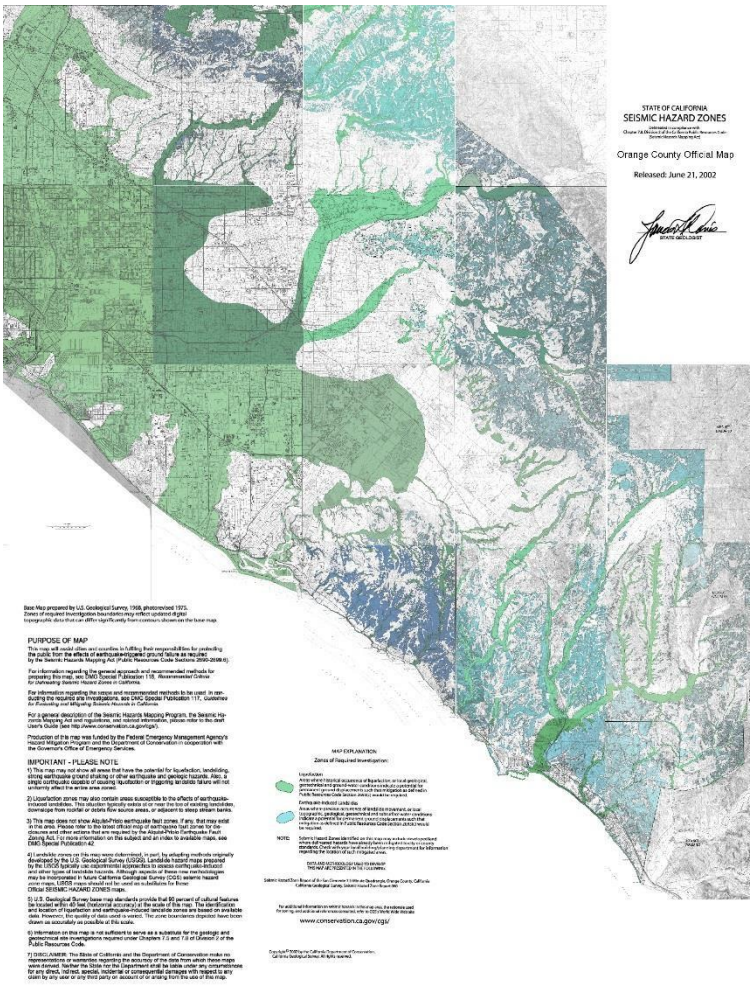
The Seismic Hazards Mapping Act, passed in 1990, addresses non-surface fault rupture earthquake hazards, including liquefaction and seismically induced landslides. The State Department of Conservation operates the Seismic Mapping Program for California. Extensive information is available at their website: http://gmw.consrv.ca.gov/shmp/index.htm.

Vulnerability Assessment

The effects of earthquakes span a large area, and large earthquakes occurring in many parts of the Southern California region would probably be felt throughout Orange County. However, the degree to which the earthquakes are felt, and the damages associated with them may vary. At risk from earthquake damage are large stocks of old buildings and bridges; many high tech and hazardous materials facilities; extensive sewer, water, and natural gas pipelines; earth dams; petroleum pipelines; and other critical facilities and private property located in the county. The relative or secondary earthquake hazards, which are liquefaction, ground shaking, amplification, and earthquake-induced landslides can be just as devastating as the earthquake.

The California Geological Survey has identified areas most vulnerable to liquefaction. Liquefaction occurs when ground shaking causes wet granular soils to change from a solid state to a liquid state. This results in the loss of soil strength and the soil's ability to support weight. Buildings and their occupants are at risk when the ground can no longer support these buildings and structures.

Orange County has many active landslide areas, and a large earthquake could trigger accelerated movement in these slide areas, in addition to jarring loose other unknown areas of landslide risk.



☐ **Map 22 – OC Seismic Hazard Map (Liquefaction in Green, Landslides in Aqua)**

Community Earthquake Issues **Susceptibility**

to Earthquakes

Earthquake damage occurs because humans have built structures that cannot withstand severe shaking. Buildings, airports, schools, and lifelines (highways and utility lines) suffer damage in earthquakes and can cause death or injury to humans. The welfare of homes, major businesses, and public infrastructure is very important. Addressing the reliability of buildings, critical facilities, and infrastructure, and understanding the potential costs to government, businesses, and individuals as a result of an earthquake, are challenges faced by the County.

Dams

There are a total of 44 dams in Orange County. The ownership ranges from the federal government to Homeowner Associations. These dams hold billions of gallons of water in reservoirs. The major reservoirs are designed to protect Southern California from flood waters and to store domestic water. Seismic activity can compromise the dam structures resulting in catastrophic flooding.

Buildings

The built environment is susceptible to damage from earthquakes. Buildings that collapse can trap and bury people. Lives are at risk and the cost to clean up the damage is great. In most California communities, including Orange County, many buildings were built before 1993 when building codes were not as strict. In addition, retrofitting is not required except under certain conditions and can be expensive. Therefore, the number of buildings at risk remains high. The California Seismic Safety Commission makes annual reports on the progress of the retrofitting of unreinforced masonry buildings.

Infrastructure and Communication

Residents in Orange County commute frequently by automobiles and public transportation such as buses and light rail. An earthquake can greatly damage bridges and roads, hampering emergency response efforts and the normal movement of people and goods. Damaged infrastructure strongly affects the economy of the community because it disconnects people from work, school, food, and leisure, and separates businesses from their customers and suppliers.

Lifelines are the connections between communities and outside services. They include water and gas lines, transportation systems, electricity and communication networks. Ground shaking and amplification can cause pipes to break open, power lines to fall, roads and railways to crack or move, and radio and telephone communication to cease. Disruption to transportation makes it especially difficult to bring in supplies or services. Lifelines need to be usable after earthquakes to allow for rescue, recovery, and rebuilding efforts and to relay important information to the public.

Bridge Damage

Even modern bridges can sustain damage during earthquakes, leaving them unsafe for use. Some bridges have failed completely due to strong ground motion. Bridges are a vital transportation link as even minor damages can make some areas inaccessible. Because bridges vary in size, materials, location and design, any given earthquake will affect them differently. Bridges built before the mid-1970's have a significantly higher risk of suffering structural damage during a moderate to large earthquake compared with those built after 1980 when design improvements were made.

Much of the interstate highway system was built in the mid to late 1960's. The bridges in Orange County are state, county or privately owned (including railroad bridges). Cal Trans has retrofitted most bridges on the freeway systems; however, there are still some county maintained bridges that are not retrofitted. The Federal Highway Administration requires that bridges on the National Bridge Inventory

be inspected every 2 years. CalTrans checks when the bridges are inspected because they administer the Federal funds for bridge projects.

Disruption of Critical Services

Critical facilities include police stations, fire stations, hospitals, shelters, and other facilities that provide important services to the community. These facilities and their services need to be functional after an earthquake event. **Businesses**

Seismic activity can cause great loss to businesses, both large-scale corporations and small retail shops. When a company is forced to stop production for just a day, the economic loss can be tremendous, especially when its market is at a national or global level. Seismic activity can create economic loss that presents a burden to large and small shop owners who may have difficulty recovering from their losses.

Forty percent of businesses do not reopen after a disaster and another twenty-five percent fail within one year according to the Federal Emergency Management Agency (FEMA). Similar statistics from the United States Small Business Administration indicate that over ninety percent of businesses fail within two years after being struck by a disaster.

The Institute of Business and Home Safety has developed “Open for Business,” which is a disaster planning toolkit to help guide businesses in preparing for and dealing with the adverse effects of natural hazards. The kit integrates protection from natural disasters into the company's risk reduction measures to safeguard employees, customers, and the investment itself. The guide helps businesses secure human and physical resources during disasters and helps to develop strategies to maintain business continuity before, during, and after a disaster occurs.

Individual Preparedness

Because the potential for earthquake occurrence and earthquake related property damage is relatively high in Orange County, increasing individual preparedness is a significant need. Strapping down heavy furniture, water heaters, and expensive personal property, as well as being earthquake insured, and anchoring buildings to foundations are just a few steps individuals can take to mitigate earthquake hazards.

Death and Injury

Death and injury can occur both inside and outside of buildings due to collapsed buildings and falling equipment, furniture, debris, and structural materials. Downed power lines and broken water and gas lines can also endanger human life.

Fire

Downed power lines or broken gas mains can trigger fires. When fire stations suffer building or lifeline damage, quick response to extinguish fires is less likely. Furthermore, major incidents will demand a larger share of resources, and initially smaller fires and problems will receive little or insufficient

resources in the initial hours after a major earthquake event. Loss of electricity may cause a loss of water pressure in some communities, further hampering firefighting ability.

Debris

After damage to a variety of structures, a considerable amount of time is spent cleaning up brick, glass, wood, steel or concrete building elements, office and home contents, and other materials. Developing a strong debris management strategy is essential in post-disaster recovery. Occurrence of a disaster does not exempt Orange County from compliance with AB 939 regulations which require recycling debris. In addition, Orange County is developing a Debris Management Plan.

Existing Mitigation Activities

Existing mitigation activities include current mitigation programs and activities that are being implemented by county, regional, state, or federal agencies or organizations.

Orange County Codes

Implementation of earthquake mitigation policies most often takes place at the local government level. OC Public Works enforces zoning ordinances, land use regulations and building codes related to earthquake hazards.

Generally, these codes seek to discourage development in areas that could be prone to flooding, landslide, wildfire and/or seismic hazards. Where development is permitted, the applicable construction standards are met. Developers in hazard-prone areas may be required to retain a qualified professional engineer to evaluate level of risk on the site and recommend appropriate mitigation measures.

Hospitals

The Alfred E. Alquist Hospital Seismic Safety Act (Hospital Act) was enacted in 1973 in response to the moderate magnitude 6.6 Sylmar Earthquake in 1971 when four major hospital campuses were severely damaged and evacuated. Two hospital buildings collapsed killing forty seven people. Three others were killed in another hospital that nearly collapsed.

In approving the Act, the Legislature noted that: “Hospitals that house patients who have less than the capacity of normally healthy persons to protect themselves, and that must be reasonably capable of providing services to the public after a disaster, shall be designed and constructed to resist, insofar as practical, the forces generated by earthquakes, gravity and winds.” (Health and Safety Code Section 129680)

When the Hospital Act was passed in 1973, the State anticipated that, based on the regular and timely replacement of aging hospital facilities, the majority of hospital buildings would be in compliance with the Act’s standards within 25 years. However, hospital buildings are not being replaced at that anticipated rate. In fact, the great majority of the State’s urgent care facilities are now more than 40 years old.

The moderate magnitude 6.7 Northridge Earthquake in 1994 caused $3 billion in hospital-related damage and evacuations. Twelve hospital buildings constructed before the Act were cited (red tagged) as unsafe for occupancy after the earthquake. Those hospitals built in accordance with the 1973 Hospital Act were very successful in resisting structural damage. However, nonstructural damage (for example, plumbing and ceiling systems) was still extensive in those post-1973 buildings.

Senate Bill 1953 (SB 1953), enacted in 1994 after the Northridge Earthquake, expanded the scope of the 1973 Hospital Act. Under SB 1953, all hospitals are required, as of January 1, 2008, to survive earthquakes without collapsing or posing the threat of significant loss of life. The 1994 Act further mandates that all existing hospitals be seismically evaluated and retrofitted, if needed, by 2030. SB 1953 applies to all urgent care facilities (including those built prior to the 1973 Hospital Act) and affects approximately 2,500 buildings on 475 campuses.

SB 1953 directed the Office of Statewide Health Planning and Development (OSHPD), in consultation with the Hospital Building Safety Board, to develop emergency regulations including "…earthquake performance categories with sub gradations for risk to life, structural soundness, building contents, and nonstructural systems that are critical to providing basic services to hospital inpatients and the public after a disaster." (Health and Safety Code Section 130005 - The Seismic Safety Commission Evaluation of the State's Hospital Seismic Safety Policies).

In 2001, recognizing the continuing need to assess the adequacy of policies, and the application of advances in technical knowledge and understanding, the California Seismic Safety Commission created an ad hoc committee to re-examine the compliance with the Alquist Hospital Seismic Safety Act. The formation of the Committee was also prompted by the recent evaluations of hospital buildings reported to the Office of Statewide Health Planning and Development revealing a large percentage (40%) of California's operating hospitals are in the highest category of collapse risk.

Orange County is currently home to 38 hospitals, but none are located in the unincorporated areas. All hospitals sit within one of the two highest seismic risk zones, according to USGS. There are no Countyowned hospitals.

California Earthquake Mitigation Legislation

California officials are painfully aware of the threats the state faces from earthquakes. Dating back to the th century, Californians have been killed, injured, and lost property as a result of earthquakes. As the

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state's population continues to grow, and urban areas become even more densely built up, the risk will continue to increase. For decades, the Legislature has passed laws to strengthen the built environment and protect the residents. Figure 9 provides a sample of State Codes related to earthquakes.

☐ **Figure 9- Partial List of the Over 200 California Laws on Earthquake Safety**

Government Code Section 8870-8870.95	Creates Seismic Safety Commission.

Government Code Section 8876.1-8876.10	Established the California Center for Earthquake Engineering Research.
Public Resources Code Section 2800-2804.6	Authorized a prototype earthquake prediction system along the central San Andreas fault near the City of Parkfield.
Public Resources Code Section 2810-2815	Continued the Southern California Earthquake Preparedness Project and the Bay Area Regional Earthquake Preparedness Project.
Health and Safety Code Section 16100-16110	The Seismic Safety Commission and State Architect will develop a state policy on acceptable levels of earthquake risk for new and existing state-owned buildings.
Government Code Section 8871-8871.5	Established the California Earthquake Hazards Reduction Act of 1986.
Health and Safety Code Section 130000-130025	Defined earthquake performance standards for hospitals.
Public Resources Code Section 2805-2808	Established the California Earthquake Education Project.
Government Code Section 8899.10-8899.16	Established the Earthquake Research Evaluation Conference.
Public Resources Code Section 2621-2630 2621.	Established the Alquist-Priolo Earthquake Fault Zoning Act.
Government Code Section 8878.50-8878.52 8878.50.	Created the Earthquake Safety and Public Buildings Rehabilitation Bond Act of 1990.
Education Code Section 3529535297 35295.	Established emergency procedure systems in kindergarten through grade 12 in all the public or private schools.
Health and Safety Code Section 19160-19169	Established standards for seismic retrofitting of unreinforced masonry buildings.
Health and Safety Code Section 1596.80-1596.879	Required all child day care facilities to include an Earthquake Preparedness Checklist as an attachment to their disaster plan.
Source: http://www.leginfo.ca.gov/calaw.html	

Earthquake Education Earthquake research and education activities are conducted at several major universities in the Southern California region, including the California Institute of Technology, the University of Southern California, the University of California – Los Angeles, the University of California – Santa Barbara, the University of California – Irvine, and the University of California – San Diego. The local clearinghouse for earthquake information is the Southern California Earthquake Center located at the University of Southern California. The Southern California Earthquake Center (SCEC) is a community of scientists and specialists who actively coordinate research on earthquake hazards at nine core institutions, and communicate earthquake information to the public. SCEC is a National Science Foundation Science and Technology Center and is cofunded by the United States Geological Survey (USGS).

Risk Analysis

Risk analysis is the third phase of a hazard assessment. Risk analysis involves estimating the damage and costs likely to be experienced in a geographic area over a period of time. Factors in assessing earthquake risk include population and property distribution in the hazard area, the frequency of earthquake events, landslide susceptibility, buildings, infrastructure, and disaster preparedness of the region. This type of analysis can generate estimates of the damages to the region due to an earthquake event in a specific location. FEMA's software program, HAZUS, uses mathematical formulas and information about building stock, local geology and the location and size of potential earthquakes, economic data, and other information to estimate losses from a potential earthquake. The HAZUS software is available from FEMA at no cost.

For greater Southern California there are multiple worst case scenarios, depending on which fault might rupture, and which communities are in proximity to the fault. But damage will not necessarily be limited to immediately adjoining communities. Depending on the hypocenter of the earthquake, seismic waves may be transmitted through the ground to unsuspecting communities. In the 1994 Northridge earthquake, Santa Monica suffered extensive damage, even though there was a range of mountains between it and the origin of the earthquake.

Damages for a large earthquake almost anywhere in Southern California are likely to run into the billions of dollars. Although current building codes are some of the most stringent in the world, tens of thousands of older existing buildings were built under much less rigid codes. California has laws affecting unreinforced masonry buildings (URM's) and although many building owners have retrofitted their buildings, hundreds of pre-1933 buildings still have not been brought up to current standards.

Non-structural bracing of equipment and contents is often the most cost-effective type of seismic mitigation. Inexpensive bracing and anchoring may be the most effective way to protect expensive equipment and furnishings and will also reduce the chance of injury for the occupants of a building.

The Orange County Essential Facilities Risk Assessment project ran detailed models on two earthquake scenarios (M6.9 Newport-Inglewood Earthquake and M6.6 San Joaquin Hills Earthquake) in Orange County. That data can be found in Attachment B – OCEFRA HAZUS Report. An additional assessment

was performed using the ShakeOut scenario and is available in the Quantitative Exposure Analysis section at the end of this chapter.

3.4 Dam Failure

Dam failures can result from a number of natural or human caused threats such as earthquakes, erosion of the face or foundation, improper siting, rapidly rising flood waters, and structural/design flaws.

A dam failure will cause loss of life, damage to property, and other ensuing hazards, as well as the displacement of persons residing in the inundation path. Damage to electric generating facilities and transmission lines could also impact life support systems in communities outside the immediate hazard areas.

Governmental assistance could be required and may continue for an extended period. These efforts would be required to remove debris and clear roadways, demolish unsafe structures, assist in reestablishing public services and utilities, and provide continuing care and welfare for the affected population including, as required, temporary housing for displaced persons.

The dams in Orange County are considered potential terrorist targets. The weapon most likely to be used would be explosives with the goal of collapsing the dam. Such an event would result in a dam inundation event with little or no warning. The potential of using other types of weapons such as chemical or biological are considered low due to the large amount of material that would be required to contaminate the reservoirs. This scenario would only apply to those dams where the reservoirs are used for drinking water.

Currently, there are 44 dams and reservoirs registered within or immediately adjacent to Orange County. They include reservoirs which normally contain water from flood control facilities which may be dry most of the time. Their capacity range from 18 acre-feet (Deimer No. 8) to 314,400 acre-feet (Prado Dam) holding capacity.

The County of Orange owns and operates 16 dams and reservoirs, the smallest facility is Harbor View with a capacity of 28 acre-feet and is located in Corona Del Mar to the Villa Park Dam with a capacity of 15,600 acre-feet and is located in Orange.

The following is a list of all registered dams and reservoirs in Orange County along with their owners and/or operators[11] and locations.

Dam or Reservoir Name	Owner	Year built	Capacity by acre-feet	Location
30 MG Central Reservoir	City of Brea	1924	92	Brea
Agua Chinon	County of Orange	1998	256	Irvine

[11] http://www.water.ca.gov/damsafety/damlisting/index.cfm

Bee Canyon Retention Basin	County of Orange	1994	243	Irvine

Dam or Reservoir Name	Owner	Year built	Capacity by acre-feet	Location
Big Canyon	City of Newport Beach	1959	600	Newport Beach
Brea Dam	Army Corps of Engineers	1942	4,018	Fullerton
Carbon Canyon Dam	Army Corps of Engineers	1961	7,033	Yorba Linda
Diemer No. 8	Metropolitan Water District of So. California	1968	18	Yorba Linda
Diemer Ozone Contact Basin	Metropolitan Water District of So. California	2011	23	Yorba Linda
Diemer Reservoir	Metropolitan Water District	1963	80	Yorba Linda
Dove Canyon	Dove Canyon Master Association	1989	415	Dove Canyon
East Hicks Canyon Retarding Basin	County of Orange	1997	75	Irvine
Eastfoot Retarding Basin	City of Irvine	2007	213	Irvine
El Toro Reservoir	El Toro Water District	1967	877	Mission Viejo
Fullerton Dam	Army Corps of Engineers	1941	706	Fullerton
Galivan Retarding Basin	County of Orange	2000	169	Newport Beach
Harbor View	County of Orange	1964	28	Corona Del Mar
Hicks Canyon Retention Basin	County of Orange	1997	110	Irvine
Lake Mission Viejo	Lake Mission Viejo Association, Inc.	1976	4,300	Mission Viejo
Lower Peters Canyon Retarding Basin	County of Orange	1990	206	North Tustin
Marshburn Retarding Basin	County of Orange	1998	424	Irvine
Orange County (Humble) Reservoir	Metropolitan Water District	1941	217	Brea
Orchard Estates Retarding Basin	County of Orange	1999	138	Irvine
Palisades Reservoir	South Coast Water District	1963	147	San Clemente
Peters Canyon	County of Orange	1932	1,090	North Tustin

Portola	Santa Margarita Water District	1980	586	Coto de Caza
Prado Dam	Army Corps of Engineers	1941	314,400	Corona
Rattlesnake Canyon	Irvine Ranch Water District	1959	1,480	Irvine
Rossmoor No. 1	El Toro Water District	1964	43	Laguna Woods
Rossmoor Retarding Basin	County of Orange	2002	175	Rossmoor
Round Canyon Retarding Basin	County of Orange	1994	286	Irvine
San Joaquin Reservoir	Irvine Ranch Water District	1966	3,036	Newport Beach
Sand Canyon	Irvine Ranch Water District	1912	960	Sand Canyon
Dam or Reservoir Name	**Owner**	**Year built**	**Capacity by acre-feet**	**Location**
Santiago Creek (Irvine Lake)	Serrano and Irvine Ranch Water Districts	1933	25,000	Silverado
Sulphur Creek	County of Orange	1966	520	Laguna Niguel
Syphon Canyon	Irvine Ranch Water District	1949	500	Irvine
Trabuco	Trabuco Canyon Water District	1984	138	Rancho Santa Margarita
Trabuco Retarding Basin	County of Orange	1996	390	Irvine
Trampas Canyon	Premier Silica LLC	1975	5,700	San Juan Capistrano
Upper Chiquita	Santa Margarita Water District	2012	753.5	Rancho Santa Margarita
Upper Oso	Santa Margarita Water District	1979	3,700	Mission Viejo
Villa Park Dam	County of Orange	1963	15,600	Orange
Veeh Reservoir	Lake Hills Community Church	1936	185	Laguna Hills
Walnut Canyon	City of Anaheim	1968	2,570	Anaheim
Yorba	County of Orange	1907	1,200	Anaheim

Historical Failure Flooding

Westminster Water Tank Failure – Westminster, Orange County

On September 21, 1998, at 5:47am, a 5 million gallon precast concrete above ground water storage tank ruptured, sending a 6 foot high wave of water through a nearby fire station and the Hefley Square Townhomes in the City of Westminster. Six people were injured and 30 were left temporarily homeless after the tidal wave gushed from the 22 foot high rupture in the tank. The fire station, 70 homes, 32

outbuildings, 2 businesses and 25 vehicles sustained damages or were destroyed. Gas, electric and telephone services were disrupted.

This 31-year-old storage tank ruptured in Westminster, California, sending a 6-foot wave of water through the city that damaged or destroyed about 50 buildings and over a dozen vehicles. Storage tanks should be replaced or periodically rehabilitated to preserve their structural integrity.

Prado Dam Seepage

In January 2005, due to preceding storm activity which produced near record water levels behind Prado Dam, the reservoir water surface elevation behind the dam peaked at 527.4 feet above sea level. On January 13, the U.S. Army Corps of Engineers discovered minor seepage on the downstream face of Prado Dam. The seepage was located in an area that was under construction to build new outlet works as part of the overall flood control improvement to Prado Dam. As a precautionary measure Corona city officials evacuated over 800 homes below the dam and Orange County officials relocated campers in the Canyon RV Park because of their proximity to the adjacent floodplain.

To decrease the amount of water behind Prado dam the release of water was increased from 5,000 cubic feet per second (cfs) to 10,000 cfs to reduce the level of water being held to 505 feet. In addition to the increase in water release, the U.S. Army Corps began holding back floodwaters upstream at both the San Antonio Dam in Los Angeles County and Seven Oaks Dam near Redlands to reduce the inflow of water to Prado Dam. As the water level was lowered, the hydraulic pressure on the dam abutment subject to seepage was reduced. When the water was reduced to 505 feet (25,750 acre feet of water) on Monday, January 17, 2005 the USACE was able to start the reconditioning of the cofferdam in order to be ready for subsequent flood inflows to the dam.

Vulnerability Assessment

Loss of life and damage to structures, roads, and utilities may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would certainly accompany the failure of one of the major dams in Orange County. Because dam failure can have severe consequences, FEMA and the California Office of Emergency Services require all dam owners to develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions. Although there may be

coordination with county officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner. For more detailed information regarding dam failure flooding, and potential flood inundation zones for a particular dam in the county, refer to the Orange County Operational Area Emergency Operations Plan – Dam / Reservoir Failure Annex.

Life and Property

Based on the number of dams in Orange County and utilizing the dam failure inundation maps, we can conclude that a large portion of the County is vulnerable to dam failure. The largest impact on the community from a dam failure is the loss of life and property.

Residential and Commercial

Vulnerable properties are those located closest to the dam inundation area. These properties would experience the largest, most destructive surge of water. Low-lying areas are also vulnerable since this is where the dam waters would collect.

Residential property in low-lying areas in an inundation zone would be heavily impacted. Orange County is an affluent community, where the median price of a home on the coastline is $800,000 to well over $1,000,000. The failure of a large dam could potentially destroy or damage hundreds of homes spreading debris for miles.

