# Floodplain Management Plan

Volume 1—Basic Plan



September 2026

TETRA TECH

# Orange County Floodplain Management Plan

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# EXECUTIVE SUMMARY

## Background

Orange County is highly susceptible to flooding and has endured significant losses over the years due to flood impacts. To address these challenges, the County developed a Floodplain Management Plan (FMP) to identify known flood problem areas, establish goals, objectives, policies, and implementation programs aimed at reducing flooding and flood-related hazards, and ensure the protection of the natural and beneficial functions of the floodplains. The long-term benefits of floodplain management planning include:

- An increased understanding of flood hazards faced by the County
- A more sustainable and disaster-resistant community
- Financial savings through partnerships that support planning and mitigation efforts
- Focused use of limited resources on hazards that have the biggest impact on the community
- Reduced long-term impacts and damages to human health and structures and reduced repair costs

The Orange County FMP is multi-jurisdictional, providing planning and analysis for the County as well as five cities located within the county, designated as participating jurisdictions: City of Anaheim, City of Laguna Woods, City of Newport Beach, City of San Juan Capistrano, and City of Santa Ana.

## Community Rating System

The National Flood Insurance Program (NFIP) provides federally backed flood insurance to encourage communities to enact and enforce floodplain regulations. The Community Rating System (CRS) encourages community floodplain management activities that exceed the minimum NFIP standards. Under the CRS, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet the three goals of the CRS:

- **Reduce flood damage to insurable property—**Communities are encouraged to map and provide regulatory flood data for all their flood hazards. The data should be used in their regulatory programs and shared with all users and inquirers. New buildings in mapped floodplains should be protected from known local flood hazards, which may require setting standards higher than the minimum national criteria of the NFIP. Communities are encouraged to reduce the exposure of existing buildings to flood damage, especially repetitive loss properties.
- **Strengthen and support the insurance aspects of the NFIP—**Communities should encourage their residents to be aware of their flood risk and to purchase and maintain a flood insurance policy to protect themselves from the financial impacts of flooding. Communities should also help make the program more financially sound by implementing mapping and information programs that help to accurately evaluate the individual property risk for flood insurance rating purposes, expand the policy base, and reduce repetitive losses.
- **Encourage a comprehensive approach to floodplain management—**Insurable property is not the only floodplain management concern of communities, so the CRS recognizes efforts that protect lives; further public health, safety, and welfare; and protect natural floodplain functions.

Communities earn credit points for activities to achieve these goals, and the amount of insurance premium reduction is based on the points earned. The CRS recognizes 19 creditable activities, organized under four

categories: Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness (FEMA 2025).There are 10 CRS classes: Class 1 requires the most credit points and gives the largest premium reduction at 45 percent; Class 10 receives no premium reduction (FEMA 2025). A community that does not apply for the CRS or that does not obtain the minimum number of credit points is Class 10.

In addition to the reduction in flood insurance premiums for residents and businesses, CRS participation benefits communities through the enhancement of public safety and reduction of flood damage to property and public infrastructure (FEMA 2025). A further benefit is building a knowledgeable community that is interested in supporting floodplain management and protecting themselves from flooding (FEMA 2025).

In the CRS Program, “community” includes state and regional agencies and private organizations that support and assist city, county, and tribal governments that are participants in the NFIP. A community’s staff should understand the physical and biological processes that form and alter floodplains and watersheds and take steps to deal with flooding, erosion, habitat loss, water quality, and special flood-related hazards. A comprehensive approach includes planning, public information, regulations, financial support, open space protection, public works activities, emergency management, and other appropriate techniques (FEMA 2025).

## The FMP Planning Process

To develop this FMP, the County accomplished the following:

- Developed a Steering Committee composed of government and non-government stakeholders that guided the planning process and provided information and feedback.
- Profiled the flood hazard.
- Estimated the inventory at risk and potential losses from flood hazards.
- Performed a comprehensive review of mitigation alternatives.
- Developed mitigation actions and goals that address the various flood hazards that impact Orange County.
- Developed mitigation plan maintenance procedures to be executed after adoption of the plan.

As required by CRS, the planning process engaged the public throughout, providing opportunities for public comment and input. In addition, numerous agencies and stakeholders participated as core or support members, providing input and expertise throughout the planning process. This multi-level coordination allowed the FMP to be developed with a built-in network of partners and resources available to assist with plan review, update, and ongoing implementation. The FMP documents the process and outcomes of the County’s efforts.