A dam failure event would impact businesses by damaging property and by interrupting business and services. Any residential or commercial structure with weak reinforcement would be susceptible to damage.

Infrastructure

Dam failure can damage buildings, power lines, and other property and infrastructure due to flooding.

Transportation routes are vulnerable to dam inundation and have the potential to be severely damaged or literally swept away, creating isolation issues. This includes all roads, railroads and bridges in the path of the dam inundation. Those that are most vulnerable are those that are already in poor condition and would not be able to withstand a large water surge. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas. Dam failure can result in collapsed or damaged buildings or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Damage to public water and sewer systems, transportation networks, and flood channels would greatly impact daily life for residents.

Roads blocked by objects during or after a dam failure may have severe consequences to people who are attempting to evacuate or who need emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric services and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences

to the local economy resulting from dam failure related to both physical damages and interrupted services.

Additional Vulnerability Analysis

While all 44 dams in Orange County would have some impact on infrastructure, by far the greatest threat is from Prado Dam on the Santa Ana River just east of the County boundary. With more than ten times the capacity of the next largest dam on the list, it is the primary concern when it comes to dam and reservoir failure planning in Orange County. The U.S. Army Corps of Engineers, who manages the dam site, does not release information on dam inundation areas, but, using old paper maps, a basic analysis has been performed to assess the vulnerability of the County's unincorporated areas and the County of Orange and the Orange County Fire Authority's facilities. This assessment is available in the quantitative exposure analysis section at the end of this chapter. In addition, a mitigation action item exists the address the lack of more current inundation maps for Prado Dam and other dams in Orange County.

3.5 Landslide/Mud Flow/Debris Flow

Landslide is a general term for a falling mass of soil or rocks; vertical movement of small pieces of soil. Mud flow is a flow of very wet rock and soil. The primary effects of mud flows/landslides can include:

- Abrupt depression and lateral displacement of hillside surfaces over distances of up to several hundreds of feet.
- Disruption of surface drainage.
- Blockage of flood control channels and roadways.
- Displacement or destruction of improvements such as roadways, buildings, and water wells.

Orange County also uses the term debris flow, usually in regard to risk of surface soil movement in areas recently burned by wildfire. Since this term is used in our official planning documents for such occurrences, it is included here.

Landslide Characteristics

A landslide is defined as, the movement of a mass of rock, debris or earth down a slope. Landslides are a type of 'mass wasting' which denotes any down slope movement of soil and rock under the direct influence of gravity. The term 'landslide' encompasses events such as rock falls, topples, slides, spreads, and flows. Landslides can be initiated by rainfall, earthquakes, volcanic activity, changes in groundwater, disturbance and change of a slope by man-made construction activities, or any combination of these factors. Landslides can also occur underwater, causing tidal waves and damage to coastal areas. These landslides are called submarine landslides.

The size of a landslide usually depends on the geology and the initial cause of the landslide. Landslides vary greatly in their volume of rock and soil, the length, width, and depth of the area affected, frequency of occurrence, and speed of movement. Some characteristics that determine the type of landslide are slope of the hillside, moisture content, and the nature of the underlying materials. Landslides are given different names, depending on the type of failure and their composition and characteristics.

Slides move in contact with the underlying surface. These movements include rotational slides where sliding material moves along a curved surface and translational slides where movement occurs along a flat surface. These slides are generally slow moving and can be deep. Slumps are small rotational slides that are generally shallow. Slow-moving landslides can occur on relatively gentle slopes and can cause significant property damage, but are far less likely to result in serious injuries than rapidly moving landslides.

Failure of a slope occurs when the force that is pulling the slope downward (gravity) exceeds the strength of the earth materials that compose the slope. They can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris-flows. Debris-flows can travel down a hillside of speeds up to 200 miles per hour (more commonly, 30 – 50 miles per hour), depending on the slope angle, water content, and type of earth and debris in the flow. These flows are initiated by heavy, usually sustained, periods of rainfall, but sometimes can happen as a result of short bursts of

concentrated rainfall in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.

Mud Flow

A mud or debris flow is a river of rock, earth and other materials, including vegetation, that is saturated with water. This high percentage of water gives the debris flow a very rapid rate of movement down a slope. Debris flows can attain speeds greater than 20 miles per hour, and can often move much faster. This high rate of speed makes debris flows extremely dangerous to people and property in their path.

Earth flows are plastic or liquid movements in which land mass (e.g. soil and rock) breaks up and flows during movement. Earthquakes often trigger flows. Debris flows normally occur when a landslide moves down-slope as a semi-fluid mass scouring, or partially scouring soils from the slope along its path. Flows are typically rapid moving and also tend to increase in volume as they scour out the channel. Flows often occur during heavy rainfall, can occur on gentle slopes, and can move rapidly for large distances.

Landslide Events and Impacts

Landslides are a common hazard in California. Weathering and the decomposition of geologic materials produces conditions conducive to landslides and human activity further exacerbates many landslide problems. Many landslides are difficult to mitigate, particularly in areas of large historic movement with weak underlying geologic materials. As communities continue to modify the terrain and influence natural processes, it is important to be aware of the physical properties of the underlying soils as they, along with climate, create landslide hazards. Even with proper planning, landslides will continue to threaten the safety of people, property, and infrastructure, but without proper planning, landslide hazards will be even more common and more destructive.

The increasing scarcity of buildable land, particularly in urban areas, increases the tendency to build on geologically marginal land. Additionally, hillside housing developments in Southern California are prized for the view lots that they provide.

Rock falls occur when blocks of material come loose on steep slopes. Weathering, erosion, or excavations, such as those along highways, can cause falls where the road has been cut through bedrock. They are fast moving materials free falling or bouncing down a slope. In falls, material is detached from a steep slope or cliff. The volume of material involved is generally small, but large boulders or blocks of rock can cause significant damage.

Landslide Conditions

Landslides are often triggered by periods of heavy rainfall. Earthquakes, subterranean water flow and excavations may also trigger landslides. Certain geologic formations are more susceptible to landslides than others. Human activities, including locating development near steep slopes, can increase susceptibility to landslide events. Landslides on steep slopes are more dangerous because movements can be rapid.

“Although landslides are a natural geologic process, the incidence of landslides and their impacts on people can be exacerbated by human activities. Grading for road construction and development can increase slope

steepness. Grading and construction can decrease the stability of a hill slope by adding weight to the top of the slope, removing support at the base of the slope, and increasing water content. Other human activities effecting landslides include: excavation, drainage and groundwater alterations, and changes in vegetation."[12]

Wildland fires in hills covered with chaparral are often a precursor to debris flows in burned out canyons. The extreme heat of a wildfire can create a soil condition in which the earth becomes impervious to water by creating a waxy-like layer just below the ground surface. Since the water cannot be absorbed into the soil, it rapidly accumulates on slopes, often gathering loose particles of soil in to a sheet of mud and debris. Debris flows can often originate miles away from unsuspecting persons, and approach them at a high rate of speed with little warning.

Natural Conditions

Natural processes can cause landslides or re-activate historical landslide sites. The removal or undercutting of shoreline-supporting material along bodies of water by currents and waves produces countless small slides each year. Seismic tremors can trigger landslides on slopes historically known to have landslide movement. Earthquakes can also cause additional failure (lateral spreading) that can occur on gentle slopes above steep streams and riverbanks.

Particularly Hazardous Landslide Areas

Locations at risk from landslides or debris flows include areas with one or more of the following conditions:

- On or close to steep hills.
- Steep road-cuts or excavations.
- Existing landslides or places of known historic landslides (such sites often have tilted power lines, trees tilted in various directions, cracks in the ground, and irregular-surfaced ground).
- Steep areas where surface runoff is channeled, such as below culverts, V-shaped valleys, canyon bottoms, and steep stream channels.
- Fan-shaped areas of sediment and boulder accumulation at the outlets of canyons.
- Canyon areas below hillside and mountains that have recently (within 1-6 years) been subjected to a wildland fire.

Although landslides are a natural occurrence, human impacts can substantially affect the potential for landslide failures in Orange County. Proper planning and geotechnical engineering can be exercised to reduce the threat of safety of people, property, and infrastructure.

[12] "Planning for Natural Hazards: The Oregon Technical Resource Guide, Department of Land Conservation and Development, (2000), Chapter 5.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading these slopes can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations

Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. However, even lawn irrigation in landslide prone locations can result in damaging landslides. Ineffective storm water management and excess runoff can also cause erosion and increase the risk of landslide hazards. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, ponding, and erosion on slopes all indicate potential slope problems.

Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides. Information gathered from the “Homeowners Guide for Landslide Control, Hillside Flooding, Debris Flows, Soil Erosion (March 1997).

Changes in Vegetation

Removing vegetation from very steep slopes can increase landslide hazards. Areas that experience wildfire and land clearing for development may have long periods of increased landslide hazard. Also, certain types of ground cover have a much greater need for constant watering to remain green. Changing from native ground cover plants may increase the risk of landslide.

There are multiple areas within Orange County that are susceptible to landslides and mud flows. An example of an Orange County landslide was in Anaheim Hills following the floods of 1992. Most, but not all, landslides in southern California begin to move when the soils have become saturated during heavy rains. In Anaheim Hills several homes located at the crest of the hill began to slide and had to be evacuated. These structures were deemed unsafe for continued habitation.

Almost all sites with potential for mud flows/landslides lie within the hillside and coastal areas of Orange County. Many slopes in the County are only marginally stable and landslides could occur. OC Public Works enforces Orange County Grading Code to ensure that areas of landslide or hillside areas are adequately identified and investigated prior to development.

Landslides as a Threat to Orange County

Landslides are a serious geologic hazard in almost every state in America. Nationally, landslides cause 25 to 50 deaths each year. The best estimate of direct and indirect costs of landslide damage in the United States range between $1 and $2 billion annually as noted in Dennis Miletti's Disasters by Design: A Reassessment of Natural Hazards in the United States. As a seismically active region, California has had a significant number of locations impacted by landslides. Some landslides result in private property damage; other landslides impact transportation corridors, fuel and energy conduits, and communication facilities. They can also pose a serious threat to human life.

Historic Southern California Landslides

The following landslide accounts comprise only a fraction of the Southern California landslide history. These are provided as a sample for mitigation planning

1978 Bluebird Canyon, Orange County

Cost, $52.7 million (2000 dollars) 60 houses destroyed or damaged. Unusually heavy rains in March of 1978 may have contributed to initiation of the landslide. Although the 1978 slide area was approximately 3.5 acres, it is suspected to be a portion of a larger, ancient landslide.

1980 Southern California Slides

$1.1 billion in damage (2000 dollars). Heavy winter rainfall in 1979-80 caused damage in six Southern California counties. In 1980, the rainstorm started on February 8th. A sequence of 5 days of continuous rain and 7 inches of precipitation fell by February 14th. Slope failures were beginning to develop by February 15th and then very high-intensity rainfall occurred on February 16. As much as 8 inches of rain fell in a 6 hour period in many locations.

1983 San Clemente, California, Orange County

Cost, $65 million in 2000 dollars on California Highway 1. Litigation at that time involved approximately $43.7 million (2000 dollars).

1994 Northridge, California earthquake landslides

As a result of the magnitude 6.7 Northridge, California, earthquake, more than 11,000 landslides occurred over an area nearly 4,000 square miles. Most were in the Santa Susana Mountains and in mountains north of the Santa Clara River Valley. They destroyed dozens of homes, blocked roads, and damaged oilfield infrastructure. It also caused deaths from Coccidioidomycosis (valley fever) the spore of which was released from the soil and blown toward the coastal populated areas. It is postulated the spore was released from the soil by the landslide activity.

March 1995 Los Angeles and Ventura Counties, Southern California

Above normal rainfall triggered damaging debris flows, deep-seated landslides, and flooding. Several deep-seated landslides were triggered by the storms, the most notable was the La Conchita landslide, which in combination with a local debris flow, destroyed or badly damaged 11 to 12 homes in the small town of La

Conchita, about 12 miles west of Ventura. There also was widespread debris-flow and flood damage to homes, commercial buildings, and roads and highways in areas along the Malibu coast that had been devastated by wildfire 2 years before.

1998 Laguna Niguel, Orange County, Landslide

During the 1997/1998 El Nino Season heavy rainfall increased movement on the site of an ancient landslide in Laguna Niguel. The storms in December 1997 had accelerated its movement and in early 1998, a crumbling hillside forced the evacuation of 10 hilltop homes and more than 10 condominium units resting below. Ultimately four of the hilltop homes collapsed, falling down hillside into the void created by the slide area. The condominium complex has since been demolished and the site sits as open space as shown below.

Before

After

Other 1997-1998 Landslides

On December 6, 1997, four homes were condemned and evacuated due to a mud flow and rockfall in Silverado Canyon. Floods and mud flows were reported in Costa Mesa, Irvine, Lake Forest, San Juan Capistrano, and Laguna Beach. mud flows occurred in Black Star, Baker, and Santiago Canyons. Many road closures were reported along the Santa Ana Freeway at Laguna Freeway, Laguna Canyon Road, Pacific Coast Highway in Newport Beach and in Huntington Beach.

On December 23, 1997, movement of an active landslide in the Anaheim Hills accelerated. This "Vista Summit Way" landslide damaged two to three houses and affected three city blocks.

On February 6, 1998, a mud flow crushed two cars in Newport Beach. On February 8, high tide and rain caused damage to shoreline properties; nine homes at a mobile home park were damaged in San Clemente. One of these houses was condemned. In Dana Point, the Holiday Inn Express was evacuated when a mud flow flowed into the underground parking structure. Cars flowed out of the building into the street with the mud. In Brea a rock and mud flow closed the Carbon Canyon Road. Other road closures occurred at Pacific Coast Highway, Laguna Canyon Road, and El Toro Road.

On On February 23, 1998, the storm forced the evacuation of eight to ten residents in Holy Jim Canyon near the Orange - Riverside County line; a half-dozen other residents declined to move despite the

growing slide threat. One home was endangered in Silverado Canyon. On February 24, Carbon Canyon Road was closed in Brea, after a hillside slid across half of the road at the La Vida Hot Springs Resort. On March 3, a landslide forced the evacuation of four homes in the 300 block of Paseo de Cristobal in San Clemente, piled dirt and large boulders onto the railroad tracks and cut off rail service.

2004-2005 Anaheim Hills

Three new multi-million dollar homes along Ramsgate Drive were destroyed by this slow-moving landslide in 2004-05.

2005 Bluebird Canyon Landslide

In the early morning of June 1, 2005, a landslide began moving in the Bluebird Canyon area of Laguna Beach, California. No rainfall or earthquake activity occurred during or immediately before the landslide movement. This movement is almost certainly related to the extremely heavy winter rains that occurred from December through February.

On February 15, 2005, USGS issued an advisory that landslides could continue to occur long after the winter rainfall ended: "An additional consequence of the above-normal rainfall in January in southern California is the potential for activation of deep-seated, slow-moving landslides. Rainfall is moving slowly through soil and bedrock, and over time (days to months), may result in destabilization of some hillslopes."

2007-2008 Post-Santiago Fire and 2014-2015 Post-Silverado Fire Debris Flows

After the Santiago Fire stripped the vegetation bare in the canyon communities of Orange County, a debris flow task force was convened to address the potential impact that post-fire winter storms could have on the slopes in the burn areas. There were several cases of mud flows that damaged homes in the Modjeska Canyon area.

Following the Silverado Fire in 2014, similar conditions were generated in the Silverado Canyon area of Orange County. While no major debris flows have been recorded in the year following the event, the threat will remain for several more years.

2010 Winter Storm Mud flows

In December 2010, a series of storms passed over Orange County, dropping several inches of rain and triggering a series of mud and debris flows in Orange County canyon and coastal areas. While not specifically associated with a fire or other event, these slides tended to occur in areas already identified as being prone to such activity.

Vulnerability and Risk

Vulnerability assessment for landslides will assist in predicting how different types of property and population groups will be affected by a hazard. Data that includes specific landslide-prone and debris flow locations in the county can be used to assess the population and total value of property at risk from future landslide occurrences.

Past landslide events have caused major property damage or significantly impacted county residents, and continuing to map landslide and debris flow areas will help in preventing future loss.

Factors included in assessing landslide risk include population and property distribution in the hazard area, the frequency of landslide or debris flow occurrences, slope steepness, soil characteristics, and precipitation intensity. The California Geological Survey produces a dataset that depicts where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements throughout all of Orange County. Using this dataset, it is possible to assess the County of Orange and Orange County Fire Authority's total exposure to the landslide hazard. This assessment is available in the Quantitative Exposure Analysis section at the end of this chapter.

Community Landslide Issues

Susceptibility to Landslides

Landslides can affect utility services, transportation systems, and critical lifelines. Communities may suffer immediate damages and loss of service. Disruption of infrastructure, roads, and critical facilities may also have a long-term effect on the economy. Utilities, including potable water, wastewater, telecommunications, natural gas, and electric power are all essential to service community needs. Loss of electricity has the most widespread impact on other utilities and on the whole community. Natural gas pipes may also be at risk of breakage from landslide movements as small as an inch or two.

Lifelines and critical facilities

Lifelines and critical facilities should remain accessible, if possible, during a natural hazard event. The impact of closed transportation arteries may be increased if the closed road or bridge is critical for hospitals and other emergency facilities. Therefore, inspection and repair of critical transportation facilities and routes is essential and should receive high priority. Losses of power and phone service are also potential consequences of landslide events. Due to heavy rains, soil erosion in hillside areas can be accelerated, resulting in loss of soil support beneath high voltage transmission towers in hillsides and remote areas. Flood events can also cause landslides, which can have serious impacts on gas lines that are located in vulnerable soils.

Losses incurred from landslide hazards in Orange County have usually been associated with roads. The Orange County Public Works, Operations & Maintenance Division is responsible for responding to slides that inhibit the flow of traffic or are damaging a road or a bridge. The Division does its best to communicate with residents impacted by landslides, but can usually only repair the road itself, as well as the areas adjacent to the slide where the county has the right of way.

It is not cost effective to mitigate all slides because of limited funds and the fact that some historical slides are likely to become active again even with mitigation measures. The County alleviates problem areas by grading slides, and by installing new drainage systems on the slopes to divert water from the landslides.

This type of response activity is often the most cost-effective in the short-term, but is only temporary.

Additional Vulnerability Analysis

While a basic assessment of the total landslide threat is available, the lack of high-resolution hazard data and parcel-level replacement values make a more in-depth analysis not feasible at this time. A mitigation action item was created to address this data limitation and it is hoped that funds will be available to correct for this in the next plan update.

3.6 Tsunami

The phenomenon we call "tsunami" is a series of traveling ocean waves of extremely long length generated primarily by earthquakes occurring below or near the ocean floor. Underwater volcanic eruptions and landslides can also generate tsunamis. In the deep ocean, the tsunami waves move across the deep ocean with a speed exceeding 500 miles per hour, and a wave height of only a few inches. Tsunami waves are distinguished from ordinary ocean waves by their great length between wave crests, often exceeding 60 miles or more in the deep ocean, and by the time between these crests, ranging from 10 minutes to an hour.

As they reach the shallow waters of the coast, the waves slow down and the water can pile up into a wall of destruction up to 30 feet or more in height. The effect can be amplified where a bay, harbor or lagoon funnels the wave as it moves inland. Large tsunamis have been known to rise over 100 feet. Even a tsunami 1-3 feet high can be very destructive and cause many deaths and injuries.

Causes of a Tsunami

There are many causes of tsunamis, but the most prevalent is earthquakes. In addition, landslides, volcanic eruptions, explosions, and even the impact of cosmic bodies, such as meteorites, can generate tsunamis.

Earthquakes and Tsunamis

An earthquake can be caused by volcanic activity, but most are generated by movements along fault zones associated with plate boundaries. Most strong earthquakes, representing 80% of the total energy released worldwide by earthquakes, occur in subduction zones where an oceanic plate slides under a continental plate or another younger oceanic plate.

Not all earthquakes generate tsunamis. To generate a tsunami, the fault where the earthquake occurs must be underneath or near the ocean, and cause vertical movement of the sea floor over a large area, hundreds or thousands of square miles. By far, the most destructive tsunamis are generated from large, shallow earthquakes with an epicenter or fault line near or on the ocean floor. The amount of vertical and horizontal motion of the sea floor, the area over which it occurs, the simultaneous occurrence of slumping of underwater sediments due to the shaking, and the efficiency with which energy is transferred from the earth's crust to the ocean water are all part of the tsunami generation mechanism. The sudden vertical displacements over such large areas disturb the ocean's surface, displace water, and generate destructive tsunami waves. Although all oceanic regions of the world can experience tsunamis, the most destructive and repeated occurrences of tsunamis are in the Pacific Rim region.

The September 2, 1992 earthquake (magnitude 7.2) was barely felt by residents along the coast of Nicaragua. Located well off-shore, the severity of shaking on a scale of I to XII, was mostly II along the coast, and reached III at only a few places. A tsunami struck the coast of Nicaragua 20 to 70 minutes after the earthquake occurred with wave amplitudes up to 13 feet above normal sea level in most places and a maximum run-up height of 35 ft. The waves caught coastal residents by complete surprise, causing many casualties and considerable property damage.

This tsunami was caused by a tsunami earthquake, an earthquake that produces an unusually large tsunami relative to the earthquake magnitude. Tsunami earthquakes are characterized by a very shallow focus, fault dislocations greater than several meters, and fault surfaces that are smaller than for a normal earthquake.

Tsunami earthquakes are also slow earthquakes, with slippage along the fault beneath the sea floor occurring more slowly than it would in a normal earthquake. The only known method to quickly recognize a tsunami earthquake is to estimate a parameter called the seismic moment using very long period seismic waves (more than 50 seconds/cycle). Two other destructive and deadly tsunamis from tsunami earthquakes have occurred in recent years in Java, Indonesia (June 2, 1994) and Peru (February 21, 1996).

Landslides and Tsunamis

Less frequently, tsunami waves can be generated from displacements of water resulting from rock falls, icefalls and sudden submarine landslides or slumps. Such events may be caused impulsively from the instability and sudden failure of submarine slopes, which are sometimes triggered by the ground motions of a strong earthquake. For example in the 1980's, earth moving and construction work of an airport runway along the coast of Southern France, triggered an underwater landslide, which generated destructive tsunami waves in the harbor of Thebes.

Tsunami Characteristics

Speed

Unnoticed tsunami waves can travel at the speed of a commercial jet plane, over 500 miles per hour. They can move from one side of the Pacific Ocean to the other in less than a day. This great speed makes it important to be aware of the tsunami as soon as it is generated. Scientists can predict when a tsunami will arrive at various places by knowing the source characteristics of the earthquake that generated the tsunami and the characteristics of the sea floor along the paths to those places. Tsunamis travel much slower in more shallow coastal waters where their wave heights begin to increase dramatically.

Size

Offshore and coastal features can determine the size and impact of tsunami waves. Reefs, bays, entrances to rivers, undersea features and the slope of the beach all help to modify the tsunami as it attacks the coastline. When the tsunami reaches the coast and moves inland, the water level can rise many feet. In extreme cases, water level has risen to more than 50 feet for tsunamis of distant origin and over 100 feet for tsunami waves generated near the earthquake's epicenter. The first wave may not be the largest in the series of waves. One coastal community may see no damaging wave activity while in another nearby community destructive waves can be large and violent. The flooding can extend inland by 1000 feet or more, covering large expanses of land with water and debris.

Frequency

Since scientists cannot predict when earthquakes will occur, they cannot determine exactly when a tsunami will be generated. However, by looking at past historical tsunamis and run-up maps, scientists know where tsunamis are most likely to be generated. Past tsunami height measurements are useful in predicting future tsunami impact and flooding limits at specific coastal locations and communities.

Types of Tsunamis

Pacific-wide and Regional Tsunamis

Tsunamis can be categorized as Pacific-wide and "local." Typically, a Pacific-wide tsunami is generated by major vertical ocean bottom movement in offshore deep trenches. A "local" tsunami can be a component of the Pacific-wide tsunami in the area of the earthquake or a wave that is confined to the area of generation within a bay or harbor and caused by movement of the bay itself or landslides.

In 1960, a large tsunami generated by an earthquake located off the coast of Chile caused loss of life and property damage not only along the Chile coast but also in Hawaii and as far away as Japan. The Great Alaskan Earthquake of 1964 killed 106 people and produced deadly tsunami waves in Alaska, Oregon and California.

In July 1993, a tsunami generated in the Sea of Japan killed over 120 people in Japan. Damage also occurred in Korea and Russia but spared other countries since the tsunami wave energy was confined within the Sea of Japan. The 1993 Japan Sea tsunami is known as a "regional event" since its impact was confined to a relatively small area. For people living along the northwestern coast of Japan, the tsunami waves followed the earthquake within a few minutes.

During the 1990s, destructive regional tsunamis also occurred in Nicaragua, Indonesia, the Philippines, Papua New Guinea, and Peru, killing thousands of people. Others caused property damage in Chile and Mexico. Some damage also occurred in the Marquesas Islands (French Polynesia) from the July 30, 1995, Chilean and February 21, 1996 Peruvian tsunamis.

In less than a day, tsunamis can travel from one side of the Pacific to the other. However, people living near areas where large earthquakes occur may find that the tsunami waves will reach their shores within minutes of the earthquake. For these reasons, the tsunami threat to many areas such as Alaska, the Philippines, Japan and the United States West Coast can be immediate (for tsunamis from nearby earthquakes which take only a few minutes to reach coastal areas) or delayed (for tsunamis from distant earthquakes which take from three to 22 hours to reach coastal areas).

All of the coastal areas in Orange County are susceptible to tsunamis. A tsunami from the South Pacific or from South America could strike the County coastal areas from the south to southwest. The Channel Islands do not provide adequate protection.

The worst recorded tsunami to hit California was in 1812. A landslide occurred in the Santa Barbara Channel, and the resulting waves are reported by some disputed sources to have been up to 15 feet above sea level in Ventura. Widespread damage and some loss of life occurred in 1964 following the

Alaskan earthquake. Tsunamis from the earthquake also destroyed a number of towns in Alaska and damaged the Los Angeles-Long Beach harbors, as well as harbors in Ventura County.

Tsunami as a Threat to Southern California

History has shown that the probability of a tsunami in Orange County is an extremely low threat. However, if a tsunami should occur, the consequences could be great. As shown on the tsunami run-up map (Map 23), the entire 42 miles of Orange County coastline could be impacted. Approximately 89,000 residents would have to be evacuated. The impact could cause loss of life, destroy thousands of high priced homes and greatly affect coastal businesses and impact tourism. Even if all residents and visitors were safely evacuated, the damage to property in this densely populated, high property value area would still be tremendous.

California's Tsunamis

Since 1812, the California coast has had 14 tsunamis with wave heights higher than three feet; six of these were destructive. The Channel Islands were hit by a tsunami in the early 1800s. The worst tsunami resulted from the 1964 Alaskan earthquake and caused 12 deaths and at least $17 million in damages in northern California.

History of Regional Tsunamis

Local

The local tsunami may be the most serious threat as it strikes suddenly, sometimes before the earthquake shaking stops. Alaska has had six serious local tsunamis in the last 80 years and Japan has had many more.

Local History of Tsunamis

Tsunamis have been recorded since ancient times. They have been documented extensively in California since 1806. Although the majority of tsunamis have occurred in Northern California, Southern California has been impacted as well. In the 1930's, four tsunamis struck the LA, Orange County, and San Diego coastal areas. In Orange County the tsunami wave reached heights of 20 feet or more above sea level. In 1964, following the Alaska 8.2 earthquake, tidal surges of approximately 4 feet to 5 feet hit the Huntington Harbor area causing moderate damage. The run-up is the height the tsunami reached above a reference level such as mean sea level. It is not always clear which reference level was used.

On February 27th, 2010, a magnitude 8.8 earthquake off Chile that literally made the planet vibrate generated a tsunami that produced 3 foot high waves in Orange County 13 hours later, including breakers that hit storm runoff in the Santa Ana River, briefly producing small, frothy rapids.

The tsunami, which traveled about 6,000 miles to get here, led officials to close virtually every beach in Orange County as well as most piers. Newport Beach sent automated phone calls to residents warning them to stay away from the ocean. Parts of Dana Point Harbor were closed. The bait barge in Dana Point Harbor was broken roughly in half. The new $1 billion destroyer USS Dewey was sent out to sea from the Seal Beach Naval Weapons Station to avoid being damaged.

A 9.0 earthquake on March 11, 2011 that occurred near Tohoku, Japan caused a two foot run up in Huntington Beach and Dana Point and a one foot run up in Newport Beach. Damages were minor with a boat pulled off its mooring and a pylon damaged when hit by a boat.

Tsunami Hazard Assessment

Hazard Identification

A tsunami threat to Orange County is considered low to moderate**.**

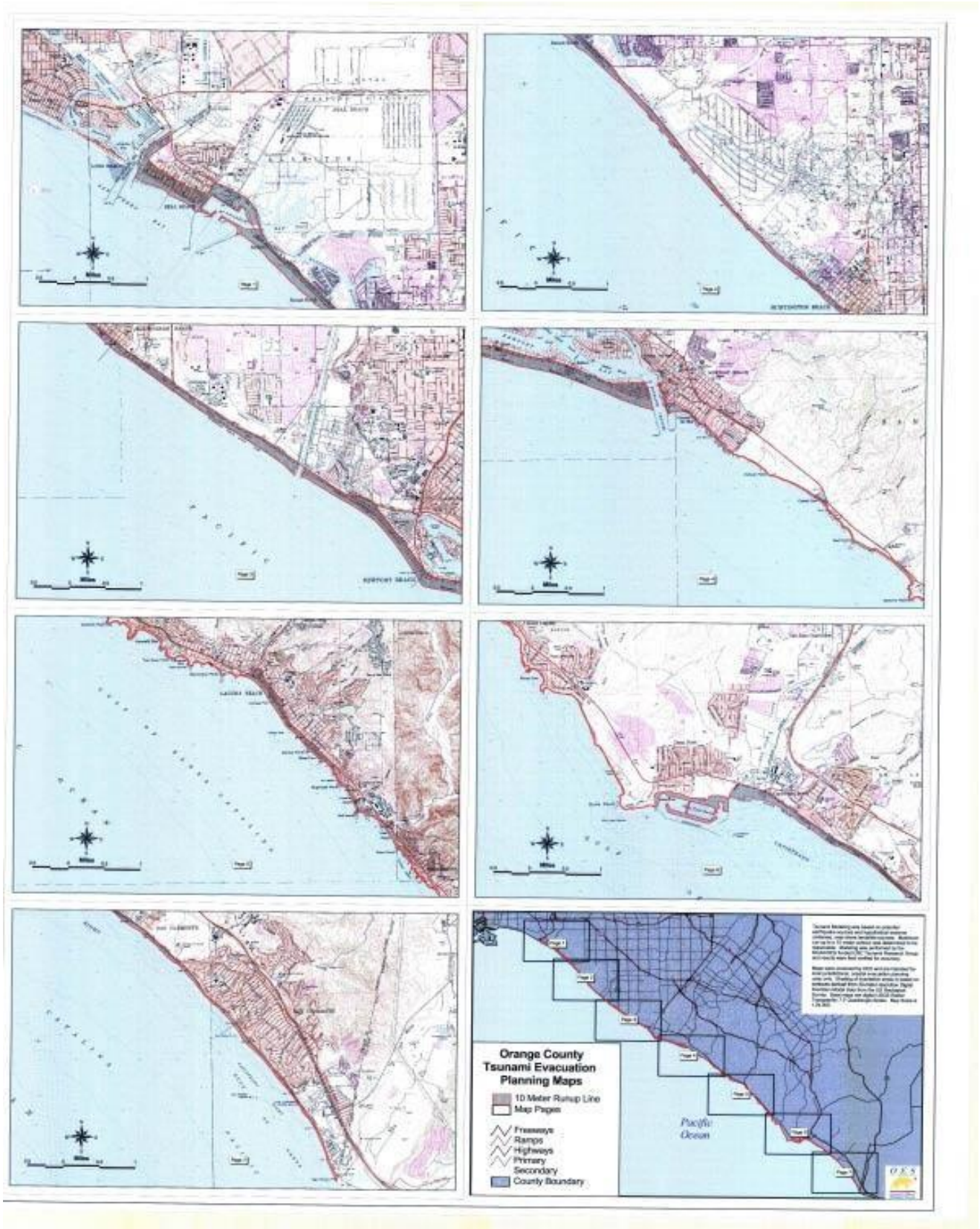
Damage factors of tsunamis:

Tsunamis cause damage in three ways: inundation, wave impact on structures, and erosion. Orange County has southwestern facing beaches that are vulnerable to tsunamis or tidal surges from the south and from the west.

Strong, tsunami-induced currents lead to the erosion of foundations and the collapse of bridges and sea walls. Flotation and drag forces move houses and overturn railroad cars. Considerable damage is caused by the resultant floating debris, including boats and cars that become dangerous projectiles that may crash into buildings, break power lines, and may start fires. Fires from damaged ships in ports or from ruptured coastal oil storage tanks and refinery facilities can cause damage greater than that inflicted directly by the tsunami. Of increasing concern is the potential effect of tsunami draw down, when receding waters uncover cooling water intakes of nuclear power plants.

Predicted wave heights, exclusive of tide and storm generated wave heights are:

For a 100 year occurrence	For a 500 year occurrence
4.0 feet minimum	6.8 feet minimum
6.6 feet average	11.4 feet average
9.2 feet maximum	16.0 feet maximum



☐ **Map 23 - Tsunami Run Up Map for Orange County**

Community Tsunami Issues

Susceptibility to Tsunami

Life and Property

Based on the "local" history events of tsunamis we can conclude that approximately 16% of the County would be heavily impacted utilizing the Tsunami Run-up Maps. The largest impact on the community from a tsunami event is the loss of life and property.

Known risk areas include, but are not limited to:

- City, County and State Beaches.
- All buildings and apartments on the water side of Pacific Coast Highway (PCH).
- Vehicles and pedestrians on PCH in low lying areas.
- Buildings that are on the inland side of PCH facing the ocean.
- Harbor areas.
- Low lying areas adjacent to the coast.

The use of the Tsunami Warning, Watch, and Advisory Bulletins would provide time to allow coastal residents to evacuate and seek higher ground for shelter. This would greatly reduce injuries and loss of life.

Residential

Property along the coast could be devastated. A large tsunami could potentially destroy or damage hundreds of homes spreading debris for miles. Orange County is an affluent community, with a median housing price of $629,500 in 2015 with coastal properties worth millions (or tens of millions) of dollars.

Commercial

The coastline of Orange County is world famous. During summer months hundreds of thousands of people a day come into the community to stay in the beautiful hotels and shop at the unique boutiques. Local governments rely heavily on tourism and sales tax. A tsunami event would impact businesses by damaging property and by interrupting business and services.

Infrastructure

Tsunamis (and earthquakes) can damage buildings, power lines, and other property and infrastructure due to flooding. Tsunamis can result in collapsed or damaged buildings or blocked roads and bridges, damaged traffic signals, streetlights, and parks, among others. Damage to public water and sewer systems, transportation networks, and flood channels would greatly impact daily life for residents.

Roads blocked by objects during a tsunami may have severe consequences to people who are attempting to evacuate or who need emergency services. Emergency response operations can be complicated when roads are blocked or when power supplies are interrupted. Industry and commerce can suffer losses from interruptions in electric services and from extended road closures. They can also sustain direct losses to buildings, personnel, and other vital equipment. There are direct consequences to the local economy resulting from tsunamis related to both physical damages and interrupted services.

Existing Mitigation Activities

Orange County has implemented a number of tsunami mitigation activities over the years. Some of the current mitigation programs include:

1. Public Information Plan for Emergency Alerting System (EAS).

2. Disaster Preparedness Public Education.

Vulnerability and Risk

The 2009 Orange County Essential Facilities Risk Assessment project ran detailed models on a tsunami coastal flood hazard affecting Orange County. That data can be found in Attachment B – OCEFRA HAZUS Report. In addition, an updated assessment of the total tsunami threat is available in the Quantitative Exposure Analysis section at the end of this chapter.

County facilities with greatest exposure to tsunami hazards are affiliated with the three harbor areas maintained by County agencies. A land annexation by the City of Huntington Beach in 2011 greatly reduced the unincorporated county area's exposure to the tsunami threat.

3.7 Drought

Unlike most other natural hazards, drought is not a sudden, catastrophic occurrence. It is often referred to as a "creeping phenomenon" and its impacts vary from region to region. Drought can therefore be difficult for people to understand. Because drought can occur over several years, it is almost impossible to determine when a drought begins and ends. Many government agencies, the National Oceanic and Atmospheric Administration (NOAA) and the California Department of Water Resources, as well as academic institutions, such as the University of Nebraska-Lincoln's National Drought Mitigation Center, generally agree that there is no clear definition of drought. Drought is highly variable depending on what part of a state or the country one is situated. In the most general sense, drought originates from a deficiency of precipitation over an extended period of time--usually a season or more--resulting in a water shortage for some activity, group, or environmental sector. Its impacts result from the interplay between the natural event (less precipitation than expected) and the demand people place on water supply, and human activities can exacerbate the impacts of drought.

Droughts may be measured by a number of indicators, including:

- Levels of precipitation
- Soil conditions (moisture)
- Temperature

There are four ways in which droughts can be viewed:

Meteorological – a measure of departure of precipitation from normal. Due to climatic differences, what may be considered a drought in one location of the country might not be a drought in another location.

Agricultural – refers to a situation where the amount of moisture in the soil no longer meets the needs of a particular crop.

Hydrological – occurs when surface and subsurface water supplies are below normal.

Annual Indicators – the California Department of Water Resources uses three indicators to evaluate water conditions in California. These are Snowpack, Precipitation, and Reservoir Storage as percentages of the annual average.

Disaster History

A significant drought, reported by many of the ranchers in southern California, occurred in 1860. The great drought of the 1930s, coined the "Dust Bowl," was geographically centered in the Great Plains yet ultimately caused water shortages in California. The drought conditions in the Plains resulted in a large influx of people to the West Coast. Approximately 350,000 people from Arkansas and Oklahoma immigrated mainly to the Great Valley of California. As more people moved into California, increases in intensive agriculture led to overuse of Santa Ana River watershed and groundwater resulting in regional water shortages.

Historically, California has experienced severe drought conditions. The approved 2013 State Hazard Mitigation Plan (SHMP) states that from 1972 to 2009, there have been eight drought-related State Emergency Proclamations in California. Through 2012, the California Office of Emergency Services administered costs due to drought totaling $2,686,858,480.

Beginning in 2009, California entered into another drought situation. Water years 2012 and 2013 were dry statewide, and the 2013 record-low precipitation has worsened California's conditions for the 2014 water year (started October of 2013). Statewide reservoir storage is down significantly and impacts of two (possibly three) dry years in a row has caused significant water delivery issues in California. In January 2014, a statewide Gubernatorial State of Emergency Proclamation was issued for the drought emergency and remains in effect until further notice. There are no indicators when this situation may improve, or if it will continue to worsen. Allocations for contractors of Department of Water Resources State Water Project (SWP) and the U.S. Bureau of Reclamation's (USBR's) Central Valley Project (CVP) are dependent upon snowpack accumulation in the Cascades and Sierra Nevada mountains. In April 2015, DWR announced an initial allocations lower than the SWP contractors' requested amounts. In Orange County, MWDOC has been subject to these decreased allocations. For more information on current drought conditions in California, visit: http://www.water.ca.gov/waterconditions/droughtinfo.cfm.

Regulatory Environment

Several bills have been introduced into Congress in an effort to mitigate the effects of drought. In 1998, President Clinton signed into law the National Drought Policy Act, which called for the development of a national drought policy or framework that integrates actions and responsibilities among all levels of government. In addition it established the National Drought Policy Commission to provide advice and recommendations on the creation of an integrated federal policy. The most recent bill introduced into Congress was the National Drought Preparedness Act of 2003, which established a comprehensive national drought policy and statutorily authorized a lead federal utility for drought assistance. Currently there exists only an ad-hoc response approach to drought unlike other disasters (e.g., hurricanes, floods, and tornadoes) which are under the purview of FEMA.

The 2015 California Drought Contingency Plan was prepared in conjunction with the California Water Plan and both documents are updated every five years. The purpose of the plan is to minimize drought impacts by improving agency coordination, enhancing monitoring and early warning capabilities, conducting water shortage impact assessments, and implementing preparedness, response, and recovery programs. The California Water Plan presents strategic plan elements including a vision, mission, goals, guiding principles, and recommendations for current water conditions, challenges, and activities. The plan includes future uncertainties and climate change impacts, scenarios for 2050, and a roadmap for improving data and analytical tools.

Localized regulations for drought are mentioned in local municipal codes. The County of Orange, Code of Ordinances Section 3 provides the definition of a drought emergency. Section 7 defines use of water and landscaping during conservation times under the state model, and Article 1 outlines water conservation and the governance over well water use in Orange County. All retail water utilities have drought ordinances that specify use of drinking water during the various phases of drought.

On a statewide basis, a number of regulatory requirements and documents address planning for drought in California, most notably the 2015 California Drought Contingency Plan.

Magnitude/Severity

Drought severity depends on numerous factors, including duration, intensity, and geographic extent, as well as regional water supply demands by humans and vegetation. The severity of drought can be aggravated by other climatic factors, such as prolonged high winds and low relative humidity. The magnitude of drought is usually measured in time and the severity of the hydrologic deficit. Drought can also be further affected by environmental restrictions.

Drought is one of the few hazards that has the potential to directly or indirectly impact each and every person within Orange County, as well as adversely affect the local economy. The impacts would be water restrictions associated with domestic supplies, agricultural losses and economic impacts associated with those losses, economic impacts to tourism and recreation industries, hydroelectric power reductions, increased wildland firefighting costs, and increased costs for water. The magnitude of the drought's impact will be directly related to the severity and length of the drought. Secondary effects include increased susceptibility to wildfires and pine beetle infestations which can weaken pine trees

and make them more susceptible to drought conditions. Increased groundwater pumping during times of drought can contribute to land subsidence problems. However, the basins in Orange County are managed basins, restricting over-pumping and managing recharge operations.

Several resources are available to evaluate drought status and estimate future expected conditions. The National Integrated Drought Information System (NIDIS) Act of 2006 (Public Law 109-430) prescribes an interagency approach for drought monitoring, forecasting, and early warning. The NIDIS maintains the U.S. Drought Portal (www.drought.gov), a web-based access point to several drought related resources.

A number of indices measure how much precipitation for a given period has deviated from historically established norms.

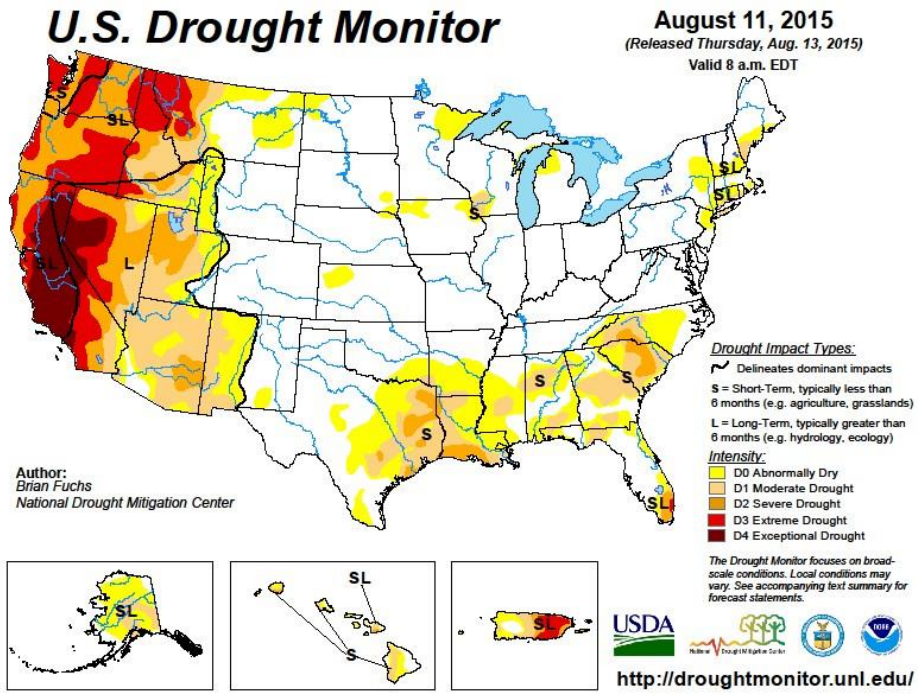
The primary indicator for the U.S. Drought Monitor and U.S Seasonal Drought Outlook for the western United States is the Palmer Drought Severity Index (PDSI). PDSI is a commonly used index that measures the severity of drought for agriculture and water resource management. It is calculated from observed temperature and precipitation values, and estimates soil moisture. While U.S. Department of Agriculture uses the PDSI to determine when to grant emergency drought assistance, it is not considered consistent enough to characterize the risk of drought on a nationwide basis (FEMA, 1997) nor is it well suited to the dry, mountainous areas in the western U.S.

For western states with mountainous terrain and complex regional microclimates, it is useful to supplement the PDSI values with other indices such as Surface Water Supply Index and Standardized Precipitation Index (SPI). The Surface Water Supply Index takes snowpack and other unique conditions into account. The National Drought Mitigation Center (NDMC) uses the SPI to identify emerging drought months sooner than the PDSI. It is computed on various time scales to monitor moisture supply conditions.

The SPI is the number of standard deviations that precipitation value would deviate from the long-term mean.

The Vegetation Drought Response Index, or VegDRI, is a bi-weekly depiction of vegetation stress across the contiguous United States. VegDRI is a fine resolution index based on remote sensing data, and incorporates climate and biophysical data to determine the cause of vegetation stress. Development of the VegDRI map and associated products is a joint effort by the NDMC, the USGS National Center for Earth Resources Observation and Science (EROS), and the High Plains Regional Climate Center (HPRCC).

The graphic below from the National Weather Service Prediction Center provides updates regarding the drought impacts both long and short term for the United States. As seen below, in 2015, majority of California, is in an extreme drought situation, and the County of Orange is no exception.



Source: http://droughtmonitor.unl.edu/

Vulnerability Assessment

Drought produces a complex web of impacts that spans many sectors of the economy and reaches well beyond the area experiencing physical drought. This complexity exists because water is integral to our ability to produce goods and provide services.

Impacts are commonly referred to as direct or indirect. Reduced crop, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat are a few examples of direct impacts. The consequences of these impacts illustrate indirect impacts. For example, a reduction in crop, rangeland, and forest productivity may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced tax revenues because of reduced expenditures, increased crime, foreclosures on bank loans to farmers and businesses, migration, and disaster relief programs. Direct or primary impacts are usually biophysical. Conceptually speaking, the more removed the impact from the cause, the more complex the link to the cause. In fact, the web of impacts becomes so diffuse that it is very difficult to come up with financial estimates of damages. The impacts of drought can be categorized as economic, environmental, or social.

Many economic impacts occur in agriculture and related sectors, including forestry and fisheries, because of the reliance of these sectors on surface and subsurface water supplies. In addition to obvious losses in yields in both crop and livestock production, drought is associated with increases in insect infestations, plant disease, and wind erosion. Droughts also bring increased problems with insects and diseases to forests and reduce growth. The incidence of forest and range fires increases substantially

during extended droughts, which in turn places both human and wildlife populations at higher levels of risk.

Income loss is another indicator used in assessing the impacts of drought because so many sectors are affected. Reduced income for farmers has a ripple effect. Retailers and others who provide goods and services to farmers face reduced business. This leads to unemployment, increased credit risk for financial institutions, capital shortfalls, and loss of tax revenue for local, state, and federal government. Less discretionary income affects the recreation and tourism industries. Prices for food, energy, and other products increase as supplies are reduced. In some cases, local shortages of certain goods result in the need to import these goods from outside the stricken region.

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

Social impacts mainly involve public safety, health, conflicts between water users, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many of the impacts specified as economic and environmental have social components as well. Population out-migration is a significant problem in California's Central Valley, as agricultural jobs are reduced. Migration is usually to urban areas within the stressed area or to regions outside the drought area. However, when the drought has abated, these persons seldom return home, depriving agricultural areas of valuable human resources necessary for economic development. For the urban area to which they have immigrated, they place ever-increasing pressure on the social infrastructure, possibly leading to greater poverty and social unrest.

In the long-term, the County of Orange must continue to focus on mitigation actions to enhance local water storage, recycle water projects, increased water conservation programs, and looking at environmental erosion control projects without causing a significant economic disruption. Drought mitigation has a cascading effect and impact on other natural hazards including flooding and wildland fire.

Other economic losses occur for water utilities and small groundwater well owners. Income loss for water retail agencies can result in the need to increase water rates in order to cover fixed operational costs. As groundwater becomes unavailable, agencies or properties are required to drill deeper wells or identify alternate sources that are often more expensive and sometimes limited. Some water utilities are having to adjust their treatment processes or supply based on availability, resulting in higher operating costs and, at times, damage to their filters over long periods of time.

3.8 Climate Change

According to the U.S. Environmental Protection Agency (EPA), Earth's average temperature has risen by 1.4°F over the past century, and is projected to rise another 2 to 11.5°F over the next hundred years. Small changes in the average temperature of the planet can result in large and potentially dangerous shifts in climate and weather.

With increases in temperature, Earth's climate is changing. Snow and rainfall patterns are shifting, and more extreme climate events like heavy rainstorms and record high temperatures are already occurring. Scientists are highly confident that many of these observed changes can be linked to the climbing levels of carbon dioxide and other greenhouse gases in our atmosphere, which are caused by human activities.

Many places have seen changes in rainfall, resulting in more floods, droughts, or intense rain, as well as more frequent and severe heat waves. The planet's oceans and glaciers have also experienced some big changes - oceans are warming and becoming more acidic, ice caps are melting, and sea levels are rising. As these and other changes become more pronounced in the coming decades, they will likely present challenges to our society and our environment.

Data from National Oceanic and Atmospheric Administration (NOAA) shows increases in observed sea level rise around the United States and globally. Climate models provide data and projections using atmosphere-ocean general circulation models (GCM) that drive climate models. They are showing an increase in carbon dioxide concentrations where multiple GCMs have been run to project 21st century climate.

Community Climate Change Issues

Water Supply & Demand

Drinking water supply for Orange County is approximately half local and half imported. The Metropolitan Water District (MWD) of Southern California provides Orange County with its import water, which is obtained from the State Water Project (SWP) and from the Colorado River Aqueduct. Water from both sources is purified and tested at the Diemer Filtration Plant in Yorba Linda then piped to the various water districts in Orange County. The groundwater basin is recharged with recycled water, natural recharge, Santa Ana River base flows, and storm flow. According to data from the Orange County Water District (OCWD), the demand for groundwater has more than doubled in the last 60 years; however, basin storage must be managed within limits or risk adverse impacts.