Plan coordination provided for input from the general public during open public meetings, as well as through non-government stakeholders on a Planning Committee. The general public was provided an array of options to be part of the planning process via public meetings, online surveys and dedicated online resources. This array of plan coordination effort ensures that stakeholders and the general public are represented throughout the planning process and that future updates to plan goals, objectives and mitigation actions are accomplished in an efficient and transparent manner by maintaining established communication channels and relationships.

To assess risk and vulnerability, the County used FEMA’s Hazus software package, supplemented by local data where feasible. Hazus assesses risk and estimates potential losses due to flooding and other hazards. It produces outputs that communicate flood risk and assist state and local governments, communities, and the private sector in implementing emergency response, recovery, and mitigation programs, including the development of FMPs.

## Local Government Support

Primary responsibility for the development and implementation of mitigation strategies and policies lies with local governments. Oversight for the preparation of this plan was provided by the Orange County FMP Steering Committee, which includes representatives from a wide array of government agencies and specializations. Agencies represented include Public Works, Planning, Development, Building Safety/Inspection, Emergency Services, Environmental, Community Development, City Managers/Administrative Offices. Table ES-1 summarizes each FMP participating jurisdiction's departments containing functional specializations.

**Table ES-1. Participating Jurisdiction Departments Involved in the FMP Development**

| Jurisdiction | Participating Departments | |
|---|---|---|
| | Department Where Floodplain Management Functions Are Performed | Other Departments |
| **City of Anaheim** | Department of Planning and Building | Department of Public Works<br>Department of Fire and Rescue |
| **City of Laguna Woods** | Department of Planning and Environmental Services | City Manager's Office |
| **City of Newport Beach** | Department of Community Development | Department of Public Works |
| **City of San Juan Capistrano** | Department of Engineering and Environmental Services | |
| **City of Santa Ana** | Department of Planning and Building | |
| **Orange County (unincorporated)** | Department of Public Works | |

## FMP Guidance

This FMP was prepared in accordance with the following regulations and guidance:

- 44 Code of Federal Regulations (CFR) part 78.5—Flood Mitigation Plan Development in accordance with the National Flood Insurance Act of 1968 (42 U.S.C. 4104c et seq.)
- CRS Coordinator's Manual (OMB No. 1660-0022)
- DMA 2000 (Public Law 106-390, October 30, 2000)
- 44 CFR Parts 201 and 206 (including: Feb. 26, 2002, Oct. 1, 2002, Oct. 28, 2003, and Sept. 13, 2004 Interim Final Rules)

# FMP Contents

The FMP is made up of two volumes. Volume 1 is the Basic Plan and Volume 2 is made up of separate annex documents for each participating jurisdiction. Volume 1 is organized into seven sections and a series of appendices. Note here that the individual annex documents will often refer to the Basic Plan. However, the individual annex documents will contain capability assessments and mitigation strategies specific to each jurisdictions unique needs, strengths, and weaknesses.

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# 1. INTRODUCTION

## 1.1 FLOODPLAIN MANAGEMENT PLANNING OVERVIEW

A floodplain management plan (FMP) is a comprehensive examination of a community's flood risk and of policies that can be implemented to lessen the negative impacts of flooding. A well thought-out comprehensive FMP will carefully identify all of the specific flood risks to the community, articulate goals and objectives, and recommend actions to directly reduce negative impacts associated with the identified flood risks.

### 1.1.1 Benefits of an FMP

An FMP aims to achieve the following in order to set the course for reducing the risk associated with flooding:

- Ensuring that all possible floodplain management activities are reviewed and implemented so that local problems are addressed by the most appropriate and efficient solutions
- Ensuring that floodplain management activities are coordinated with one another and with other community goals and activities, preventing conflicts and reducing the cost of implementing each individual activity
- Coordinating local floodplain management activities with federal, state and regional programs
- Educating residents on the flood hazard, loss reduction measures, and the natural and beneficial functions of floodplains
- Building public and political support for projects that mitigate the flood risk
- Fulfilling planning requirements for obtaining state or federal funding assistance
- Facilitating the implementation of floodplain management and mitigation activities through an action plan that has specific tasks, staff assignments and deadlines.

Preparing an FMP is a strategic approach to reducing community losses that occur due to flooding, including loss of life, personal injury, and property. A thoughtfully prepared floodplain management plan will articulate strategies such as planning, policy changes, programs, projects, and other activities that can alleviate many of the negative impacts associated with floods. Moreover, a floodplain management plan plays a crucial role in aligning agency decisions with the most up-to-date information available. Without proper planning, flood protection decisions may become disconnected, which can lead to inefficient use of public resources and flood problems that continue to go unmitigated.