Because of the importance of imported water supply to Orange County, potential impacts of climate change to water resources must be considered over a region broader than the Orange County area. Changes in observed climatic variables in this larger region representing the Western U.S. have been studied through data collected over the past 100 years. Within this period it has been observed, particularly in winter and spring, temperatures have risen significantly across western North America. Data collected over the past 50 years indicate warming in the mountainous western North America that has led to a higher rain-to-snow ratio, lower snow water content, a decline in March snow cover, and a

shift toward earlier annual snowmelt. These observations strongly support the need for incorporating climate change into long-term water resources planning efforts.

An overall assessment of vulnerability to climate change for Orange County following a checklist presented in the DWR Climate Change Handbook for Regional Water Planning, and specifically recommended for climate change planning was performed and is available from Orange County Public Works. As noted, the major water supply system vulnerabilities are tied to the water supply system in California and the Colorado River Basin that are being evaluated through statewide or regional efforts.

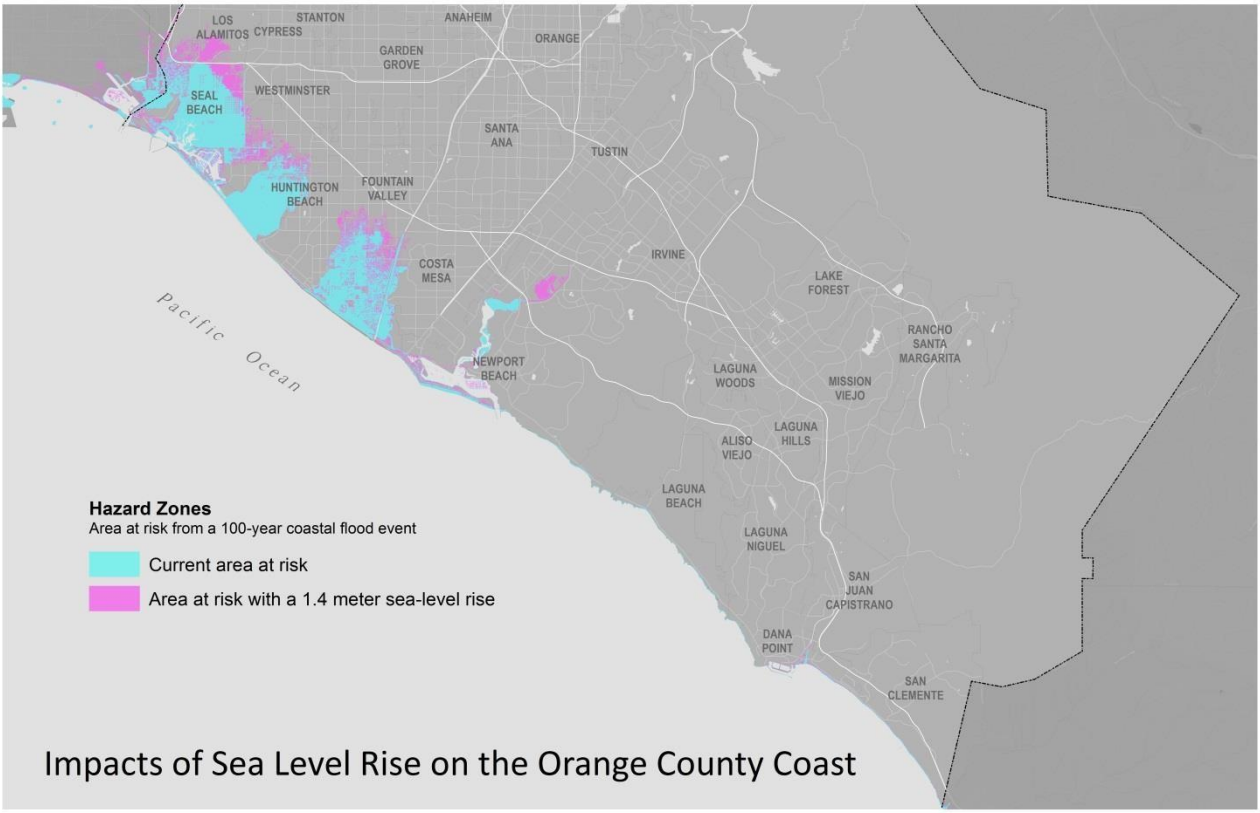
The best current understanding of climate change has been incorporated in the assessment of impacts, especially those relating to water supply and sea level rise. Several major planning studies have been performed for Orange County water supply regions that consider the impacts of climate change. Based on projected climate change conditions for the region, comprehensive analyses for both the California and the Colorado basins are severely water constrained indicating it will be challenging to meet current allocations in future years. The planning model projections indicate there will be years where deliveries will sometimes fall short of allocations, over planning horizons that range from 20 to 50 years into the future with assumptions that no changes are made to the existing operational infrastructure of the system. Population growth and anticipated increases in municipal demands must be addressed in the dual challenge of reduced supplies and increased demand. Looking forward, it is expected that these plans will be updated as better information on climate projections, including extreme events become available, and impacts to other sectors, such as water quality and habitats will be similarly evaluated.

Sea Level Rise

Although variable at different points along the coast due to regional factors, sea levels are rising globally due to climate warming including expansion of ocean water and melting of land ice. Along the Pacific Coast, the highest values of sea level rise in Southern California have been reported at Newport Beach near the study region, where the observed increase is 2.22 mm per year. These rates are projected to accelerate over the 21st century.

A recent review of different calculation approaches by the National Academy of Sciences reported estimated global sea level rise. This review also projected that sea level in Southern California, which is slightly higher than the global average because of land subsidence, and will be approximately (relative to year 2000) 2 to 12 inches by 2030, 5 to 24 inches by 2050 and 17 to 66 inches by 2100. Numerous studies have been done that will report different results as each are based on different methodologies. Future sea level rise estimates will vary based on future greenhouse gas emissions and projections.

Maps illustrating the effects of sea level have been developed for California to identify approximate vulnerable areas. An example is shown for Orange County in Map 24.



☐ **Map 24 - Impacts of Sea Level Rise on the California Coast-(Pacific Institute, 2009 (Projections still current as of 2015))**

Much of the damage from this accelerated sea level rise will be likely caused by an increase in the frequency and intensity of coastal flooding and erosion associated with extreme weather events and storm surges. In addition to sea-level rise, California's coastal and ocean resources are expected to experience dramatic changes. These include more severe atmospheric events (e.g. El Nino events); changes in ocean chemistry (e.g. temperature and pH) and estuarine chemistry (temperature, pH, and salinity); and changes to ecosystem processes (e.g. nutrient upwelling). The outlook and future of the coast is uncertain; however, we will need to change the way we manage our natural assets. Existing laws such as the California Coastal Act, provides state and local governments with tools for addressing the effects of climate change but also impose some significant limitations.

Water Quality

Less frequent but more intense rainfall patterns could have serious consequences on water quality at our beaches. Lower precipitation in summertime may also leave contaminants more concentrated in stream flows. Heavy runoff offers a medium for infectious disease vectors to spread and multiply. Large amounts of runoff could overwhelm the capacity of infrastructure including storm drains, flood control channels and pump stations.

Flooding

Past El Nino events have resulted in significant financial damages and exposed large numbers of people to flooding hazards. Flooding having a significant impact in the Canyon areas and along flood control channels also creates challenges for wastewater utilities as they receive increased flows in their systems. Climate change will likely exacerbate these impacts with larger waves and higher water levels. Coastal erosion and sediment transport patterns will be impacted by larger and longer duration of winter waves and increased exposure to tropical weather systems.

Property

The largest impact on the community from gradual sea water inundation is the loss of property, if plans are not made to mitigate for sea level rise and protection from storm surges and other flood related events. Known risk areas include, but are not limited to: City, county and state Beaches; buildings and other types of structures, in harbors and along the coastal inundation areas. In coastal areas where topography is relatively flat, the risk would include low-lying areas adjacent to but further away from the coast. As sea levels continue to rise, structures on the inland side of Pacific Coast Highway will be affected. Although sea level rise would be a gradual, planning and implementation would greatly reduce impacts to lives.

Orange County has many communities along its coastline with high to very high-priced homes. The results of sea level rise due to climate change could potentially destroy or damage thousands of homes and businesses over time resulting in displacement and relocation of people and businesses.

Infrastructure

Over time, if infrastructure is not relocated outside possible inundation areas, damage to roads, bridges, water infrastructure, power lines, vital equipment, and other property and facilities could occur due to flooding. Damage to public water and sewer systems, and transportation networks would greatly impact residents.

Consideration and planning for the protection of infrastructure will be very challenging as coastal Orange County is completely developed; however, there would be direct consequences to the local economy resulting from non-action to protect infrastructure.

Services

Planning considerations and efforts of local agencies and community entities whose facilities and offices are located within the possible inundation areas should include the possibility of relocation. While some time allows for planning, locations of public offices, schools, senior homes and emergency serviceshospitals, fire and police stations should all be studied.

Ecosystem and Habitat Vulnerability

Environmental losses are the result of damages to plant and animal species, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil

erosion. Environmental effects are likely to become permanent. Wildlife habitat, for example, may be degraded through the loss of their habitat; however, many species could relocate, survive and maybe recover adjusting to new environments, resulting in the entry of invasive species crowding out already stressed native species and the local appearance of tropical disease vectors. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity of the landscape. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects.

Earth's oceans have maintained a relatively stable acidity level for tens of millions of years. But research shows that this balance is being undone by a recent and rapid drop in surface pH that could have devastating global consequences.

Since the early 1800s, fossil fuel-powered machines have driven human industry and advancement. Unfortunately the consequence has been the emission of billions of tons of carbon dioxide (CO2) and other greenhouse gases into Earth's atmosphere. Scientists know that about half of this man-made CO2 has been absorbed over time by the oceans. Relatively new research is finding that the introduction of massive amounts of CO2 into the seas is altering water chemistry and affecting the life cycles of many marine organisms, particularly those at the lower end of the food chain.

Mitigation Activities

More detailed analysis of the effects of sea level rise in specific areas along the coastline is recommended. These analyses need to consider the dynamics of storm surges and the existing protective infrastructure. We also need to consider the occurrence of extreme precipitation events for planning emergency response.

A new set of projections are expected in 2013-14 (the fifth assessment) and may provide more current information for planners. Similarly, there is an ongoing effort to develop detailed dynamically downscaled climate projections for North America that may provide better information on future climate in the region.

Along with other counties in California, Orange County has been working with FEMA on remapping California Coastal areas through the CCAMP and FEMA Open Pacific Coast Study to complete coastal analysis to be included in the next version of the FEMA FIRM maps (“Flood Risk”). As mapping is a necessary step in assessing potential adverse conditions, Orange County needs to implement more climate change mitigation activities over the next few years. However, in bringing the subject to the forefront and to familiarize businesses and the general public, some of the mitigation activities could include:

1. Public information plan for sea level rise
2. Disaster preparedness public education for climate change
3. Estimates for the value of potential loss

Vulnerability and Risk

Climate change has the possibility of producing impacts that span many sectors of the economy and reaches well beyond the area of experiencing physical sea level rise or long term temperature rise. The impacts would be complex and can be direct or indirect. A few examples of direct impacts are productivity from agriculture could decrease; fire hazard could increase; drinking water levels could decrease; wildlife mortality rates and damage to wildlife and fish habitat could increase. The consequences of these impacts may result in reduced income for businesses, increased prices for food and resources, unemployment, reduced tax revenues due to reduced expenditures, increased crime, foreclosures on bank loans to businesses, and migration. The web of impacts would be complex making it challenging to come up with financial estimates of damages. The impacts of climate change can be categorized as economic, environmental, or social.

Social impacts involve public safety, health, reduced quality of life, and inequities in the distribution of impacts and disaster relief. Many of the impacts specified as economic and environmental have social components as well. We could see migration out of the coastal areas where increasing pressure on the social infrastructure could result.

Municipalities will have to make decisions about which critical assets to protect, relocate, or remove and what is economically feasible. It will be challenging to achieve multiple goals such as protection of critical infrastructure, sustained coastal recreation, and ecosystem protection. Agencies need to recognize there could be conflicts and develop priorities while working with the regulatory agencies.

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3.9 Epidemic

Vaccines, antibiotics, and improved living conditions resulted in dramatic declines in communicable diseases in the latter part of the 20th Century. However, infectious diseases have become an increasing threat to all persons in Orange County over the past decades due to a variety of factors such as: population growth (crowding, aging, migration), methods of food production (large scale, wide distribution, importation), environmental changes (drought, encroachment of humans on wild areas,

global warming), microbial adaptation (resistance to antibiotics, re-assortment of genetic material), changes in health care (drugs causing immunosuppression, widespread use of antibiotics), and human behavior (travel, diet, sexual behavior, compromised immune systems, immunization rates).

Orange County has programs within the Health Care Agency (HCA) that monitor the occurrence of communicable diseases and work to prevent their occurrence. Under California law, certain communicable diseases are required to be reported to local health departments. An on-call system utilizing Orange County Sheriff's Department (OCSD) Communications Control One allows urgent reports to be received 24 hours per day, 7 days a week. HCA staff investigates individual cases of reported communicable diseases and outbreaks, analyzes trends in disease occurrence, and makes recommendations to prevent spread. More information is available at http://ochealthinfo.com/phs/about/dcepi/.

Although transmission of communicable diseases occurs on a daily basis in every community, most instances are not of the severity or magnitude to be considered a county-wide hazard. However, an outbreak, epidemic, or pandemic, or the introduction of a novel disease, could pose a large threat to the health of the community. An **outbreak** is an increase, usually sudden, of occurrences of a particular disease over the baseline occurrence, for a specific time period and place. An **epidemic** is an outbreak that spreads quickly and widely through a given community or location over a relatively short period of time. A **pandemic** is a widespread outbreak or epidemic that spreads to other geographic areas, countries or continents.

Current epidemic threats include:

- Foodborne illness, including norovirus;
- Influenza, including seasonal, novel, and/or pandemic influenza strains;
- Childhood vaccine-preventable diseases, such as measles and pertussis;
- West Nile Virus and other vector-borne diseases;
- Emerging pathogens such as Middle East Respiratory Syndrome Coronavirus (MERS-CoV) or Ebola

General Public Health Response to an Outbreak/Epidemic

Once an outbreak is suspected by HCA Public Health, an investigation is launched which includes the following steps:

1. Confirmation of the outbreak.
2. Investigation of the epidemic to determine its etiology, source, mode of transmission and persons affected and at risk.
3. Determining and recommending control measures to prevent further spread.
4. Health professional and public notification and education as needed.

Coordination of response to large outbreaks and epidemics is outlined in the HCA Emergency Operations Plan Disease Outbreak Response Annex and other supporting agency plans. In addition, HCA has developed policies and procedures for the use, implementation and enforcement of health officer orders for isolation and quarantine as part as the response to communicable diseases and

outbreaks/epidemics. In the event of a vector-borne disease outbreak or emerging vector-borne disease, HCA collaborates with the Orange County Mosquito and Vector Control District (OCMVCD).

Foodborne Illness, including Norovirus

The Centers for Disease Control and Prevention (CDC) estimates that every year approximately one (1) in 6 Americans (or 48 million people) gets sick, 128,000 are hospitalized, and 3,000 die of foodborne diseases in the United States. Extrapolated to the Orange County population, that would suggest approximately 500,000 people get sick with foodborne illness each year. Examples of reportable infections that may potentially be food-borne include bacteria such as *Salmonella, Campylobacter,* and shiga-toxin producing *Escherichia coli* (STEC). In Orange County, on average approximately 400 cases of *Salmonella,* 400 *Campylobacter*, and 40 STEC are reported each year. Not all foodborne illness is reportable and even the diseases that are reportable are under-reported and under-diagnosed. We do not have exact numbers of how many people are affected.

In general, foodborne illnesses cause symptoms such as diarrhea, vomiting, and/or abdominal cramps. Some people may also have fever. Complications of foodborne illnesses include dehydration, and spread of the infection to the blood or other parts of the body, especially if a bacteria is involved.

Foodborne illnesses can result from exposure to contaminated food prepared at home or at a restaurant or market, from contaminated food sources and/or human error in preparation or storage. Each year, the Orange County HCA receives 800-1,000 reports of foodborne illness, and investigates 20-40 foodborne outbreaks. Most foodborne illnesses can be prevented with proper handling and preparation of food and avoiding having ill persons handle and serve food.

Mitigation Measures for Foodborne Illness

To mitigate the hazard of foodborne illness, HCA conducts the following activities:

- Operation of a Foodborne Illness Hotline to receive reports of foodborne illness from the public.
- Receipt and review of all communicable disease reports.
- Outreach and education of local medical providers and healthcare facilities about the importance of timely reporting of reportable diseases and potential outbreaks.
- Prompt review and assessment of all reported disease events that could be associated with foodborne illness outbreaks.
- Investigation of potential foodborne illness to determine the source and decrease transmission.
- Laboratory testing to identify specific pathogens and determine if individual infection reports are linked to a community outbreak.
- Conducting *Risk-Based Inspections* that focus on the five identified CDC risk-based factors that are mostly identified in foodborne illness outbreaks (based on FDA 1998-2008 study). This includes regular audits of inspectors to ensure their focus during routine inspections remains on the major risk factors.
- Utilization of the Food and Drug Administration's Oral Culture Learning format to better communicate food safety measures for non-traditional written base cultures, such as the Hispanic culture. These training guides utilize stories or pictures to better communicate food safety practices.

- Provision of routine trainings relative to foodborne illness investigations through town hall meetings and an annual Council to Improve Foodborne Outbreak Response (CIFOR) training for all field inspectors to focus their attention on preventing or eliminating CDC Risk Factor violations.
- Provision of written and web-based materials to educate food workers to stay home when ill.
- Implementation of restaurant education programs that address education about food handling and staying home when ill.
- Collaboration with the Orange County Department of Education to provide safe food handling information to children.
- Coordination with HCA and community partners to distribute educational materials about safe food handling.

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Influenza, including Seasonal, Novel, and/or Pandemic Influenza Strains

Influenza is a contagious respiratory illness caused by influenza viruses. Although many illnesses are selflimited and mild, complications of seasonal influenza cause on average more than 200,000 hospitalizations and up to 49,000 deaths each year in the United States. In Orange County, severe influenza cases (defined as persons who have influenza and are admitted to the intensive care unit or die) in persons less than 65 years of age are reportable. Since 2010 (not including the H1N1 pandemic year), Orange County has had up to 57 severe influenza cases, with 21 deaths, in one season during the annual epidemic period.

A pandemic occurs when a new (novel) virus that humans have not encountered before, and therefore have no immunity to, begins circulating, causes infections and spreads quickly from person to person, causing substantial morbidity and mortality across geographic areas. Orange County HCA routinely does surveillance for seasonal influenza as well as enhanced surveillance for novel strains and human infections with bird (avian) or pig (swine) influenza strains that are circulating in other parts of the country and the world.

In 2009, an H1N1 influenza pandemic spread quickly and led to over 200 severe influenza cases and 50 deaths in Orange County. The 2009 H1N1 influenza virus quickly established itself as a seasonal influenza

strain and was the predominant virus in the 2013-2014 influenza season. Although the mortality rate from H1N1 Influenza during this pandemic was low, other strains may cause more severe illness with case fatality rates over 3%.

An influenza pandemic is likely to occur in "waves" of infection, each lasting approximately 8 to 12 weeks and separated by weeks of inactivity. In total, it could last from 18 months to several years. An influenza pandemic is likely to affect everyone in Orange County at some point and can greatly impact "business as usual" in any sector of society or government. A pandemic will place a great strain on existing health care resources and may exceed available resources. Personnel, supplies, equipment, and pharmaceutical responses (e.g., vaccination and antivirals) may be in short supply and/or unavailable. If transportation is compromised in the region or country, food and other essentials may be unavailable as well. Outbreaks are expected to occur simultaneously throughout much of the County and the State, which may limit the availability of mutual aid assistance and resources from other areas.

Mitigation Measures for Influenza (including Seasonal, Novel, and/or Pandemic Influenza Strains)

To mitigate the hazard of seasonal, novel and/or pandemic influenza, HCA conducts the following activities:

- Maintenance of routine influenza surveillance and a network of sentinel outpatient care providers.
- Investigation and reporting of severe influenza cases (defined above).
- Education of health care providers and the public about the importance of annual influenza vaccination and prompt treatment of suspect influenza cases at high risk for complications with antiviral medication
- Laboratory testing to identify circulating viruses causing influenza-like illness, and monitor influenza strains
- Investigation of outbreaks of respiratory illness in the community and institutional settings.
- Provision of publicly funded influenza vaccine through HCA clinics and community partners.
- Annual exercising of mass vaccination clinics (Point of Dispensing [POD] sites) using influenza vaccine.
- Maintenance of an *Eye on Influenza* newsletter and distribution list to provide influenza updates to healthcare and community partners.
- Maintenance of current information on the HCA website and issuing of press releases as needed with important updates.
- Collaboration with school nurses, local medical societies and other community healthcare partners as well as emergency management to provide uniform up-to-date recommendations and messaging to the public.
- Enhanced surveillance for novel or pandemic influenza strains using Centers for Disease Control and Prevention (CDC) and California Department of Public Health (CDPH) guidelines to support early detection.
- Utilization of health officer orders for isolation and quarantine as needed early in a pandemic or after introduction of a novel influenza strain to limit further spread in the community.

- Provision of recommendations for infection control, treatment, prophylaxis, and nonpharmaceutical community mitigation measures such as strict adherence to respiratory hygiene and cough etiquette, hand washing, self-isolation, and social distancing.

Childhood Vaccine-Preventable Diseases, such as Measles and Pertussis

Before the middle of the last century, life-threatening diseases such as *Haemophilus influenzae*, diphtheria, polio, measles and rubella affected hundreds of thousands of infants, children, and adults in the United States, with thousands dying every year. Since the advent and widespread use of vaccines, these diseases have declined dramatically and nationally, vaccine-preventable disease levels are at or near record lows. Vaccinations for chickenpox, diphtheria, *Haemophilus influenzae* type B, hepatitis A, hepatitis B, influenza, measles, mumps, pertussis, polio, pneumococcus, rotavirus, and rubella are now routinely available for infants and children. However, this is not the case throughout the world and outbreaks of diseases such as polio and measles still occur regularly. Even though most children in the U.S. have received the recommended vaccines by age 2 years, many under-immunized children remain, leaving the community vulnerable to outbreaks of these diseases. The California Department of Public Health compiles data annually on immunization rates at kindergarten entry by school and makes it available on an interactive website (http://www.shotsforschool.org/k-12/how-doing/). For Orange County-specific data on vaccination rates for the MMR (measles, mumps, rubella) vaccine by school district, see https://media.ocgov.com/civicax/filebank/blobdload.aspx?BlobID=41625.

Measles – Measles is one of the most contagious of all infectious diseases with over 90% of exposed people developing infection if they are not already immune, either by previous infection or immunization. In the pre-vaccination era, there were on average over 500,000 cases in the U.S. and almost 500 deaths reported annually. Cases dropped dramatically after vaccination against measles was introduced in the 1960's and a second dose of vaccine was routinely recommended in 1989. In 2000, measles was declared eliminated in the U.S., meaning there was no ongoing transmission, but cases and outbreaks continue to occur from visitors or returning travelers from countries were measles is still common introducing the virus into unvaccinated or under-vaccinated communities. In the U.S. there have been between 37 to 644 cases of measles reported each year, with multiple outbreaks reported in 2013, 2014, and now 2015. In Orange County, 0-1 cases of measles were reported annually between 2010 and 2013, but large outbreaks resulted in 23 cases reported in 2014, and 35 cases reported in the first few months of 2015.

Pertussis – Pertussis (whooping cough) is a highly contagious respiratory infection caused by a bacteria *Bordetella pertussis*. Although symptoms may be mild and resemble an ordinary "cold" in some people, the infection may become more serious, particularly in infants, and cause hospitalizations and even death. Infections in the U.S. decreased dramatically with the advent of the whole-cell DTP (diphtheria, tetanus, pertussis) vaccine in the 1940's, but have increased over the past 20-30 years, partially because of increased awareness, improved testing, better reporting, and waning immunity from the acellular pertussis vaccine (DTaP) used since the 1990's. California has had particularly large outbreaks since 2010 with numbers as high as those in the 1940's. Over 9,000 pertussis cases and 10 infant deaths were reported with disease onset in 2010 and over 11,000 cases and 3 infant deaths were reported with disease onset in 2014. In Orange County, 467 pertussis cases were reported in 2010 and 397 in 2014.

Mitigation Measures for Childhood Vaccine-Preventable Diseases, such as Measles and Pertussis

To mitigate the hazard of childhood vaccine-preventable diseases in Orange County, HCA conducts the following activities:

- Case investigation and contact tracing to monitor incidence of diseases and limit further transmission in the community.
- Maintenance of adequate vaccine supply for publicly funded vaccine and outbreak response.
- Coordination of Vaccines for Children (VFC) vaccine supply and distribution through the Immunization Action Program.
- Collaboration with multiple community partners to educate the public and healthcare about the importance of vaccination ○ Coordination of Orange County Immunization Coalition, with monthly meetings and a newsletter
    - Quarterly attendance at school nurse meetings to provide immunization updates ○ Provision of immunization updates in the local American Academy of Pediatrics newsletter and at the Orange County Medical Association meetings
    - Outreach to California Health and Disability Prevention (CHDP) providers ○ Participation in community forums
    - Outreach to obstetricians, perinatal service providers and pharmacist associations to improve vaccination rates in pregnant women—especially for pertussis and influenza.
- Collaboration with community-based organizations to address low vaccination rates ○ Orange County Children's partnership ○ Social Services Agency ○ Children's and Families Commission
- Publication of an annual Conditions of Children report summarizing immunization rates and mapping State data on immunization rates of incoming kindergarteners by school district.
- Maintenance of current information on the HCA website, including links to the Immunization Action Coalition and Shots for Schools website, and issuing of press releases as needed with vaccinepreventable disease instances in the community prompting immunization reminders.

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Emerging Pathogens such as Middle East Respiratory Syndrome Coronavirus (MERS-CoV) or Ebola

With advances in travel, diseases can quickly spread throughout the world. Orange County with its diverse population and large tourism industry is particularly at risk for importation of diseases that may previously have been localized to other countries or continents. These diseases pose a significant hazard if they are highly transmissible from person to person and if they have significant morbidity or mortality. In the past decade, we have prepared to respond to multiple such diseases such as Severe Acute Respiratory Syndrome (SARS), avian influenza H5N1, MERS-CoV and Ebola. Although these diseases may have different modes of

transmission, symptoms, and natural history, the approach to handling the threat of an emerging or novel communicable disease is similar.

Mitigation Measures for Emerging Pathogens such as Middle East Respiratory Syndrome Coronavirus (MERS-CoV) or Ebola

To mitigate the hazard of emerging or novel pathogens in Orange County, HCA conducts the following activities:

- Maintenance of a network of sentinel outpatient care providers for surveillance.
- Enhanced surveillance for emerging or novel pathogens using CDC and CDPH guidelines to support early detection.
- Investigation of suspect cases meeting surveillance criteria and confirmation through laboratory testing.
- Contact tracing and monitoring to limit transmission in the community.
- Utilization of health officer orders for isolation and quarantine as needed to limit transmission in the community.
- Education of health care providers and the public about the signs and symptoms of the disease, risk factors, treatment and prevention.
- Maintenance of a newsletter and alert distribution list to provide updates to healthcare and community partners.
- Maintenance of current information on the HCA website and issuing of press releases as needed with important updates.
- Collaboration with school nurses, local medical societies and other community healthcare partners as well as emergency management to provide uniform up-to-date recommendations and messaging to the public.

Vector-Borne Diseases

According to the Centers for Disease Control and Prevention (CDC), vector-borne diseases are among the most complex of all infectious diseases to prevent and control due to the difficulty of predicting habits of vectors like mosquitoes, fleas, and ticks. These vectors transmit viruses, bacteria, or other pathogens that infect animals as well as humans. For example, West Nile virus, which is primarily a disease of birds, can be transmitted to humans and other animals by the bite of a mosquito and has been responsible for causing 532 reported infections, including 18 deaths, in Orange County since its introduction to the county in 2004.

The Orange County Mosquito and Vector Control District (OCMVCD) is an independent special district charged with protecting the citizens of Orange County from vectors and vector-borne disease under the California Health and Safety Code (CAL. HSC. § 2000-2910). OCMVCD operates year-round to provide service to all 34 cities within Orange County as well as unincorporated areas, federal, and state lands.

OCMVCD utilizes an Integrated Vector Management (IVM) Program strategy to control populations of mosquitoes, filth flies and black flies, red imported fire ants (RIFA), and rats. The IVM Program consists of the following activities:

1) Surveillance for vectors, vector habitats, and associated pathogens/diseases, including field and laboratory analysis of vectors in order to evaluate populations and emerging disease threats;

2) Source reduction to limit breeding by vectors, including management of vegetation, land, and water with appropriate landowners to minimize vector production and harborage;

3) Education and outreach efforts targeted toward the public and private landowners in ways to facilitate source reduction and minimize disease-carrying vectors;

4) Distribution of mosquito fish (*Gambusia affinis*), a biological control measure used to reduce mosquito production in isolated aquatic features, such as neglected residential swimming pools; and

5) Application of pesticides to minimize vector populations and reduce the threat of potential vector-borne disease transmission to humans.

The vector-borne diseases currently of major public health threat in Orange County include:

- West Nile Virus and other mosquito-borne infections;
- Flea-borne typhus and other flea-borne infections;
- Other vector-borne diseases with the potential to emerge or re-emerge in Orange County.

West Nile Virus (WNV) and other Mosquito-Borne Infections

West Nile Virus - West Nile virus was first detected in Orange County in 2003. This virus is spread by mosquitoes and has become well-established in Orange County since its introduction. Epidemics of West Nile virus infections are expected every year. Although only a small proportion of persons infected develop symptoms, which can include fever, body aches, headaches, and/or rash, infection can also be very severe, resulting in meningitis or encephalitis (inflammation of the brain) and serious sequelae. HCA works closely with the OCMVCD to monitor the presence of the virus in the County.

Other mosquito-borne diseases potentially transmitted by locally abundant Orange County mosquitoes include Saint Louis Encephalitis (SLE), Western equine encephalitis (WEE), and malaria. Although SLE was considered the most important mosquito-borne virus in North America until the arrival of WNV in 1999, SLE virus activity has not been detected in Orange County since the introduction of WNV into the County in late 2003. WEE was a significant cause of death and disease in humans and horses in the United States prior to the establishment of organized vector control programs in the late 1940s. However, WEE has not been detected in mosquitoes, or host animals such as birds in Orange County in many years and is unlikely to pose a threat in the future. Malaria is a serious infection caused by a parasite called
Plasmodium. Although malaria is thought to be eradicated in the United States, imported malaria cases among travelers returning home have the potential to spark a reintroduced of locally-transmitted malaria among the

County's *Anopheles* mosquitoes, which are largely restricted to wetland habitats in Orange County. The last confirmed outbreak of locally transmitted malaria in Southern California occurred in 1991 along the San Diego County/Orange County border. HCA works closely with the OCMVCD to monitor the presence of imported cases of malaria in the County.

Mosquito-borne diseases transmitted by Aedes mosquitoes not currently known to be present in Orange County but in other areas of California include dengue and chikungunya. With recent introductions of several species of non-native mosquitoes from the genus *Aedes* in southern California, including the Asian tiger mosquito (*Aedes albopictus*) and the yellow fever mosquito (*Aedes aegypti*), there is potential for diseases like chikungunya and dengue to become established in Orange County. In 2015, *Aedes aegypti* was detected in Anaheim and believed to be locally eradicated. *Aedes albopictus* has been collected several times in Orange County following small, focal introductions in 2001 and 2004 and successfully eradicated. These mosquitoes are known vectors of dengue and chikungunya viruses. Although local transmission of these viruses is not known from Orange County, human cases of dengue and chikungunya are regularly reported to HCA from travelers returning from known endemic disease areas. Therefore, traveling humans infected with the virus could spread the disease once in areas of Orange County with established populations of these mosquitoes.

- **Dengue** –The World Health Organization reports that dengue is the most rapidly spreading mosquito-borne viral disease in the world. Dengue is transmitted by the bite of a mosquito infected with one of the four dengue virus serotypes. Unlike other mosquitoes, *Aedes aegypti*, the main vector for dengue, bites during the day. *Aedes albopictus*, a secondary dengue vector, can survive in cooler temperate regions. Similar to chikungunya, dengue would likely enter Orange County via an infectious person returning from an area of the world where these diseases are endemic. Symptoms of dengue include fever, severe headache, pain behind the eyes, muscle and joint pain, swollen glands and rash. There is no vaccine or any specific medicine to treat dengue. The only method to reduce the transmission of dengue virus is to control vector mosquitoes and protect against mosquitoes bites. HCA works closely with the OCMVCD to monitor the presence of imported cases of dengue of in the County.
- **Chikungunya** - Chikungunya is a viral tropical disease transmitted by *Aedes* mosquitoes. In recent years the virus has been regularly detected in parts of Mexico and the Caribbean. Typical symptoms are an acute illness with fever, skin rash and incapacitating joint pains that can last for weeks. The latter distinguishes chikungunya virus from dengue, which otherwise shares the same vectors, symptoms and geographical distribution. Most patients recover fully but, in some cases, joint pain may persist for several months or even years. The spread of disease via movement of infected humans is specifically relevant for a pathogen such as chikungunya virus. As with dengue, the only method to reduce transmission of chikungunya is to control vector mosquitoes and protect against mosquitoes bites. HCA works closely with the OCMVCD to monitor the presence of imported cases of chikungunya in the County.

Mitigation Measures for Mosquito-Borne Diseases

To mitigate the hazard of West Nile virus and other mosquito-borne diseases, HCA conducts the following activities:

- Case investigation and collaboration with OCMVCD about potential areas of mosquito exposure.
- Laboratory testing for confirmation of suspect cases especially early in the season.
- Education of health care providers and the public about the signs and symptoms of the disease, testing, risk factors, treatment and prevention.
- Maintenance of a newsletter and alert distribution list to provide updates to healthcare and community partners.
- Maintenance of current information on the HCA website and issuing of press releases as needed with important updates.
- Education of persons with recently acquired dengue or chikungunya infections to avoid mosquito exposure for the seven days after symptom onset.

To mitigate the hazard of West Nile virus and other mosquito-borne diseases, OCMVCD conducts the following activities:

- Extensive larval and adult mosquito control activities throughout Orange County to suppress mosquito populations.
- Education and outreach to the public on source reduction (elimination of vector breeding sources and vector favorable conditions) and personal protection measures.
- Conduct mosquito exposure investigations of WNV human cases.
- Provision of training and consultation to private firms, municipal staff, and other interests to reduce and eliminate vector breeding sources.
- Coordination with regional vector control districts to respond quickly to the detection of new invasive mosquito species and diseases.
- Provision of education materials in multiple languages to the public.
- Coordination with OCMVCD public health, municipal, and community partners in the event of a mosquito-borne disease outbreak or epidemic

Since the detection of mosquitoes carrying human pathogens may result in area-wide application of pesticides by truck or aircraft, OCMVCD will work closely with HCA and the County Agricultural Commissioner for application notification.

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Flea-Borne Diseases

Flea-borne typhus - Orange County has experienced a resurgence of flea-borne typhus over the last ten years. Since 2006, 132 human cases have been reported to HCA. Flea-borne typhus is a bacterial (rickettsial) infection transmitted by fleas found on backyard wildlife and domestic pets. The transmission cycle in Orange County involves cat fleas, cats, opossums, and other backyard wildlife. Symptoms include fever, muscle aches, rash, and sometimes vomiting and headache. Approximately 85% of cases reported to HCA are hospitalized. HCA works closely with Orange County Mosquito and Vector Control District to investigate exposure sites with large populations of fleas and host animals. Flea-borne typhus exposure sites with large populations of host animals may be referred to local animal care agencies for assistance.

Plague - Plague is a zoonotic disease caused by the bacterium *Yersinia pestis*. In its sylvatic cycle, it is transmitted by fleas found on locally abundant ground squirrels, rodents and rabbits. Humans usually get plague after being bitten by a rodent flea that is carrying the plague bacterium or by handling an animal infected with plague. Most persons with plague develop fever and swollen lymph nodes. Plague bacteria can also migrate to the lungs causing a pneumonic presentation where respiratory droplets may serve as the source of person-to-person transfer that can lead to localized outbreaks or devastating epidemics. According to CDPH, plague is rare among humans but is found each year among squirrels, chipmunks, and other rodents in California and the southwestern U.S. Plague epizootics can be detected by large die-offs of naturally infected hosts such as rabbits and ground squirrels. Domestic cats are also susceptible to plague and can pass the infection to their owners.

The California Department of Public Health (CDPH) Vector-Borne Disease Section lists the Santa Ana Mountains as a plague endemic area. Plague has occurred in Orange County sporadically, including instances in ground squirrels during 1982 in the Anaheim Hills and in a roof rat from the City of Orange in 1998. Pneumonic plague transmission last occurred along the Orange County and Los Angeles County border in 1988 and involved a pet cat. HCA works closely with the OCMVCD to monitor the presence of plague in the County.

Mitigation Measures for Flea-Borne Diseases

To mitigate the hazard of flea-borne typhus and other flea-borne diseases, HCA conducts the following activities:

- Case investigation and collaboration with OCMVCD about potential areas of exposure.
- Laboratory testing for confirmation of suspect cases.
- Education of health care providers and the public about the signs and symptoms of the disease, testing, risk factors, treatment and prevention.
- Maintenance of a newsletter and alert distribution list to provide updates to healthcare and community partners.

- Maintenance of current information on the HCA website and issuing of press releases as needed with important updates.

To mitigate the hazard of flea-borne typhus and other flea-borne diseases, OCMVCD conducts the following activities:

- Routine monitoring of fleas and host animals for the presence of flea-borne typhus and plague. Inspection of potential exposure sites for the presence of fleas and host animals Investigation of animal die-offs in Orange County.
- In collaboration with the Orange County Agricultural Commissioner and CDPH, application of pesticides to control fleas.
- Education and outreach to the public on source reduction (elimination of vector breeding sources and vector favorable conditions) and personal protection measures.
- Conduct vector investigations surrounding human cases.
- Provision of training and consultation to private firms, municipal staff, and other interests to reduce and eliminate vector breeding sources.
- Coordination with OCMVCD partners.
- Provision of education materials in multiple languages to the public.
- Coordination with OCMVCD public health, municipal, and community partners in the event of an epidemic.
- Coordination with local animal care agencies in the event of a flea-borne typhus outbreak or epidemic.

References

California Department of Public Health (CDPH). *Plague*. State of California 2015. Web (http://www.cdph.ca.gov/HealthInfo/discond/Pages/Plague.aspx). 9 July 2015.

Other Vector-Borne Diseases

Although less prevalent than West Nile virus and flea-borne typhus, other vector-borne diseases have the potential to re-emerge or emerge in Orange County should environmental conditions change or new competent vector species successfully become established. These diseases are not considered a major health hazard in Orange County at this time, but include tick-borne diseases such as Lyme disease, Pacific Coast tick fever, and tularemia, and rodent-borne diseases such as Hantavirus. OCMVCD is constantly monitoring local vector populations in order to detect the presence of these diseases and mitigate the potential for these hazards.

Vulnerability Assessment

Requirement §201.6(c)(2)(ii): [The risk assessment **shall** include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description **shall** include an overall summary of each hazard and its impact on the community.

Estimating Potential Losses

The FEMA HAZUS program was used to estimate losses due to the following potential hazards in Orange County: earthquake, flood, and tsunami. Thanks to a FEMA sponsored pilot project called the Orange County Essential Facilities Risk Assessment project, enhanced data was collected and utilized to run improved HAZUS loss estimation modeling. The results of these models are described in the 2009 HAZUS report attachment.

For other hazards, what data and maps that were available are used to demonstrate the vulnerability of that hazard to the surrounding communities. For more information, see the Exposure Analysis section below.

Analyzing Development Trends

Development trends are included in Chapter 2 of this Hazard Mitigation Plan under Land Use and Formation and Development of Orange County, including a Zoning Map.

Identifying Structures

Using an inventory list provided by the County Executive Office, Office of Risk Management the Hazard Mitigation Task Force has identified County owned or leased properties and buildings (See Attachment C). The list includes the property or building name, address, city or county, operating organization, year built, gross area, real and personal property value, and any pertinent notes on the property/building. Included in these figures are critical facilities since the County maintains numerous critical facilities vital to the safety and operation of the county area.

Current data indicates that Orange County owns or leases 698 properties or buildings with an estimated replacement value of $2,520,347,802. The County's property insurance schedule was used to provide values for real property (building). Maintaining the County's property inventory is an ongoing process and the County is continuously working on updates and improvements with the involvement of multiple County agencies. A current updated list is maintained by the County Executive Office, Office of Risk Management.

Quantitative Exposure Analysis

Based on data availability, a quantitative exposure analysis is possible most hazards. The County parcel layer, as well as County of Orange and OCFA property inventories were used to assess the potential impact of flood events, wildfires, landslides, tsunami, the failure of Prado Dam, and an earthquake on the San Andreas Fault defined by the USGS ShakeOut scenario. Census blocks from the 2010 Census were used to approximate exposed population estimated. The tables below display the results of these assessments. Not included in these assessments are drought, climate change and epidemic, as their spatial and quantitative components are considerably more difficult to model and analyze, based on available data. For these hazards, the vulnerability assessments are more qualitative in nature. As additional information becomes available, the County of Orange and the Orange County Fire Authority hope to expand exposure analysis and assessment efforts.

☐ **Table 3 – Vulnerability Analysis for Unincorporated Orange County**

Hazard Type	Exposed Population Estimate (2010)	Number of Residential Parcels	Number of Commercial/Industrial Parcels	Number of County Properties	Potential Exposure for County Properties
Prado Dam Inundation*	20,812	7,228	162	195	$1,369,667,342
Landslide**	29,118	6,748	163	11	$1,993,082
100 Year Flood Event	10,723	713	58	79	$14,967,640
500 Year Flood Event	31,299	9,043	175	218	$1,948,211,714
Wildland Fire (Very High Hazard Area)	40,805	15,354	230	181	$34,819,674
7.8 Earthquake on San Andreas Fault ("ShakeOut" Scenario)***	52042	22118	453	477	$2,311,481,267
Tsunami	0	62	2	70	$101,127,067

*Based on digitizing of inundation area from print USACE maps prepared in 1985. USACE does not provide inundation maps to local emergency planners due to terrorism fears.

**Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

*** Based on exposure to ground movement equivalent to an MMI rating of VI or greater.

☐ **Table 4 – Vulnerability Analysis for OCFA Facilities**

Hazard Type	Exposed OCFA Facilities	Potential Exposure for OCFA Properties
Prado Dam Inundation*	21	$37,161,200
Landslide**	3	$5,848,100
100 Year Flood Event	3	$2,223,800
500 Year Flood Event	19	$38,516,400
Wildland Fire (Very High Hazard Area)	10	$15,839,050
7.8 Earthquake on San Andreas Fault ("ShakeOut" Scenario)***	43	$138,701,150

Tsunami	1	$795,000

*Based on digitizing of inundation area from georeferenced print USACE maps prepared in 1985. USACE does not provide inundation maps to local emergency planners due to terrorism fears.

**Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.
*** Based on exposure to ground movement equivalent to an MMI rating of VI or greater.

Chapter 4 Hazard Mitigation Strategy

Requirement §201.6(c)(3): *[The hazard mitigation strategy **shall** include a] mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.*

Multi-Hazard Goals and Action Items

Hazard mitigation strategies can reduce the impacts concentrated at large employment and industrial centers, public infrastructure, and critical facilities. This section provides information on the process used to develop the mitigation strategy, based on goals and action items that pertain to the hazards addressed in this mitigation plan. It also describes the framework that focuses the plan on developing successful mitigation strategies.

Requirement §201.6(c)(3)(i): *[The hazard mitigation strategy **shall** include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.*

The plan goals describe the overall direction that Orange County agencies, organizations, and residents can take to minimize the impacts of natural hazards. The goals serve as stepping-stones between the broad direction of the mission statement and the specific recommendations outlined in the action items and help to guide direction of future activities aimed at reducing risk and preventing loss from natural hazards. The goals listed here serve as checkpoints as agencies and organizations begin implementing mitigation action items. For the 2015 revision, the Hazard Mitigation Planning task force reviewed these goals and reaffirmed they reflect the intended direction of hazard mitigation planning for the County of Orange.

- **Protect Life and Property**
  - Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.
  - Reduce losses and repetitive damage for chronic hazard events, while promoting insurance coverage for catastrophic hazards.
  - Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.
- **Public Awareness**
  - Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards. ○ Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.
- **Natural Systems** ○ Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.

  - Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.

- **Partnerships and Implementation** ○ Strengthen communication and coordinate participation among and within public agencies, residents, non-profit organizations, business, and industry to gain a vested interest in implementation.
  - Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.
- **Emergency Services** ○ Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.
  - Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.
  - Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures.

Hazard Mitigation Plan Action Items

The action items are a listing of activities in which County agencies and residents can be engaged to reduce risk. The mitigation plan identifies short- and long-term action items developed through data collection and research, and the public participation process. Mitigation plan activities may be considered for funding through Federal and State grant programs, and when other funds are made available through the County. Action items address multi-hazard and hazard specific issues. To help ensure activity implementation, each action item includes information on the time line and coordinating organizations. Upon implementation, the coordinating organizations may look to partner organizations for resources and technical assistance. A description of the partner organizations is provided in the Resource Directory of this plan.

Identification

The process to identify mitigation initiatives for the original plan and this plan update were prepared in a similar manner. Each Task Force member represented their agency and was responsible for gathering and coordinating the information required for their initiatives. Emergency management staff provided planning partners a variety of data to support the development of their mitigation initiatives:

- County of Orange Emergency Operations Plan, 2015
- County of Orange General Plan, 2005
- County of Orange Comprehensive Annual Financial Report, 2014
- Orange County Essential Facilities Risk Assessment Project Report, 2009
- Anaheim/Santa Ana UASI THIRA, 2014
- California Multi-Hazard Mitigation Plan, 2013
- Southern California Catastrophic Earthquake Response Plan, 2010
- The ShakeOut Scenario (USGS Open File Report 2008-1150), 2008
- Overview of the ARkStorm Scenario (USGS Open File Report 210-1312), 2010
- City of Huntington Beach Hazard Mitigation Plan, 2012
- City of Berkeley Local Hazard Mitigation Plan, 2014

- City of Simi Valley Local Hazard Mitigation Plan, 2015
- National Flood Insurance Program Community Rating System Coordinator's Manual, 2013
- Local Mitigation Plan Review Guide, 2011
- Local Mitigation Planning Handbook, 2013
- Benefit cost review worksheets and instructions
- Local mitigation initiative template with instructions

The process for evaluating vulnerabilities and identifying a range of alternative mitigation actions to reduce actual and potential hazard exposures varied among agencies depending upon their capabilities and resources. In general, Task Force members collaborated with staff and or committees within their jurisdictions that were most familiar with their infrastructural systems, facilities, assets, services, or the geographic area being addressed. Local planning partners referenced a variety of materials such as their risk assessment, comprehensive plans, strategic plans, emergency management plans, capital facility plans, after action review debriefings, and other planning documents. The planning partners' identification processes considered existing initiatives from the original hazards mitigation plan, new and original initiatives identified in this plan update process, and initiatives that have already been identified or documented in a different planning process such as a storm water utility capital facilities plan.

Previous Action Items

Requirement §201.6(d)(3)): *A local jurisdiction must review and revise its plan to reflect changes in development, progress in local mitigation efforts, and changes in priorities.*

Many of the items listed in the 2010 plan have been completed, removed or continued due to various reasons. Some continuing projects, particularly where the Orange County Fire Authority is the lead agency, have also been shifted due to changing priorities. 2010 projects and their statuses are listed below.

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
OCPW1	**OCPW1**	Santa Ana River Channel Project	Orange County Public Works	**Ongoing**, The U.S. Army Corps of Engineers has completed construction of the Lower Santa Ana River from the Pacific Ocean to Prado Dam to convey the 190year storm event and the Seven Oaks Dam. Currently the Orange County Flood Control District is acquiring land necessary to accommodate the increase in reservoir capacity with the Prado Dam spillway elevation being raised by the USACE.

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
OCPW2	**OCPW2**	East Garden Grove-Wintersburg Channel (Facility No. C05) Project	Orange County Public Works	**Ongoing**, Five flood control capital improvement projects completed, (1995 thru 2013) upstream and downstream of the I-405 Freeway totaling 1.3 miles at a cost of $15,000,000. Three capital improvement projects are currently under construction. An additional seven projects, totaling 6.5 miles at an estimated cost of $110,000,000 (2010 dollars) within the 7-Year Flood Control Capital Improvement Project Plan are currently undergoing the design process.
OCPW3	**OCPW3**	San Juan Creek Channel (Facility No. L01) Project, Lower Reach	Orange County Public Works	**Ongoing**, Four flood control capital improvement projects completed (2008 thru current) and four projects in the design phase which includes obtaining regulatory permits.
OCPW4	**OCPW4**	Trabuco Creek Channel (Facility No. L02) Project	Orange County Public Works	**Ongoing**, Four flood control capital improvement projects completed, One project under construction and one in the design phase
OCPW5	**OCPW5**	Westminster Channel (Facility No. C04) Project	Orange County Public Works	**Ongoing**, One flood control capital improvement project completed and two projects in the design phase
OCPW6	**OCPW6**	Santa Ana-Delhi Channel (Facility No. F01) Project, Lower Reach	Orange County Public Works	**Ongoing**, One flood control capital improvement project completed and one project in 7-Year Flood Control Capital Improvement Project Plan.

OCPW7	**OCPW7**	Oceanview Channel (Facility No. C06) Project	Orange County Public Works	**Ongoing**, One flood control capital improvement project completed and two projects in the preliminary design phase

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
OCPW8	**OCPW8**	San Diego Creek Channel (Facility No. F05) Project	Orange County Public Works	**Ongoing**, In the process of designing and obtaining regulatory permits to rehabilitate this channel segment to previous conditions and to restore flood capacity, the Regulatory agencies conditioned two (2) offsite mitigation projects. In the process of obtaining permits. Additional time was added for the design and construction process for the offsite mitigation projects.
OCPW9	**OCPW9**	Lane Channel (Facility No. F08) Project	Orange County Public Works	**Ongoing**, Two projects totaling nearly 10,000 linear feet are scheduled in the 7-Year Flood Control Capital Improvement Project Plan. The beginning reach starting at the confluence with San Diego Creek and ending at Von Karman, is currently undergoing the design process for repair and construction to convey the 100-year storm event. The upstream segment from Von Karman to 1,000' downstream of Red Hill Avenue was recently selected into the 7-Year Flood Control Capital Improvement Project Plan.