### 1.1.2 Groups Involved in Preparing and Implementing an FMP

The responsibility for floodplain management rests on the shoulders of many stakeholder groups working as a collective unit to reduce the overall vulnerability of the community. Private property owners, major employers, business owners, major industry representatives, and public sector government all participate in the plan creation process, recognizing that planning provides a mechanism to identify the best alternatives that are within the capacity of a community to attain.

The effectiveness of a floodplain management plan is dependent upon its implementation, which in turn is the responsibility of multiple individuals and stakeholder groups. Implementing an FMP relies on cooperation between

and within stakeholder groups: private property owners, the local business community, the industrial sector, the agricultural community, local government officials, and state and federal government agencies.

Several state and federal agencies and programs promote floodplain management planning. Most notable is the Federal Emergency Management Agency's (FEMA), National Flood Insurance Program (NFIP), which provides benefits in the form of flood insurance. FEMA also provides regulatory oversight and guidance that communities can use to meet minimum floodplain management requirements.

The State of California administers floodplain management programs through the California Department of Water Resources (DWR). State floodplain management programs include the Delta Levees Program, Local Levee Assistant Program, Urban Flood Risk Reduction Program, and the Small Communities Flood Risk Reduction Program (DWR n.d.-e). DWR also provides risk awareness notifications to properties protected by the States' levee system and is involved in cooperative outreach efforts with County Emergency Operation centers.

## 1.2 THE 2026 ORANGE COUNTY FLOODPLAIN MANAGEMENT PLAN

The 2026 Orange County Floodplain Management Plan (FMP) presents measures to mitigate potential flood problems throughout the County, with the ultimate goal of protecting life and property from flooding. The FMP identifies long-term and short-term strategies such as planning, policy changes, programs, projects, and other activities to mitigate the impacts of floods. The strategies presented in this FMP were selected in order to meet state or federal program requirements and to address flood risks that are particular to the County.

This FMP identifies resources, information, and strategies for mitigating risk and reducing vulnerability stemming from flood hazards. It will serve as a guide to coordinate flood mitigation activities. The FMP was developed to meet the following objectives:

- Increase the flood resilience for Orange County and its jurisdictions.
- Meet the needs of the County as well as state and federal requirements.
- Meet planning requirements allowing Orange County to remain in the FEMA's Community Rating System (CRS) program by earning credit under CRS Activity 510.
- Coordinate existing plans and programs so that high-priority actions to mitigate flood impacts are funded and implemented.
- Create a linkage between the FMP and established plans of Orange County and its jurisdictions to ensure they can work together in achieving successful mitigation.

The Orange County FMP is multi-jurisdictional, providing planning and analysis for the County as well as five cities located within the county, designated as participating jurisdictions: City of Anaheim, City of Laguna Woods, City of Newport Beach, City of San Juan Capistrano, and City of Santa Ana.

All residents, businesses, and visitors of Orange County are the ultimate beneficiaries of this plan. Participation in the development of the plan by key stakeholders helps ensure that outcomes will be mutually beneficial. The plan's goals and recommendations can lay groundwork for the development and implementation of local mitigation activities and partnerships.

## 1.3 FLOODPLAIN MANAGEMENT PLANNING AND THE CRS PROGRAM

Orange County is an NFIP participating community. In order to participate in the NFIP, a community must implement minimum flood risk reduction standards. For NFIP participating communities that want to go above and beyond the NFIP minimum standards, FEMA developed the Community Rating System (CRS), a program that incentivizes greater flood risk reduction actions. In order for the CRS program to achieve its goals to reduce flood losses, facilitate accurate flood insurance rating, and promote awareness of flood insurance, the CRS program offers 19 creditable activities in four categories (see Table 1-1) (FEMA 2025):

- **Public Information** activities (300 Series) credit programs that advise people about the flood hazard, encourage the purchase of flood insurance, and provide information about ways to reduce flood damage. These activities serve all community members but can be directed to residents of the floodplain, property owners, real estate agents, and insurance agents. Example activities for this series include maintaining correct FEMA elevation certificates for new or substantially improved buildings in the Special Flood Hazard Area (SFHA), providing inquirers with information about local flood hazards, and flood protection promotion.
- **Mapping and Regulation** activities (400 Series) credit programs that enact and enforce regulations exceeding the NFIP minimum standards so that new and existing development is provided with more flood protection. These activities only affect certain parts of a community, usually those that are located in the SFHA. Example activities for this series include mapping areas not shown on FEMA's Flood Insurance Rate Map (FIRM), preserving open space, and enforcing higher regulatory standards.
- **Flood Damage Reduction** activities (500 series) credit programs that reduce flood risk to existing development. Activities for this series include floodplain management planning (such as the preparation of this FMP), building acquisition and relocation, retrofitting and other forms of flood protection, and drainage system maintenance.
- **Warning and Response** activities (600 series) credit measures that protect life and property during a flood through flood warning and response programs. Activities for this series focus on flood warning and response, levees, and dams.