OCPW10	**OCPW10**	Carbon Creek Channel (Facility No. B01) Project	Orange County Public Works	**Ongoing**, There are six projects (including Cypress Pump Station) listed on the 7-Year Flood Control Capital Improvement Project Plan. The projects located in the middle of the channel system within the City of Anaheim total 2 miles (11,500 linear feet).
OCPW11	**OCPW11**	Brea Creek Channel (Facility No. A02) Project	Orange County Public Works	**Ongoing**, There is one project listed on the 7-Year Flood Control Capital Improvement Project Plan. The project is located near the beginning of the channel system within the

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
				City of Buena Park totaling 1 mile (5,900 linear feet).
OCPW12	**OCPW12**	Fullerton Creek Channel (Facility No. A03) Project	Orange County Public Works	**Ongoing**, There are three projects listed on the 7-Year Flood Control Capital Improvement Project Plan.
OCPW13	**OCPW13**	Santa Ana-Santa Fe Channel (Facility No. F10) Project	Orange County Public Works	**Ongoing**, A 2-mile reach starting at the confluence with Peters Canyon Channel to upstream Red Hill Avenue is a qualified future project to be included in the 7-Year Flood Control Capital Improvement Project Plan.

OCPW14	**OCPW14**	Santa Ana Gardens Channel (Facility No. F02) Project	Orange County Public Works	**Ongoing**, The project listed in the 7-Year Flood Control Capital Improvement Project Plan includes this segment. The project is located near the downstream end of the channel system within the City of Costa Mesa totaling 1/3 mile.
OCPW15	**OCPW15**	Bolsa Chica Channel (Facility No. C02) Project	Orange County Public Works	**Ongoing**, There is one project listed in the 7-Year Flood Control Capital Improvement Project Plan. The project, a retarding basin and channel, is located near the upstream end of the channel system within the U.S. Joint Armed Forces Reserve Center.
OCPW16	**N/A**	Huntington Beach Channel (Facility No. D01) Project	Orange County Public Works	**Completed**
OCPW17	**N/A**	Talbert Channel (Facility No. D02) Project	Orange County Public Works	**Completed**

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
OCPW18	**N/A**	Fountain Valley Channel (Facility No. D05) Project	Orange County Public Works	**Completed**

OCPW19	**OCPW16**	Peters Canyon Channel (Facility No. F06) Project	Orange County Public Works	**Ongoing**, A segment of the channel, upstream and downstream of Barranca Parkway has been constructed to ultimate conditions to convey the 100-year storm event. This project was partially funded from Assessment Districts through the City of Irvine. There is one project on the 7-Year Flood Control Capital Improvement Project Plan starting from the confluence with San Diego Creek Channel and ending at Barranca Parkway totaling 3,600 linear feet.
OCPW20	**OCPW17**	Laguna Canyon Channel (Facility No. I02) Project	Orange County Public Works	**Ongoing**, There is one project listed in the 7-Year Flood Control Capital Improvement Project Plan. The project requires acquiring real estate for construction of flood control facilities for a 1 mile reach.
OCFA1	**OCFA3**	Reduce the amount of combustible fuels within 14 atrisk communities	Orange County Fire Authority	**Ongoing**, The OCFA Pre-Fire Management Section continues to develop and expand the READY! SET! GO! Program which is the single point comprehensive wildfire prevention program to accomplish this effort.

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status

OCFA2	**OCFA6**	Enhance outreach and education programs aimed at mitigating wildland/urban hazards and reducing and preventing the exposure of residents, public agencies, private property owners and business to these hazards.	Orange County Fire Authority	**Ongoing**, This program has been implemented but is under continual evaluation/expansion. Currently restructuring and reorganizing the Pre-Fire Management section to better identify and focus on the hazards and methods to minimize exposure to residents, government, and business. The identification and assigning of resources and training needs are in progress.
OCFA3	**OCFA2**	Increase communication, coordination and collaboration between wildland/urban interface property owners, local and county planners and fire prevention crews and officials to address risks, existing mitigation measures and federal assistance programs.	Orange County Fire Authority	**Ongoing**, While there has been great progress in involving property owners and officials alike, OCFA is constantly seeking new partners to further the process. This includes increased involvement at the homeowner level through city councils to continue improvement to the educational process and strategy associated with wildland fire safety.
OCFA4	**OCFA11**	Inventory alternative firefighting water sources and encourage the development of additional sources.	Orange County Fire Authority	**Ongoing,** OCFA is working with MWDOC to identify all helicopter accessible water points and is working with GIS Unit on a layer in new mapping system. Working to create additional water sources at Rancho Mission Viejo. Exploring building water points into new park designs.

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status

OCFA5	**OCFA8**	Enhance efficiency of wildfire/urban response and recover activities. Installation of additional fire reporting stations. provide for improved coverage and access. A need has been identified to develop a County call list that includes all at-risk wildland/urban interface residents within the unincorporated area of Orange County in order to contact them during evacuations.	Orange County Fire Authority	**Modified and Ongoing,** There is now the Red Flag Firewatch program established and operational throughout the county. OCFA assists with the training and provides notification to the groups based on weather forecasts from the National Weather Service. **Alert OC is in place but is not coordinated by OCFA. Evacuation is a Law Enforcement function.**
OCFA6	**OCFA7**	Establish a "County Wide" Fire Safe Council	Orange County Fire Authority	**Ongoing**, This has been implemented but is continually being assessed and evaluated. The Countywide Fire Safe Council is established and functioning.
OCFA7	**OCFA9**	Development and dissemination of maps relating to the fire hazard to help educate and assist builders and home owners in being engaged in wildland/urban mitigation activities and to help guide emergency services during response.	Orange County Fire Authority	**Ongoing,** OCFA is in the process of developing and testing a mapping and inspection application to fulfill this mission.
OCFA8	**OCFA12**	Educate agency personnel on federal cost-share and grant programs, Fire Protection Agreements and other related federal programs.	Orange County Fire Authority	**Ongoing,** Efforts currently underway. Several meetings held with OCFA staff to identify, coordinate and prioritize grant programs and cost-share options.
OCFA9	**OCFA4**	Encourage implementation of wildfire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management and community stability.	Orange County Fire Authority	**Ongoing**, OCFA has entered into work agreements, partnerships and MOU's with landowners (both public and private) to improve access and reduce hazardous fuel loading. COAST (County of Orange Area Safety Task Force) has been formed to address these topics on a countywide level.

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
CEO1	**OCSD19**	Mass Notification	County Executive Office	**Ongoing** (Program transferred to Orange County Sheriff's Department)
OCSD1	**OCSD17**	Geographic Information Systems Data and Analysis	Orange County Sheriff's Department	**Ongoing**, Parcel data now freely available due to CA Supreme Court decision, assessor data still unavailable
OCSD2	**OCSD18**	Dam Inundation Mapping	Orange County Sheriff's Department	**Ongoing**, efforts to secure inundation data from USACE and CalOES continue. One alternative will be to secure firm to produce new inundation maps and data
OCWR1	**N/A**	Frank R. Bowerman Landfill – Phase 8 East Flank/Heat Vents Excavation Project	Orange County Waste and Recycling	**Completed**
OCWR2	**N/A**	Olinda Alpha Landfill – Middle East Channel Improvements	Orange County Waste and Recycling	**Completed**
OCWR3	**N/A**	Disaster Debris Disposal Guidelines for Residents	Orange County Waste and Recycling	**Completed**
OCCR1	**OCCR1**	Niguel Shores Revetment Rehabilitation	Orange County Community Resources	**Ongoing**, On hold due to lack of consensus with the public and adjacent property owners.
DPH1	**DPH1**	Quay Wall	Dana Point Harbor	**Ongoing**, currently not implemented due to changing priorities but listed in Capital Improvement Plan

2010 Plan Project Number	2015 Plan Project Number	Action Item	Coordinating Organization	Status
PARKS1	**OCCR2**	Drought Mitigation - Develop a water management plan in the County park and facility system to conserve and efficiently manage water usage.	Orange County Parks	**Ongoing**, Work on this program is in progress. OC Parks continues to implement water-saving measures, but has not yet finalized a comprehensive water management plan.

National Flood Insurance Program

Requirement: §201.6(c)(3)(ii): *[The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program (NFIP), and continued compliance with NFIP requirements, as appropriate.*

In 1968, the US Congress created the National Flood Insurance Program (NFIP). Community participation is voluntary; however, in order to receive funding from the Federal Emergency Management Agency (FEMA), it is a requirement for all communities to participate in the program. The Orange County Flood Control District (OCFCD) is a long time participant in the program and administers the floodplains within the unincorporated areas of the County. Within the incorporated areas, Orange County cities administer their floodplains. Since the creation of NFIP, OCFCD has worked cooperatively with cities in Orange County to reduce the floodplain within the County of Orange by constructing flood control facilities that provide 100-year flood protection. Such facilities typically traverse through the cities and ultimately outlet into the Pacific Ocean.

The County participates in the National Flood Insurance Program (NFIP) that is conducted under the auspices of Federal Emergency Management Agency (FEMA).

Ordinance No. 09-008, of the County of Orange, California, amending sections 7-9-113 through 7-9-113.10 and adding sections 7-9-113.11 and 7-9-113.12 of the codified ordinances of the County of Orange regarding floodplain district regulations was adopted on November 24, 2009.

Orange County worked closely with Region IX in the FEMA Map Modernization process which resulted in digital Federal Insurance Rate Maps (FIRM) dated December 3, 2009. The County worked with FEMA to reach other cities within Orange County.

The Community Rating System (CRS) is an NFIP program that governs the rate of flood insurance for the unincorporated areas of Orange County and consists of certain flood prevention activities. As a condition of membership in good standing, OC Public Works is required to be certified each year that it

continues to conduct those activities as part of the CRS program by signing of Form AW-214, CRS Annual recertification of the following activities:

1. Activity 310 – Elevation Certificates
2. Activity 320 – FIRM Information
3. Activity 330 – Outreach Projects
4. Activity 350 – Flood Protection Information
5. Activity 360 – Flood Protection Assistance
6. Activity 410 – Additional Flood Data
7. Activity 420 – Open Space Preservation
8. Activity 430 – Higher Regulatory Standard
9. Activity 450 – Stormwater Management
10. Activity 440 – Flood Data Maintenance
11. Activity 502 – Repetitive Losses
12. Activity 510 – Floodplain Management Plan
13. Activity 540 – Drainage System Maintenance
14. Activity 610 – Flood Threat Recognition System

Recertification requires certain documentation from Operations and Maintenance Section in order to complete annual recertification for the CRS activities.

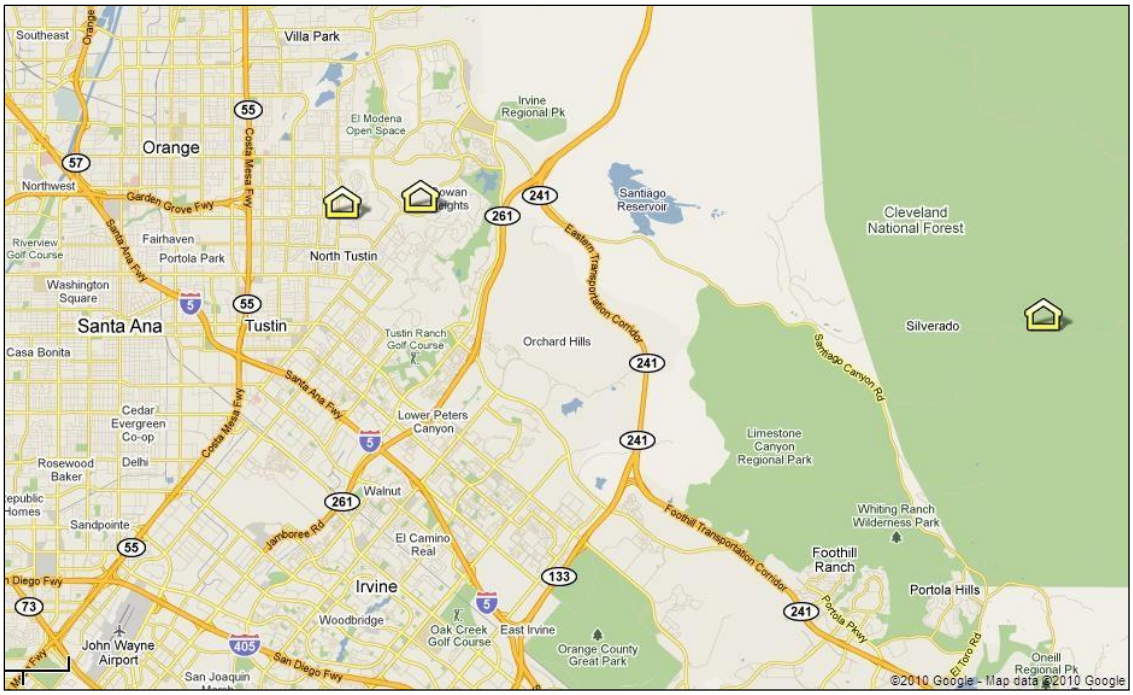
Orange County (unincorporated) as a community is in full compliance with the minimum National Flood Insurance Program requirements as specified in Title 44, Code of Federal Regulations, Section 59, 60.3 through 60.6. Projects that maintain continued compliance with NFIP were also given heavy weight during the prioritization process.

For more information on Orange County's exposure to the flood threat, see the Quantitative Exposure Analysis section in Chapter 3.

Repetitive Loss Structures

Requirement §201.6(c)(2)(ii): *[The risk assessment]* ***must*** *also address National Flood Insurance Program (NFIP) insured structures that have been repetitively damaged by floods.*

According to the National Flood Insurance Program (NFIP), a repetitive loss structure is an insured building that has had two or more losses of at least $1,000 each being paid under the NFIP within any 10-year period since 1978. Within unincorporated Orange County, there are only three structures that currently fit this definition: one in Silverado, one in North Tustin, and one in Cowan Heights. These locations are highlighted on the map below (Map 25).



☐ **Map 25 - Repetitive Loss Structures**

Prioritization

Requirement: §201.6(c)(3)(iii): *[The mitigation strategy section **shall** include] an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization **shall** include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.*

The mitigation action items were prioritized by the Task Force. The members utilized a numerical ranking process to sort the initiatives. All of the initiatives were listed on a voting sheet. The workgroup discussed the benefits and the significance of each initiative as they related to the plan's goals and objectives and the most pressing needs of the region. Actions related to the protection of life and property and NFIP projects were given the highest weight. Each workgroup member assigned a numerical ranking to each action. The ranks were summed for each action. The action with the lowest value received the highest priority and so forth.

Benefit Cost Review

FEMA requires local governments to analyze the benefits and costs of range of mitigation actions that can reduce the effects of each hazard within their community. A hazard mitigation plan must demonstrate that a process was employed that emphasized a review of benefits and costs when prioritizing the mitigation actions. The benefit-cost review must be comprehensive to the extent that it can evaluate the monetary as well as the non-monetary benefits and costs associated with each action. The benefit-cost review should at least consider the following questions:

- How many people will benefit from the action?
- How large an area is impacted?

- How critical are the facilities that benefit from the action (which is more beneficial to protect, the fire station or the administrative building)?
- Environmentally, does it make sense to do this project for the overall community?

The severity of hazards and their impacts vary among the county's agencies due to the varying range of resources and services that they are responsible for providing their customers. As such, their range of mitigation actions for the same hazard will differ substantially. Each plan partner has to consider their agency's exposure, their capabilities, their resources, and select an appropriate process to evaluate the benefits and costs of various mitigation actions.

For the plan update process, the Task Force selected a benefit-cost review method known as STAPLEE. STAPLEE is an acronym for the following criteria that are scored according to benefits or costs of any proposed initiative: social, technical, administrative, political, legal, economic, and environmental. The STAPLEE method is outlined in FEMA's how-to guide, *Developing the Mitigation Plan (FEMA 386-3, 2003).* Task Force members were provided a worksheet and instructions for conducting this process. The worksheet provided general criteria but agencies could elect to modify the criteria to fit their needs. Agency staff scored each mitigation initiative or alternative action according to its benefit (positive score) or cost (negative score) as follows:

Benefit			**Cost**		
Low, +1	Moderate, +2	High, +3	Low, -1	Moderate, -2	High, -3

The worksheet allowed members to score multiple alternatives mitigation actions to address a particular vulnerability or a hazard, and compare the relative benefits and costs of each of the alternative actions. A final score is tallied for each alternative mitigation initiative by summing the score assigned to each alternative across the criteria. The greater the score, the greater the project benefit. Agencies could use this rating to select a preferred alternative and/or prioritize mitigation actions.

Mitigation Action Items

Requirement §201.6(c)(3)(ii): *[The mitigation strategy **shall** include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.*

Priority	Status	Project Number	Hazard	Mitigation Action	Responsible Agency	Time to Completion	Funding Source(s)
1	Existing	OCPW1	Flood	Santa Ana River Channel Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/Infrastructure Programs	25 years	Federal and local sponsorship
2	Existing	OCPW2	Flood	East Garden Grove-Wintersburg Channel (Facility No. C05) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/Infrastructure Programs	1995 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.
3	Existing	OCPW3	Flood	San Juan Creek Channel (Facility No. L01) Project, Lower Reach - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/Infrastructure Programs	2005-2025	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.
4	Existing	OCPW4	Flood	Trabuco Creek Channel (Facility No. L02) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2005-2025	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.
5	Existing	OCPW5	Flood	Westminster Channel (Facility No. C04) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2005 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.
6	Existing	OCPW6	Flood	Santa Ana-Delhi Channel (Facility No. F01) Project, Lower Reach - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2015 to 2020	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.
7	Existing	OCPW7	Flood	Oceanview Channel (Facility No. C06) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	1995 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

8	Existing	OCPW8	Flood	San Diego Creek Channel (Facility No. F05) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2010 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/state grants.

Priority	Status	Project Number	Hazard	Mitigation Action	Responsible Agency	Time to Completion	Funding Source(s)
9	Existing	OCPW9	Flood	Lane Channel (Facility No. F08) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2010 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
10	Existing	OCPW10	Flood	Carbon Creek Channel (Facility No. B01) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2010 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
11	Existing	OCPW11	Flood	Brea Creek Channel (Facility No. A02) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	To Be Determined	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
12	Existing	OCPW12	Flood	Fullerton Creek Channel (Facility No. A03) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	1985 to 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
13	Existing	OCPW13	Flood	Santa Ana-Santa Fe Channel (Facility No. F10) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2010 thru 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
14	Existing	OCPW14	Flood	Santa Ana Gardens Channel (Facility No. F02) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2010 thru 2035	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.

15	Existing	OCPW15	Flood	Bolsa Chica Channel (Facility No. C02) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	2015 thru 2040	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
16	Existing	OCPW16	Flood	Peters Canyon Channel (Facility No. F06) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	To Be Determined	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
17	Existing	OCPW17	Flood	Laguna Canyon Channel (Facility No. I02) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	To Be Determined	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.

Priority	**Status**	**Project Number**	**Hazard**	**Mitigation Action**	**Responsible Agency**	**Time to Completion**	**Funding Source(s)**
18	New	OCPW18	Flood	Greenville-Banning Channel (Facility No. D03) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	To Be Determined	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
19	New	OCPW19	Flood	Barranca Channel (Facility No. F09) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	To Be Determined	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
20	New	OCPW20	Flood	Los Alamitos Channel (Facility No. C01) Project - Design and Construction of Flood Control Improvements	Orange County Flood Control District/Orange County Public Works/ Infrastructure Programs	To Be Determined	Orange County Flood Fund is mainly acquired from a portion of Orange County property taxes, and Federal/State grants.
21	New	OCSD1	Drought	Replace Cooling Towers at Theo Lacy Jail Facility	Orange County Sheriff's Department	12 months / Construction 14 months	Grants and/or Annual Budgets
22	New	OCSD2	Multi-Hazard	Replace Emergency Generator at Sheriff Headquarters Facility	Orange County Sheriff's Department	Design: 12 months / Construction 14 months	Grants and/or Annual Budgets
23	New	OCSD3	Multi-Hazard	Replace Emergency Generator at Brad Gates Facility	Orange County Sheriff's Department	Design: 12 months / Construction 14 months	Grants and/or Annual Budgets

24	New	OCSD4	Multi-Hazard	Seismic retrofit, ADA compliance upgrade and hazardous material abatement and remediation renovation to HQ	Orange County Sheriff's Department	Design: 16 months / Construction 20 months	Grants and/or Annual Budgets
25	New	OCSD5	Multi-Hazard	Replace Fire Pumps – Loma Ridge Emergency Operations Center	Orange County Sheriff's Department	Design: 10 months / Construction 7 months	Grants and/or Annual Budgets
26	New	OCSD6	Multi-Hazard	Brad Gates Building: Replace and Upgrade the Existing and UPS System	Orange County Sheriff's Department	Design: 11 months / Construction 11 months	Grants and/or Annual Budgets
27	New	OCSD7	Multi-Hazard	Emergency Operations Center Communications Redundancy Project	Orange County Sheriff's Department	Design: 10 months / Construction 8 months	Grants and/or Annual Budgets
28	New	OCSD8	Multi-Hazard	Emergency Operations Center Uninterruptible Power Supply capabilities and coverage	Orange County Sheriff's Department	Design: 12 months / Construction 14 months	Grants and/or Annual Budgets
29	New	OCSD9	Drought	Replace Screw Type Chillers at the Coroner Facility	Orange County Sheriff's Department	Design: 6 months / Construction 9 months	Grants and/or Annual Budgets
30	New	OCSD10	Multi-Hazard	Replace Emergency Generator at Theo Lacy Facility	Orange County Sheriff's Department	Design: 10 months / Construction 9 months	Grants and/or Annual Budgets
31	New	OCSD11	Drought	Install Waterless Urinals in all Administrative Areas	Orange County Sheriff's Department	Design: 4 months / Construction 3 months (per facility)	Grants and/or Annual Budgets

Priority	**Status**	**Project Number**	**Hazard**	**Mitigation Action**	**Responsible Agency**	**Time to Completion**	**Funding Source(s)**
32	New	OCSD12	Drought	Install Electro-Mechanical Valves in all Jail Facility Showers and Lavatories	Orange County Sheriff's Department	Design: 10 months / Construction 6 months (per facility)	Grants and/or Annual Budgets
33	New	OCSD13	Wildland Fire	Replace Skins on the JAMF North Compound Inmate Housing Tents	Orange County Sheriff's Department	Design: 12 months / Construction 10 months	Grants and/or Annual Budgets
34	New	OCSD14	Multi-Hazard	Emergency Operations Access Road Widening	Orange County Sheriff's Department	Design: 16 months / Construction 10 months	Grants and/or Annual Budgets
35	New	OCSD15	Earthquake	Complete Seismic Assessments for Sheriff Facilities	Orange County Sheriff's Department	Assessment: To Be Determined	Grants and/or Annual Budgets
36	New	OCSD16	Earthquake	Bring Sheriff-Coroner Essential Facilities up to Current Essential Building Standards	Orange County Sheriff's Department	To Be Determined	Grants and/or Annual Budgets

37	Existing	OCSD17	Multi-Hazard	Geographic Information Systems Data and Analysis	Orange County Sheriff's Department	5 years	Grants
38	Existing	OCSD18	Dam Failure	Dam Inundation Mapping	Orange County Sheriff's Department	5 years	Not identified
39	Existing	OCSD19	Multi-Hazard	Mass Notification	Orange County Sheriff's Department	2011	Grants and/or Annual Budgets
40	Existing	OCCR1	Flood Hazard	Niguel Shores Revetment Rehabilitation	OC Parks	2 years	Annual Budgets
41	Existing	DPH1	Flooding, Tsunami, Earthquake, Climate Change	Quay Wall	Dana Point Harbor	1-2 years for 5:1 Repair to Replacement Ratio. 58 years for 100% Full Replacement	Grants and/or Annual Budgets
42	Existing	OCCR2	Drought	Drought Mitigation - Develop a water management plan in the County park and facility system to conserve and efficiently manage water usage.	OC Parks / Facility Operations	1-2 years	Grants and/or Annual Budgets
43	New	OCFA1	Wildland Fire	Implementation of a real-time remote sensing and fire detection platform to increase the ability to detect, respond to, and monitor wildland areas in Orange County	Orange County Fire Authority	2 Years	Grants and/or Annual Budgets

Priority	**Status**	**Project Number**	**Hazard**	**Mitigation Action**	**Responsible Agency**	**Time to Completion**	**Funding Source(s)**
44	Existing	OCFA2	Wildland Fire	Increase communication, coordination and collaboration between Wildland-Urban Interface (WUI) property owners, local and county planners and fire prevention crews and officials to address risk, existing mitigation measures and federal assistance programs	Orange County Fire Authority	Ongoing with Annual Review	Grants and/or Annual Budgets
45	Existing	OCFA3	Wildland Fire	Reduce the amount of combustible fuels within identified at-risk communities	Orange County Fire Authority	Ongoing	Grants and/or Annual Budgets

46	Existing	OCFA4	Wildland Fire	Encourage implementation of wildfire mitigation activities in a manner consistent with the goals of promoting sustainable ecological management and community stability	Orange County Fire Authority	Ongoing	Grants and/or Annual Budget
47	New	OCFA5	Wildland Fire	Evaluate and implement roadway hardening measures on identified high risk roadways in wildland areas in Orange County	Orange County Fire Authority	Ongoing	Grants and/or Annual Budget
48	Existing	OCFA6	Wildland Fire	Enhance outreach and education programs aimed at mitigating Wildland-Urban Interface (WUI) hazards thereby reducing the exposure of stakeholders (public and private) to these hazards	Orange County Fire Authority	Ongoing	Grants and/or Annual Budget
49	Existing	OCFA7	Wildland Fire	Establish a countywide wildland fire prevention education "Task Force"	Orange County Fire Authority	2 Years	Grants and/or Annual Budget
50	Existing	OCFA8	Wildland Fire	Enhance efficiency of Wildland-Urban Interface/Intermix response and recovery activities	Orange County Fire Authority	Ongoing	Grants and/or Annual Budget
51	Existing	OCFA9	Wildland Fire	Development and dissemination of maps relating to the fire hazard to help educate and assist builders and home owners in being engaged in wildland/urban mitigation activities and to help guide emergency services during response	Orange County Fire Authority	1-3 Years	Annual Budget
52	New	OCFA10	Earthquake	Seismic Reinforcement for Structural Strengthening of Facilities	Orange County Fire Authority	2 years from start	Grants
53	Existing	OCFA11	Wildland Fire	Inventory alternative firefighting water sources and encourage the development of additional sources	Orange County Fire Authority	TBD	Grants and/or Annual Budget

Priority	**Status**	**Project Number**	**Hazard**	**Mitigation Action**	**Responsible Agency**	**Time to Completion**	**Funding Source(s)**
54	Existing	OCFA12	Multi-Hazard	Educate agency personnel on federal cost-share and grant programs, Fire Protection Agreements and other related federal programs	Orange County Fire Authority	1 – 2 Years	Grants and/or Annual Budget
55	New	OCHCA1	Epidemic	Enhance detection and reporting of outbreaks and increases in absenteeism in schools.	Orange County Health Care Agency	1 to 2 years	Grants and/or annual budgets

Chapter 5 Plan Maintenance

Requirement §201.6(c)(4)(i): *[The plan maintenance process **shall** include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.*

The Plan Maintenance Chapter of this document details the formal process that will ensure the County of Orange and Orange County Fire Authority Hazard Mitigation Plan remains an active and relevant document. The plan maintenance process is based upon annual review and a plan revision will be produced every five years. This chapter describes how the County will integrate public participation throughout the plan maintenance process. Finally, this chapter includes an explanation of how the Orange County government intends to incorporate the mitigation strategies outlined in this Plan into existing planning mechanisms such as the County's General Plan, Capital Improvement Plans, and Building and Safety Codes.

Coordinating Body

The County of Orange Hazard Mitigation Planning Task Force will be responsible for coordinating implementation of Plan action items and undertaking the formal review process. The Board of Supervisors and County Executive Officer will assign representatives from County agencies, including, but not limited to, the current Hazard Mitigation Planning Task Force members.

Convener

The Orange County Sheriff's Department Emergency Management Division will serve as the convener to facilitate the Hazard Mitigation Planning Task Force meetings, and will assign tasks such as updating and presenting the Plan to the members of the committee. Plan implementation and evaluation will be a shared responsibility among all of the Hazard Planning Task Force Members. The Orange County Sheriff's Department Emergency Management Division will conduct annual reviews of the Hazard Mitigation Plan based upon public comments and feedback, as well as facilitate plan updates every five years, at a minimum.

Adopting, Monitoring, and Updating the Hazard Mitigation Plan

The County Board of Supervisors and the Orange County Fire Authority (OCFA) Board of Directors are responsible for adopting the County of Orange and Orange County Fire Authority Hazard Mitigation Plan. The Board of Supervisors has the authority to promote sound public policy regarding natural hazards and the OCFA Board of Directors is the governing board overseeing Fire Authority matters. Once the plan has been adopted, the County Emergency Manager will be responsible for submitting it to the State Hazard Mitigation Officer at the California Office of Emergency Services. The California Office of Emergency Services will then submit the plan to the Federal Emergency Management Agency (FEMA) for review. This review will address the federal criteria outlined in FEMA Interim Final Rule 44 CFR Part 201. Upon acceptance by FEMA, the County of Orange and the Orange County Fire Authority will gain eligibility for Hazard Mitigation Grant Program funds.

The Hazard Mitigation Plan will need to be periodically revised and re-adopted to meet changes in the hazard risks and exposures in the community. The approved Hazard Mitigation Plan will be significant in

the future growth and development of the community.

The Hazard Mitigation Plan will be monitored and evaluated on an annual basis to determine the effectiveness of programs, and to reflect changes in land development or programs that may affect mitigation priorities. The evaluation process includes a firm schedule and time line, and identifies the local agencies and organizations participating in plan evaluation. The Orange County Sheriff's Department, Emergency Management Division will be responsible for contacting the Hazard Mitigation Planning Task Force members and organizing the annual meeting in August of each year. Task Force members will be responsible for monitoring and evaluating the progress of the mitigation strategies in the Plan.

The Task Force will review the goals and action items along with public feedback to determine their relevance to changing situations in the County, as well as changes in State or Federal policy, and to ensure they are addressing current and expected conditions. The Task Force will also review the risk assessment portion of the Plan to determine if this information should be updated or modified, given any new available data. The coordinating organizations responsible for the various action items will report on the status of their projects, the success of various implementation processes, difficulties encountered, success of coordination efforts, and which strategies should be revised. Orange County Public Works will also ensure that a Project Status Report is completed annually for each mitigation project listed in the plan (See Attachment D for Project Status Reports). This Report will be approved as an attachment to the plan by the Emergency Management Council as part of the annual update process.

The Orange County Sheriff's Department, Emergency Management Division will assign the duty of updating the plan to one or more of the Task Force members. The designated members will have 30 days to make appropriate changes to the Plan before submitting it to the Hazard Mitigation Task Force members, and presenting it to the County Emergency Management Council for approval. All updates within the 5 year revision cycle will be adopted by the County Emergency Management Council. The Hazard Mitigation Planning Task Force will also notify all holders of the County plan when changes have been made. Every five years the updated plan will be submitted to the State Hazard Mitigation Officer and the Federal Emergency Management Agency for review. Once approved by FEMA the updated plan is adopted by the County Board of Supervisors and the Orange County Fire Authority Board of Directors.

Incorporating Mitigation Into Existing Planning Mechanisms

Requirement §201.6(c)(4)(ii): *[The plan **shall** include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.*

Each agency will be responsible for implementation of their individual mitigation action item based on funding availability, availability of resources, and agency priorities. The mechanism for implementation through existing programs will vary between agencies and departments. This section is intended to give an overview of the mechanisms available in Orange County.

Orange County addresses statewide planning goals and legislative requirements through its General Plan,

Capital Improvement Plans, and County Building and Safety Codes. Each of these processes involves and requires public notification and involvement. The Hazard Mitigation Plan provides a series of recommendations--many of which are closely related to the goals and objectives of existing planning programs. OC Public Works will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

In addition, the County of Orange and Orange County Fire Authority Hazard Mitigation Plan has been incorporated into the Safety Element of the General Plan by the County Board of Supervisors as required by state law. The County Emergency Operations Plan is also a partner document and utilizes much of the vulnerability assessment information available in the Hazard Mitigation Plan. These comprehensive plans are required to be updated regularly by various state and federal laws.

Orange County Public Works is responsible for administering Building and Safety Codes. In addition, the Hazard Planning Task Force will work with other agencies at the state level to review, develop and ensure Building and Safety Codes that are adequate to mitigate or present damage by natural hazards. This is to ensure that life-safety criteria are met for new construction.

The goals and action items in the mitigation plan may be achieved through activities recommended in the County's Capital Improvement Projects (CIP). Various County departments develop plans, and review them on an annual basis. Upon annual review of the Capital Improvement Projects, the Hazard Mitigation Planning Task Force will work with the County departments to identify areas that the hazard mitigation plan action items are consistent with CIP planning goals and integrate them where appropriate. Many of the action items listed in the Hazard Mitigation Plan are directly related to CIP.

Within six months of formal adoption of the mitigation plan, the recommendations listed above will be incorporated into the process of existing planning mechanisms at the County level. The meetings of the Hazard Mitigation Planning Task Force will provide an opportunity for committee members to report back on the progress made on the integration of mitigation planning elements into County planning documents and procedures.

Flood Event Post-Disaster Policies and Procedures / Action Items

The Community will identify the operations and strategies to allow more effective post-disaster recovery. Much of the County’s most vulnerable areas, as mentioned in Section 3.1, include areas within the cities of Westminster, Garden Grove, Fountain Valley, Huntington Beach, Seal Beach, San Juan Capistrano, and Laguna Beach. The most vulnerable areas within unincorporated Orange County include the canyon areas which will be the focus of post-disaster action items.

To reduce long-term vulnerability and to become more resilient in future disasters, mitigation actions such as effective building code adoption and enforcement, will be applied in the post-disaster recovery activities by our community. A post-disaster planning committee should be formed that includes representatives of all affected communities where flooding had occurred.

Individuals that may be needed for post disaster activities should be trained, made aware of their potential assignments, review mutual aid agreements for negotiation and approval for fire and police departments.

Repairs to buildings located within the 100-year floodplain will comply with the local laws for floodplain development, which specify that structures that are substantially damaged (cost of restoring the structure to its before damaged condition would equal or exceed 50% of the market value of the structure before the damage occurred) will only be rebuilt if they are brought into compliance with the latest floodplain development standards.

Plan Review and Update

Following a major flood event, the Plan will be reviewed and revised as necessary to reflect lessons learned or to address specific issues and circumstances arising from the event. It will be the responsibility of the
Floodplain Administrators to reconvene the Post-Disaster Planning Committee and to ensure that appropriate stakeholders are invited to participate in the plan revision and update process following any emergency or disaster events. In addition, the Committee should evaluate which actions from the Plan may be appropriate for implementation during the post-disaster period as resources and needs become clear.

Flood Event Post-Disaster Action Items

Activity	*Agency/Department*	*Timeframe*
Review the mutual aid agreements between the County and communities regarding post disaster actions and revise as appropriate to include code enforcement departments, planning departments and public information officers.	Emergency Management Departments from affected Municipalities	3 months
Prepare brochures or fliers that address post disaster actions by property owners. Disseminate information about floodproofing, building elevation, relocation, and other property protection measures. Many Publications are available from State and federal agencies. Prepare and distribute notices to property owners and renters, advising them of the types of insurance available. Ensure the public is aware of actions it should be taking to mitigate damages as well as encouraging property owners and renters to work with their insurance agents to help cover their losses	Public Information Officers (PIOs) - Multiagency	6 months

Activity	*Agency/Department*	*Timeframe*

Conduct preliminary damage assessment to include creation of a map that provides locations and collected data with photos identifying all damaged structures	Affected Cities and OC Public Works	4 months
Advise code enforcement (CE) departments of areas affected by the flood for further evaluation by CE. Determine the extent of damages, including whether the structures are substantially damaged as defined in the ordinances of each affected community	Affected Cities, County Emergency Managers and OC Public Works Building & Safety	3 months
Evaluate the suitability of rebuilding damaged structures in unincorporated Orange County and make recommendations to property owners.	OC Public Works	3 months
Review the Hazard Mitigation Plan to determine if any revisions are needed.	Hazard Mitigation Committee	Within 6 months of a Presidential or state declared disaster
Provide outreach to the affected communities informing them of the risks of floods and how to prepare for future events	OC Public Works	3 months
Ensure that residents have the proper permits before repairing structures and ensuring that the repair is completed according to Orange County codes	OC Public Works	As Needed (within 5 years)
Determine appropriate mitigation actions given the extent of damages. Consider redevelopment of standards and determine whether any temporary permit and construction moratoriums need to be established. Determine whether necessary to modify the mitigation plan or to revise/modify codes or ordinances.	OC Public Works	1 year
Determine funding that is available to assist the owners in mitigating future damages. Identify potential opportunities to pursue Section 406 mitigation projects under the FEMA Public Assistance Grant Program	OC Public Works	1 year
Determine extent of damages (system-wide or isolated reach) to OCFCD flood control channels, roadways and	Affected County Agencies and OC Public Works	1 month

Activity	*Agency/Department*	*Timeframe*
bridges and other county facilities and study to repair or replace/improve facility.		
Extensive replacement/improvements to County public facilities require incorporation into respective CIP's or alternative funding. Seek grant opportunities through DWR and FEMA and apply for grants as appropriate and develop project applications as appropriate.	Affected County Agencies and OC Public Works	2 to 5 years
Work with the State and FEMA to collect important flood data like high water marks	OC Public Works	6 months
Evaluate the need to update FIRMs for the areas that flooded	OC Public Works	3 years

Continued Public Involvement

Requirement §201.6(c)(4)(iii): *[The plan maintenance process **shall** include a] discussion on how the community will continue public participation in the plan maintenance process.*

The Orange County Emergency Management Council (EMC) is committed to continued public involvement and education. The EMC meets quarterly in a public meeting to discuss emergency management related issues, including hazard mitigation. It will be important that natural hazards mitigation continues to be integrated into existing programs and is part of the way jurisdictions make decisions about land use and facilities planning. As mentioned in the preceding section, General Plan amendment processes as well as capital improvement planning both have elements of public notification and involvement. These local plans require updating regularly with an associated public process. These processes will provide a venue that promotes public dialogue regarding the importance of hazard mitigation.

As was the case in the compilation of this plan, when there is a plan update (at least every 5 years) the General Plan and Capital Improvement Plans will need to be reviewed to assure consistency between all planning efforts. It will be important to identify where and how hazard mitigation planning initiatives have been integrated in the General Plan and Capital Improvement Plans.

The Emergency Management Council will also need to encourage its governmental entities to combine the natural hazards plan elements into existing emergency preparedness activities and information in order to continue to educate the public on the importance of managing the risk for natural hazards. If there are efforts to re-write emergency preparedness public information (such as brochures),

integration of natural hazards mitigation information will be considered. The County Emergency Operations Plan will continue to integrate hazard mitigation planning into that document and associated public education efforts.

There is constant public information engagement with the county residents through emergency management staff participation at public safety and preparedness fairs, the annual Orange County Fair, Inner Canyon League preparedness meetings, Orange County Fire Authority town hall meetings, and other opportunities to inform the public as they arise.

The public will also continue to have the opportunity to provide feedback about the Plan. Copies of the Plan will be catalogued and kept at the Orange County Hall of Administration and at all County operated public libraries. The plan also includes the address and the phone number of the Orange County Sheriff's Department Emergency Management Division, responsible for keeping track of public comments on the Plan. In addition, copies of the Plan and any proposed changes will be posted on the Orange County Sheriff's Department Emergency Management website at www.ocgov.com/eoc. This site will also contain an email address to which the public can direct their comments and concerns.

Since 2010, the Emergency Management Division has continued to foster public involvement in the hazard mitigation process, both through existing meetings with stakeholders, like the Orange County Emergency Management Organization, Collaborating Organizations Active in Disasters, and the Disabilities and Access and Functional Needs Working Group, and through direct outreach to the public through the Emergency Management Division's digital presence and at public events. This process has continued to yield constructive feedback and participation in ongoing Orange County hazard mitigation planning.

Moving forward, the Emergency Management Division will seek to augment its efforts to maximize public engagement in the mitigation process. One strategy will be to focus specific attention on the somewhat disparate and fragmented county areas (rural canyon areas in the northeast, planned communities in the southeast, and older neighborhoods closer to the Los Angeles County border) with dedicated presentations that focus on that area's local hazards. This would allow more pointed discussion of the risks present in individual communities. Another strategy will be to enhance social media messaging regarding hazard mitigation to county residents. For the 2015 update, the social media focus was either encouraging residents to participate in the online survey or to review the complete text of the draft plan. Moving forward, the Emergency Management Division will strive to also include short educational messages about the hazards that face the County of Orange and the importance of mitigation planning.

Chapter 6 Local Capability Assessment

Agency Name (Mission/Function)	Programs, Plans, Policies, Regulations, Funding, or Practices	Point of Contact Name, Address, Phone, Email	Effect on Loss Reduction* Support Facilitate Hinder	Comments
Orange County	Codified Ordinances	Orange County Clerk of the Board, Darlene Bloom 10 Civic Center Plaza, Room 465 Post Office Box 687 Santa Ana, CA 92702 www.ocgov.com	S	Ordinances dedicated to Public Facilities; Public Morals, Safety and Welfare; Property Maintenance; Health and Sanitation and Animal Regulations; Business and Special Licenses, Regulations; Highways, Bridges, Rights-of-Way, Vehicles; Land Use and Building Regulations; Fees; Water Quality—Orange County Flood Control; Stormwater Management and Urban Runoff.
Orange County Agencies & Departments	Standard Operating Procedures	See website, www.ocgov.com for Department Contacts	S	Dependent upon mission and goals of the agency/department.

Agency Name (Mission/Function)	**Programs, Plans, Policies, Regulations, Funding, or Practices**	**Point of Contact Name, Address, Phone, Email**	**Effect on Loss Reduction*** **Support** **Facilitate** **Hinder**	**Comments**
Orange County Fire Authority (OCFA) . Mission: To serve the changing needs of the community by providing the highest quality regional emergency, safety and support services, including protecting lives, property, and the environment with compassion, vigilance and dedication to excellence	Orange County Hazardous Materials Area Plan (November, 1999)	Emergency Planning & Coordination Section, OCFA (714-573-6000)	S	Addresses the storage , use and emergency planning for hazardous materials
	California Fire Code 2001		S	The purpose of the Code is to prescribe regulations governing conditions hazardous to life and property from fire or explosion. (For Fuel Modification and enforcement of hazardous fuels within populated areas) Section 27, Appendix 2-A1, Article 11, Section 1103.2.4
	California Public Resources Code, Division 4. Forests, Forestry and Range and Forage Lands		S	The purpose is to prescribe regulations governing forests, forestry and fire issues.

Agency Name (Mission/Function)	**Programs, Plans, Policies, Regulations, Funding, or Practices**	**Point of Contact Name, Address, Phone, Email**	**Effect on Loss Reduction*** **S**upport **F**acilitate **H**inder	**Comments**
Orange County Health Care Agency (HCA) Mission: Protect and promote the optimal health of individuals, families and our diverse communities	HCA Emergency Operations Plan (EOP)	Health Disaster Management Division 405 West 5th Street, Suite 301A Santa Ana, CA 92701 (714-834-3500)	S	To provide for and coordinate the response to and recovery from health and environmental emergencies.
	Disease Outbreak Response Annex to HCA EOP	Health Disaster Management Division 405 West 5th Street, Suite 301A Santa Ana, CA 92701 (714-834-3500)	S	Preparedness and response plan for the request and distribution of medical countermeasures such as drugs, vaccines, and medical supplies.
	Medical Countermeasures (MCM) Annex	Health Disaster Management Division 405 West 5th Street, Suite 301A Santa Ana, CA 92701 (714-834-3500)	S	Preparedness and response plan for the request and distribution of medical countermeasures such as drugs, vaccines, and medical supplies.
Orange County Mosquito and Vector Control District (OCMVCD)	OCMVCD Integrated Vector Management and Response Plan	13001 Garden Grove Blvd. Garden Grove, CA 92843 (714-971-2421)	S	Enhanced surveillance and response program for mosquito-borne viruses

Orange County Public Works: Operations and Maintenance, Planning, and Infrastructure Programs Mission: Protect and enrich the community through efficient delivery and maintenance of public works infrastructure, planning, and development services.	Flood Season Erosion Control Policies and Procedures	OC Public Works O&M 2301 Glassell Street, Building A (714)955-0200	S	Coordinate overall "Flood Season" erosion control efforts to minimize erosion and deposition of sediment on private and public properties.
	7-Year Flood Control Capital Improvement Program	OC Public Works Infrastructure Programs 300 North Flower Street Santa Ana, CA 92702 (714-834-2300)	S	Coordinates the 7-year Capital Improvement Program with regard to flood control.
	OC Public Works Plans and Manuals	OC Public Works Infrastructure Programs 300 North Flower Street Santa Ana, CA 92702 (714-834-2300)	S	Orange County Hydrology Manual; Orange County Flood Control District Design Manual; Orange County Drainage Design Criteria and Aids; Orange County Standard Plans for Public Works Construction; Americans with Disabilities Act 2 and 3
	Orange County Zoning Code	OC Planning 300 North Flower Street Santa Ana, CA 92703 (714-834-2300)	S	To provide a guide for the growth and development of the County in accordance with the Government Code.

Agency Name (Mission/Function)	Programs, Plans, Policies, Regulations, Funding, or Practices	Point of Contact Name, Address, Phone, Email	Effect on Loss Reduction* Support Facilitate Hinder	Comments
Orange County Public Works (Continued)	Orange County Grading Code	OC Planning 300 North Flower Street Santa Ana, CA 92703 (714-834-2300)	S	This Code sets forth rules and regulations to control excavation, grading and earthwork construction, including fills and embankments, and establishes administrative requirements for issuance of grading permits and approval of plans and inspection of grading construction in accordance with the requirements for grading and excavation as contained in the Uniform Building Code then in effect as adopted and modified by County ordinance as well as water quality requirements relevant to activities subject to this article.
	California Building Code 2007, International Building Code 2006		S	The purpose is to prescribe regulations for the erection, construction, enlargement, alteration, repair, improving, removal, conversion, demolition, occupancy, equipment, use, height, area and maintenance of all buildings and structures.
OC Waste and Recycling	• Administers the Countywide Integrated Waste Management Plan (CIWMP). • Administers municipal solid waste collection, recycling, and planning for the County unincorporated area.	Environmental Services 320 North Flower Street Suite 400 Santa Ana, CA 92703 (714-834-4122)	S	To meet the solid waste disposal needs of Orange County through efficient operations, sound environmental practices, strategic planning, innovation and technology.

Agency Name (Mission/Function)	**Programs, Plans, Policies, Regulations, Funding, or Practices**	**Point of Contact Name, Address, Phone, Email**	**Effect on Loss Reduction*** **S**upport **F**acilitate **H**inder	**Comments**
Orange County Sheriff's Department (OCSD) Mission: To provide professional, responsive, and caring law enforcement services to the residents, visitors and businesses of Orange County. We believe a safe community can only exist through a partnership with our employees, residents, businesses and other public entities.	Orange County Emergency Operations Plan	OCSD, Emergency Management 2644 Santiago Canyon Road Silverado, CA 92676 (714-628-7054)	S	To provide for the coordinated response and recovery from major emergencies and disasters.
	County of Orange and Orange County Fire Authority Hazard Mitigation Plan	OCSD, Emergency Management 2644 Santiago Canyon Road Silverado, CA 92676 (714-628-7054)	S	Describes mitigation strategy, plans and projects within Orange County.

Chapter 7 Plan Resource Directory

The following resource directory lists the resources and programs that can assist county communities and organizations. The resource directory will provide contact information for local, county, regional, state and federal programs that deal with natural hazards.

Multi-Hazard Resources

County	Address	Phone	Fax	Summary of Resources
Orange County Health Care Agency	405 W. Fifth Street Santa Ana, CA 92701 Website: http://www.ochealthinfo.com			
	Health Disaster Management 405 W. Fifth Street Santa Ana, CA 92701 Website: http://healthdisasteroc.org	714-834-3500		Coordinates the agency's emergency response functions and preparedness activities for all hazards
	Public Health Services (PHS) 1725 W. 17th Street Santa Ana, CA 92706 Website: http://ochealthinfo.com/phs/	714-834-7700		Provides information and services related to communicable diseases, immunizations, and public health nursing
	PHS Environmental Health Division 1241 East Dyer Road, Suite 120 Santa Ana, CA 92705 Website: http://ochealthinfo.com/eh/	714-433-6000		Provides information and services related to food safety, water quality, and hazardous wastes

Orange County Mosquito and Vector Control District	13001 Garden Grove Blvd. Garden Grove, CA 92843 Website: http://www.ocvcd.org	714-971-2421		Dedicated to controlling mosquitoes, rats, Red Imported Fire Ants, and flies.

County	Address	Phone	Fax	Summary of Resources
OC Public Works - Watershed & Coastal Resources	300 North Flower Street Santa Ana, CA 92703 Website: http://www.ocpublicworks.com/	714-834-2300	714-834-2395	Protects property and promotes public safety.
OC Environmental Resources	Glassell Field Office 2301 North Glassell St. Orange, CA 92865 Website: http://www.ocwatersheds.com	714-955-0600	714-955-0639	Provides near real time rainfall accumulations for Orange County.
OC Public Works - Storm Operations Center		714-955-0333		Activated when heavy to extreme rainfall is predicted or occurs and/or when storm runoff conditions are such that there is a probability of flood damage.
Orange County Sheriff's Department Emergency Management Division	2644 Santiago Canyon Road Silverado, CA 92676 Website: http://www.ocgov.com/eoc	714-628-7054	714-628-7154	Provides emergency management and preparedness services to Orange County.

State	Address	Phone	Fax	Summary of Resources
California Department of Conservation, Southern California Regional Office	655 South Hope Street, #700 Los Angeles, CA 90017	213-239-0878	213-239-0984	Provides services and information to promote environmental health, economic vitality, informed land-use decisions and sound management of the state's natural resources.

California Resources Agency	1416 Ninth Street, Suite 1311 Sacramento, CA 95814	916-653-5656		Restores, protects and manages the state's natural, historical and cultural resources.
California Department of Transportation (CalTrans)	Headquarters 1120 N Street P.O. Box 942873 Sacramento, CA 94273-0001 Website: http://www.dot.ca.gov/ District 12 (Orange County) 3347 Michelson Drive, Suite 380 Irvine, CA 92612-7684 Website: http://www.dot.ca.gov/dist12/	916-654-5266 949-724-2000		Responsible for design, construction, maintenance and operation of highway system.
California Department of Water Resources (DWR)	1416 Ninth Street P.O. Box 942836 Sacramento, CA 94236-0001	916-653-5791	916-653-5028	Operates and maintains the State Water Project, provides dam safety and flood control and inspection services, assists local water districts in water management and water conservation planning, and plans for future statewide water needs.
California Division of Forestry & Fire Protection (CAL FIRE)	1416 Ninth Street Post Office Box 944246 Sacramento, CA 94244-2460 Website: http://www.calfire.ca.gov/	916-653-5123		Responsible for all aspects of wildland fire protection,

Federal	**Address**	**Phone**	**Fax**	**Summary of Resources**
California Division of Mines and Geology (DMG)	801 K Street Sacramento, CA 95814 Website: http://www.consrv.ca.gov/cgs/	916-445-1825	916-445-5718	Develops and disseminates technical information and advice on California's geology, geologic hazards, and mineral resources.

California Geological Survey Headquarters, Office of the State Geologist	801 K Street Sacramento, CA 95814 http://www.consrv.ca.gov/cgs/index.htm	916-845-8162	916-323-7778	Provides information on the geology, natural resources and geologic hazards of California.
DWR – California Data Exchange Center (CDEC)	Website: http://cdec.water.ca.gov/	916-574-1777		Provides real-time decision support system to DWR Flood Management and other flood emergency response organizations, providing operational and historical hydrologic and meteorological data, forecasts, and reports.
California Office of Emergency Services (Cal OES) Cal OES – Southern Region (Los Alamitos)	Post Office Box 419047 Rancho Cordova, CA 95741-9047 Website: http://www.caloes.ca.gov 4671 Liberty Avenue Los Alamitos, CA 90720	916-845-8911 562-795-2900 or 795-2941	916-845-8910 562-795-2877	Coordinates overall state agency response to major disasters in support of local government.

Federal	**Address**	**Phone**	**Fax**	**Summary of Resources**
Federal Emergency Management Agency (FEMA) Region IX	1111 Broadway, Suite 1200 Oakland, CA 94607 Website: http://www.fema.gov	510-627-7100	510-627-7112	Tasked with responding to, planning for, recovering from and mitigating against disasters.
Federal Emergency Management Agency (FEMA) Mitigation Division	500 C Street, S.W. Washington, D.C. 20472 Website: http://www.fema.gov	202-566-1600		Manages the NFIP and oversees FEMA's mitigation programs.

Federal	**Address**	**Phone**	**Fax**	**Summary of Resources**

Institute for Business & Home Safety	4775 East Fowler Avenue Tampa, FL 33617 Website: http://www.ibhs.org/	813-286-3400	813-286-9960	Works to reduce death, injury, property damage, economic losses and human suffering caused by natural disasters.
United States Geological Survey	345 Middlefield Road Menlo Park, CA 94025 Website: http://www.usgs.gov/	650-853-8300		Provides reliable scientific information to describe and understand the Earth, minimize loss of live and property.

Flood Resources

County

See Multi-Hazard Resources.

State

See Multi Hazard Resources.

Federal	Address	Phone	Fax	Summary of Resources
American Public Works Association	2345 Grand Boulevard, Suite 500 Kansas City, MO 64108-2641	816-472-6100	816-472-1610	Provides a forum in which public works professionals can exchange ideas, improve professional competency, increase the performance of their agencies and companies and bring important public works-related topics to public attention in local, state and federal arenas.

Federal	Address	Phone	Fax	Summary of Resources

Association of State Floodplain Managers (ASFPM)	2809 Fish Hatchery Road Madison, WI 53713 Website: http://www.floods.org/	608-274-0123	608-274-0696	Organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning and recover.
Bureau of Reclamation Mid Pacific Region Federal Office Building Southern California Area Office	2800 Cottage Way Sacramento, CA 95825-1898 Website: http://www.usbr.gov/mp/ 27710 Jefferson Ave., Suite 201 Temecula, CA 92590 Websites: http://www.usbr.gov/lc/	916-978-5000 909-695-5310	916-978-5599 909-695-5319	Leadership and technical expertise in water resources development. Responsible for water conservation, reclamation and reuse projects throughout southern California.
Floodplain Management Association (California)	P.O. Box 712080 Santee, CA 92072-2080 Website: http://www.floodplain.org/	619-204-4380		Promotes the reduction of flood losses and encourages the protection and enhancement of natural floodplain values through the use of effective wetland management strategies and engineering technologies.
National Flood Insurance Program (NFIP)	500 C Street, S.W. Washington, D.C. 20472 Websites: http://www.fema.gov/business/nfip/	202-566-1600		Flood Insurance Rate Maps, General Floodplain information.

Federal	Address	Phone	Fax	Summary of Resources
National Resources Conservation Service (NRCS) US Department of Agriculture	14th and Independence Ave., SW, Room 5105-A Washington, D.C. 20250 Website: http://www.nrcs.usda.gov/	202-720-7246	202-720-7690	Wetlands Reserve Program, Flood Risk Management Program, Emergency Watershed Protection Program.

National Oceanic & Atmospheric Administration (NOAA)	14th Street & Constitution Avenue, NW Room 6217 Washington, DC 20230 Website: http://www.noaa.gov/	202-482-6090	202-482-3154	Primary source of weather data, forecasts and warnings for the United States and the sole US official voice for issuing warnings during lifethreatening weather situations.
National Weather Service (NWS)	1325 East West Highway Silver Spring, MD 20910 Website: http://www.nws.noaa.gov/			
National Weather Service Los Angeles/Oxnard Weather Forecast Office	520 North Elevar Street Oxnard, CA 93030 Website: http://www.nwsla.noaa.gov/	Administrative: 805-988-6615 Forecast & Weather Info: 805-988-6610		Provides weather information for Los Angeles, Ventura, Santa Barbara, and San Luis Obispo counties, as well as adjacent coastal waters out 60 nautical miles.
National Weather Service San Diego Weather Forecast Office	11440 W. Bernardo Court, Suite 230 San Diego, CA 92172 Website: http://www.wrh.noaa.gov/sgx/index.php	858-675-8700		Provides all the weather and flood warnings, daily forecasts, and meteorologic and hydrologic data for extreme Southwest California, including Orange, San Diego, Southwest San Bernardino, and Western Riverside counties. NEXRAD (Next Generation Radar) obtains weather information (precipitation and wind) based upon returned

Santa Ana Mountains Radar	Website: http://radar.weather.gov/radar.php?rid=sox			energy.

Federal	Address	Phone	Fax	Summary of Resources
NWS Office of Hydrologic Development	1325 East West Highway, SSMC2 Silver Spring, MD 20910 Website: http://www.nws.noaa.gov/oh/index.html	301-713-1658	301-713-0963	Information of flooding, water, supply outlooks, current hydrologic conditions.

US Army Corps of Engineers Operations Center (USACE OC)	441 G. Street, NW Room 3J50 Washington, DC 20314-1000	202-761-1001		Responsible for protection and development of water resources.
Los Angeles District	915 Wilshire Blvd., Suite 980 Los Angeles, CA 90017 E-Mail: publicaffairs-spl@usace.army.mil Website: http://www.spl.usace.army.mil/	213-452-3333		
USGS Water Resources	6000 J Street, Placer Hall Sacramento, CA 95819-6129 Website: http://water.usgs.gov/index.html	916-278-3000	916-278-3070	Current US water news, current and historical water data, and water survey programs.

Publications

Title	Website	Phone	Fax	Summary of Resources
Floodplain Management: A Local Floodplain Administrator's Guide to the NFIP	http://www.fema.gov/business/nfip/	800-480-2520		Discussion for floodplain processes and terminology.

NFIP Community Rating System Coordinator's Manual Indianapolis, IN	http://www.fema.gov/business/nfip/crs.shtm	800-480-2520 317-848-2898		Detail the CRS point system and rating for community.
Title	**Website**	**Phone**	**Fax**	**Summary of Resources**
Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials, (February, 1987), FEMA-116	Federal Emergency Management Agency http://www.fema.gov	800-480-2520		Opportunities for flood hazard mitigation, mapping assistance for floodplains.

Wildland/Urban Fires

County	Address	Phone	Fax	Summary of Resources
Orange County Fire Authority	One Authority Road Irvine, CA Website: http://www.ocfa.org	714-881-2411		Principal agency responding to wildland/urban fires.

State	Address	Phone	Fax	Summary of Resources
Office of the State Fire Marshal (OSFM)	1131 "S" Street Post Office Box 944246 Sacramento, CA 94244-2640	916-445-8200	916-445-8509	Protects life and property through the development and application of fire prevention, engineering, education and enforcement.

Federal	Address	Phone	Fax	Summary of Resources
Federal Wildland Fire Policy, Wildland/Urban Interface Protection	http://www.fs.fed.us/fire/management/policy.html			Report describing federal policy and interface fire.
National Fire Protection Association (NFPA) Public Fire Protection Division Firewise Program	1 Battery March Park Post Office Box 9101 Quincy, MA 02269-9101	617-770-3000		Principal Federal agency involved in the National Wildland/Urban Interface Fire Protection Initiative.
National Interagency Fire Center (NIFC)	3833 South Development Avenue Boise, Idaho 83705 Website: http://www.nifc.gov/	208-387-5512		Support center for wildland firefighting.
US Fire Administration FEMA Planning Branch Mitigation Directorate	16825 South Seton Avenue Emmitsburg, MD 21727 Websites: http://www.usfa.dhs.gov/	301-447-1000		To reduce life and economic losses due to fire and related emergencies.

Publications

Title	Address	Phone	Fax	Summary of Resources
National Fire Protection Association Standard 299: Protection of Life and Property from Wildfire,	National Wildland/Urban Interface Fire Protection Program (1991) National Fire Protection Association Publications Washington, D.C. Website: http://www.nfpa.org or http://www.firewise.org	800-344-3555		Provides criteria for fire agencies, land use planners, architects, developers and local governments.

Earthquake

County

See Multi-Hazard Resources

Regional	Address	Phone	Fax	Summary of Resources
Southern California Earthquake Center (SCEC)	3651 Trousdale Parkway, Suite 169 Los Angeles, CA 90089-0742	213-740-5843	213-740-0011	Gathers new information on EQ and communicates to public.

State	Address	Phone	Fax	Summary of Resources
Western States Seismic Policy Council (WSSPC)	801 K St #1236, Sacramento, CA 95814 Website: http://www.wsspc.org/	(916) 444-6816	(916) 444-8077	Website is great resource, with information clearly categorized from policy to engineering to education.

Publications

Title	Address	Phone	Fax	Summary of Resources
"Elementary Seismology"	C F Richter, pp 135-149; 650-653 Published by: W H Freeman and Company, San Francisco, CA			
"Faults of Southern California"	Southern California Earthquake Center, Website: http://www.scec.org/			

Title	Address	Phone	Fax	Summary of Resources
"Land Use Planning for Earthquake Hazard Mitigation: Handbook for Planners"	Myer R Wolf, et. Al.,(1986) University of Colorado, Institute of Behavioral Science, Nations Science Foundation Contact: Natural Hazards Research and Applications Information Center, University of Colorado, 482 UCB, Boulder, CO 80309-0482 Website: http://www.colorado.edu/UCB/Research/IBS/hazards	303-492-6818	303-492-2151	Provides techniques that planners and others can utilize to help mitigate for seismic hazards.
"Late Quaternary Uplift and Earthquake Potential of the San Joaquin Hills, Southern Los Angeles Basin, California"	Geology, Volume 27, Page 1031-1034 (1999) L. B. Grant, K J Mueller, E M Gath, H. Chang, R L Edwards, R Munro and G L Kennedy			
"Seismic Hazards in Southern California: Probable Earthquakes, 1994 to 2024"	Southern California Earthquake Center Website: http://www.data.scec.org/general/PhaseII.html			

Landslide

County

See Multi-.Hazard Resources

State

See Multi-Hazard Resources.

Federal

See Multi-Hazard Resources

Publications

Title	Address	Phone	Fax	Summary of Resources

Planning for Hillside Development (1996)	Robert B. Olshansky, American Planning Association			Describes history, purpose and functions of hillside development.
Title	**Address**	**Phone**	**Fax**	**Summary of Resources**
Public Assistance Debris Management Guide (July 2000)	Federal Emergency Management Agency			Developed to assist local officials in planning, mobilizing, organizing and controlling large-scale debris clearance, removal and disposal operations.

Unstable Ground: Landslide Policy in the United States (1987)	Robert B. Olshansky & J. David Rogers, Ecology Law Quarterly			History and policy of landslide mitigation in the US.
USGS Landslide Program Brochure	National Landslide Information (NLIC), United States Geologic Survey			General information on the importance of landslide studies, types and causes of landslides, rock falls, and earth flows.

Tsunami

County	**Address**	**Phone**	**Fax**	**Summary of Resources**
Orange County Sheriff's Department, Emergency Management Division	Tsunami Coordinator 2644 Santiago Canyon Road Silverado, CA 92676	714-628-7054	714-628-7154	General information on the results of Tsunami related disasters.

Regional	**Address**	**Phone**	**Fax**	**Summary of Resources**
National Tsunami Warning Center	910 South Felton Street Palmer AK 99645	907-745-4212	907-745-6071	To rapidly locate and size major earthquakes, determine their tsunami potential, predict arrival times and run up and proved timely and effective information and warning bulletins.

State	**Address**	**Phone**	**Fax**	**Summary of Resources**
University of California, Irvine Department of Earth Sciences	Elizabeth J. Ford, Department Manager Croul Hall Irvine, CA 92697-3100	949-824-3877		Study of tsunamis.

University of Southern California Department of Civil and Environmental Engineering Tsunami Research Group	Dr. Costas E. Synolakis, Director 3620 Vermont Avenue Kaprielian Hall 210 Los Angeles, CA 90089-2531	213-740-0603	213-744-1426	Study of tsunamis.

Chapter 8 Appendices

Appendix A: List of Acronyms

Appendix B: List of Maps

Appendix C: List of Figures

Appendix A – List of Acronyms

Acronym	Definition
A&W	Alert and Warning
AA	Administering Areas
AAR	After Action Report
AASHTO	American Association of State Highway and Transportation Officials
AB	Assembly Bill (State of California)
ACOE	US Army Corps of Engineers
ALERT	Automated Local Evaluation in Real Time
ARC	American Red Cross
ARES	Amateur Radio Emergency Services
ARP	Accidental Risk Prevention
ATC	Applied Technology Council
ATC20	Applied Technology Council Form 20
ATC21	Applied Technology Council Form 21
ATWC	Alaska Tsunami Warning Center
B/CA	Benefit/Cost Analysis
BCP	Budge Change Proposal
BFE	Base Flood Elevation
BLM	Bureau of Land Management
BMP	Best Management Practices
BNSF	Burlington Northern Santa Fe Railway
BOS	Board of Supervisors
BSA	California Bureau of State Audits
BSSC	Building Seismic Safety Council
CAER	Community Awareness & Emergency Response
CAL TECH	California Institute of Technology
ALARP	California Accidental Release Prevention
CALBO	California Building Officials
Cal OES	California Office of Emergency Services
CALEPA	California Environmental Protection Agency
CD	Civil Defense
CDBG	Community Development Block Grant
CDEC	California Data Exchange Center (DWR)
CAL FIRE	California Department of Forestry and Fire Protection
CDMG	California Division of Mines and Geology
CEC	California Energy Commission
CEO	Chief Executive Officer
CEPEC	California Earthquake Prediction Evaluation Council
CERT	Community Emergency Response Team
CESRS	California Emergency Services Radio System
CFR	Code of Federal Regulations
CFS	Cubic Feet Per Second
CHIP	California Hazardous Materials Identification Program
CHMIRS	California Hazardous Materials Incident Reporting System
CHP	California Highway Patrol
CIP	Capital Improvement Projects
CIWMB	California Integrated West Management Board
CLETS	California Law Enforcement Telecommunications System
CRS	Community Rating System
CSTI	California Specialized Training Institute
CUEA	California Utilities Emergency Association
CUPA	Certified Unified Program Agency
DAC	Disaster Application Center
DAD	Disaster Assistance Division (of Cal OES)

CALREP	California Radiological Emergency Plan
CALSTARS	California State Accounting Reporting System
CALTRANS	California Department of Transportation
CBA	Cost Benefit Analysis
CBO	Community Based Organization
CBSP	Commuter Bikeways Strategic Plan
DAE	Disaster Assistance Employee
DAMP	Drainage Area Management Plan
DCO	Defense Coordinating Officer
DFO	Disaster Field Office
DGS	California Department of General Services
DHS	Department of Homeland Security (US Government)
DHSRHB	California Department of Health Services, Radiological Health Branch
DMA	Disaster Mitigation Act
DMG	California Division of Mines and Geology
DO	Duty Officer
DOC	Department Operations Center
DOE	Department of Energy (US)
DOF	California Department of Finance
DOJ	California Department of Justice
DPA	California Department of Personnel Administration
DPIG	Disaster Preparedness Improvement Grant
DR	Disaster Response
DSA	Division of the State Architect
DSR	Damage Survey Report
DSW	Disaster Service Worker
DWR	California Department of Water Resources
EAP	Emergency Action Plan
EAS	Emergency Alerting System
EDA	Economic Development Administration
EDC	Economic Development Commission (Orange County)
EDIS	Emergency Digital Information System
EERI	Earthquake Engineering Research Institute
EICC	Emergency Information Coordination Center (FEMA)
EM	Emergency Management
EMA	Emergency Management Assistance
ER	Emergency Relief
ERT	Emergency Response Team
ESC	Emergency Services Coordinator
ESRI	Environmental Systems Research Institute
EWP	Emergency Watershed Protection (NRCS Program)
FAS	Federal Aid System
FAST	Field Assessment Team
FAY	Federal Award Year
FCO	Federal Coordinating Officer (FEMA)
FDAA	Federal Disaster Assistance Administration
FEAT	Flood Emergency Action Team
FEMA	Federal Emergency Management Agency
FFY	Federal Fiscal Year
FHWA	Federal Highway Administration
FIR	Final Inspection Reports
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Studies
FMA	Flood Mitigation Assistance (FEMA Program)
FP	Flood Plan
FRP	Federal Response Plan
FSR	Feasibility Study Report
FTE	Full Time Equivalent
FY	Fiscal Year
GIS	Geographic Information System
GMA	Growth Management Act
GNS	Institute of Geological and Nuclear Science (International)
GSA	General Services Administration
HAD	Housing and Community

EMD	Emergency Management Division (OCSD)
EMC	Emergency Management Council (Orange County)
EMI	Emergency Management Institute
EMMA	Emergency Managers Mutual Aid
EMS	Emergency Medical Services
EOC	Emergency Operations Center
EOP	Emergency Operations Plan
EPA	Environmental Protection Agency (US)
EPEDAT	Early Post Earthquake Damage Assessment Tool
EPI	Emergency Public Information
EPIC	Emergency Public Information Council

	Development (alternate - see HCD)
HAZMAT	Hazardous Materials
HAZMIT	Hazardous Mitigation
HAZUS	Hazards US
HCA	Health Care Agency
HCD	Housing and Community Development (alternate - see HAD)
HEICS	Hospital Emergency Incident Command System
HEPG	Hospital Emergency Planning Guidance
HIA	Hazard Identification and Analysis Unit
HMEP	Hazardous Mitigation Emergency Preparedness

HMG	Hazard Mitigation Grant
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HMPG	Hazard Mitigation Program Grant
HMPT	Hazard Mitigation Plan Task Force (Orange County)
HMST	Hazard Mitigation Survey Team
HUD	Housing and Urban Development (US)
IA	Individual Assistance
IBHS	Institute for Business and Home Safety
ICC	Increased Cost of Compliance
IDE	Initial Damage Estimate
IFG	Individual & Family Grant (program)
IHMT	Interagency Hazard Mitigation Team
IPA	Information and Public Affairs (Cal OES)
IRG	Incident Response Geographic Information System
LAMS	Los Angeles Metropolitan Statistical Area
LAN	Local Area Network
LEA	Local Enforcement Agency
LEMMA	Law Enforcement Master Mutual Aid
LEPC	Local Emergency Planning Committee
LIP	Local Implementation Plan
LUPIN	California Land Use Planning Information Network

NIFC	National Interagency Fire Center
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NPP	Nuclear Power Plant
NPS	National Park Service
NRCS	National Resources Conservation Service
NSF	National Science Foundation
NTS	Natural Treatment System
NWS	National Weather Service
OA	Operational Area
OAEX	Operational Area Executive Board
OASIS	Operational Area Satellite Information System
OCC	Operations Coordination Center
OCD	Office of Civil Defense
OCEMO	Orange County Emergency Management Organization
OCFA	Orange County Fire Authority
OCHCA	Orange County Health Care Agency
OCPW	OC Public Works
OCSD	Orange County Sheriff's Department
OCTA	Orange County Transportation Authority
OCWR	OC Waste and Recycling

M	Magnitude
MARAC	Mutual Aid Regional Advisory Council
MEP	Maximum Extent Practicable
MH	Multi-Hazard
MHID	Multi-Hazard Identification
MOU	Memorandum of Understanding
MSL	Meters above Sea Level
NAWS	National Warning System
NBC	Nuclear, Biological, Chemical
NCDC	National Climate Data Center
NDAA	National Disaster Assistance Act
NEMA	National Emergency Management Association
NEMIS	National Emergency Management Information System
NEXRAD	Next Generation of Radar
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NHMP	National Hazard Mitigation Plan (AKA 409 Plan)
NIBS	National Institute of Building Sciences

OEP	Office of Emergency Planning
OSD	Operations Support Division (Sheriff's Department)
OSFM	Office of State Fire Marshal
OSHPD	Office of Statewide Health Planning and Development
OSPR	Oil Spill Prevention and Response
PA	Public Assistance
PC	Personal Computer
PCH	Pacific Coast Highway
PDA	Preliminary Damage Assessment
PDMGP	Post Disaster Mitigation Grant Program
P-DMGP	Pre-Disaster Mitigation Grant Program
PDSD	Planning & Development Services Division
PEW	Project Evaluation Worksheet
PIO	Public Information Office
POST	Police Officer Standards and Training

PPA/CA	Performance Partnership Agreement/Cooperative Agreement (FEMA)
PSA	Public Service Announcement
PSTRG	Private Sector Terrorism Response Group
PTAB	Planning and Technological Assistance Branch
PTR	Project Time Report
RA	Regional Administrator (Cal OES)
RADEF	Radiological Defense (program)
RAMP	Regional Assessment of Mitigation Priorities
RAPID	Railroad Accident Prevention & Immediate Deployment
RDMHC	Regional Disaster Medical Health Coordinator
RDO	Radiological Defense Officer
REOC	Regional Emergency Operations Center
REPI	Reserve Emergency Public Information
RES	Regional Emergency Staff
RMP	Risk Management Plant
RPU	Radiological Preparedness Unit (Cal OES)
RRT	Regional Response Team
SAM	State Administration Manual
SARA	Superfund Amendments & Reauthorization Act
SARS	Severe Acute Respiratory Syndrome
SAVP	Safety Assessment Volunteer Program
SB	Senate Bill (State of California)
SBA	Small Business Administration
SCEC	Southern California Earthquake Center
SCO	California State Controller's Office
SEAO	Structural Engineers Association of Oregon
SEPIC	State Emergency Public Information Committee
SFHA	San Francisco Housing Authority
SONGS	San Onofre Nuclear Generating Station
SOP	Standard Operation Procedure
SWEPC	Statewide Emergency Planning Committee
TEC	Travel Expense Claim
TOR	Transfer of Development Rights
TRU	Transuranic
TTT	Train the Trainer
UCI	University of California Irvine
UCLA	University of California Los Angeles
UCSB	University of California Santa Barbara
UGB	Urban Growth Boundary
UPA	Unified Program Account
UPRR	Union Pacific Rail Road
UPS	Uninterrupted Power Source
URM	Unreinforced Masonry
USACE	United States Army Corps of Engineers
USAR	Urban Search and Rescue
USBR	United States Bureau of Reclamation
USC	University of Southern California
USDA	United States Department of Agriculture
USFA	United States Fire Administration
USFS	United States Forest Service
USGS	United States Geological Survey
WAN	Wide Area Network
WC	California State Warning Center
WEE	Western Equine Encephalomyelitis
WEROC	Water Emergency Response of Orange County
WGA	Western Governors' Association
WIPP	Waste Isolation Pilot Project
WNV	West Nile Virus
WSSPC	Western State Seismic Policy Council

SHMO	State Hazard Mitigation Officer
SLA	State and Local Assistance
SLE	St. Louis Equine Encephalitis
SNV	Sin Nombre Virus
SOC	Storm Operations Center

Appendix B - Table of Maps

Orange County Geomatics developed many of the maps included in this plan. The contributions from this department were essential in illustrating the extent and potential losses associated with the natural hazards affecting the County. The information on the maps in this plan was derived from the Orange County Public Works, Geomatics Office. Care was taken in the creation of these maps, but they are provided "as is." Orange County cannot accept any responsibility for any errors, omissions or positional accuracy, and therefore, there are no warranties that accompany these products (the maps). Although information from Land Surveys may have been used in the creation of these products, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

List of Maps

Appendix C - List of Figures and Tables

Chapter 9 Attachments

Attachment A: Hazard Mitigation Task Force Planning Documentation

Attachment B: Orange County Essential Facilities Risk Assessment Project Report (Hazus Analysis)

Attachment C: County of Orange Property Schedule

Attachment D: Project Status Reports