The CRS's creditable activities were developed around the overall premise that, if implemented properly, each activity incrementally reduces the risks of loss from flooding events. Under the CRS program, NFIP participating communities can extend flood insurance premium discounts to their residents and property owners in line with the reduced flood risk resulting from community actions to meet the CRS goals. How much of a flood insurance premium discount depends on the number of creditable actions a community takes. The more activities a community implements, the greater the discount percentage. CRS communities are ranked on a scoring system of points.

The CRS rating classes range from a Class 1, where a community receives a 45-percent premium discount for properties within the SFHA, to a Class 9, where a community receives a 5-percent discount. As shown in Table 1-2, insurance premium discounts for classifications between 1 and 9 are staggard in increments of 5 percent. A Class 10 community, by default, is a community that does not participate in the CRS program or is a community that does not have any creditable activities to advance to a Class 9 community. Class 10 communities do not receive any flood insurance premium discounts.

**Table 1-1. Community Rating System (CRS) Activities by Series Category**

| Series Number and Name | Activity Number | Activity Name | Maximum Points |
|---|---|---|---|
| **300 Series – Public Information** | 310 | Elevation Certificates | 116 |
| | 320 | Map Information Service | 150 |
| | 330 | Outreach Projects | 300 |
| | 340 | Hazard Disclosure | 80 |
| | 350 | Flood Protection Information | 125 |
| | 360 | Flood Protection Assistance | 110 |
| | 370 | Flood Insurance Promotion | 190 |
| **400 Series – Mapping and Regulations** | 410 | Floodplain Mapping | 850 |
| | 420 | Open Space Preservation | 3,720 |
| | 430 | Higher Regulatory Standards | 3,762 |
| | 440 | Flood Data Maintenance | 222 |
| | 450 | Stormwater Management | 755 |
| **500 Series – Flood Damage Reduction** | 510 | Floodplain Management Planning | 762 |
| | 520 | Acquisition and Relocation | 2,250 |
| | 530 | Flood Protection | 2,600 |
| | 540 | Drainage System Maintenance | 470 |
| **600 Series – Warning and Response** | 610 | Flood Warning and Response | 395 |
| | 620 | Levees | 235 |
| | 630 | Dams | 160 |

Source: (FEMA 2025)

**Table 1-2. CRS Credit Points, Classes, and Premium Discounts**

| CRS Credit Points | CRS Class | CRS Discount (Premium Reduction) |
|---|---|---|
| **4,500+** | 1 | 45% |
| **4,000 – 4,499** | 2 | 40% |
| **3,500 – 3,999** | 3 | 35% |
| **3,000 – 3,499** | 4 | 30% |
| **2,500 – 2,999** | 5 | 25% |
| **2,000 – 2,499** | 6 | 20% |
| **1,500 – 1,999** | 7 | 15% |
| **1,000 – 1,499** | 8 | 10% |
| **500 – 999** | 9 | 5% |
| **0 – 499** | 10 | 0% |

Source: (FEMA 2025)

## 1.3.1 CRS Credits Associated With Floodplain Management Planning

A significant portion of CRS credits can be earned by meeting the minimum criteria for floodplain management planning. Formulating and maintaining an FMP may lead to qualifying credits under the CRS program for any community that chooses to actively participate in the FMP development process.

Additional qualifying activities include CRS Activity 370—Flood Insurance Coverage Assessment (FIA), which credits communities that evaluate their current level of flood insurance coverage, identify shortcomings, and propose solutions to address gaps.

Another qualifying activity is CRS Activity 500—Flood Damage Reduction (FDR). FDR is coordinated with the creation and implementation of an FMP. The FDR activity includes evaluating repetitively flood damaged structures via a repetitive loss area analysis (RLAA) and identifying floodplain management actions that protect a floodplain's natural functionality—or a Natural Floodplain Function Plan (NFP) (FEMA 2025).

All of these additional activities will be sought through the formulation of this FMP to not only fully leverage available CRS credits, but to ensure the FMP addresses as many floodplain management measures as feasible for the County and for other participating jurisdictions.

## 1.3.2 Other Local Plans That Contribute CRS Credits

The CRS program complements other plans that communities can develop to address their local hazards and environmental protection. It encourages a comprehensive approach to floodplain management, and the information provided in other plans can assist a community with receiving CRS credits and mitigating the effects of flooding. Hazard mitigation plans (HMPs) are plans developed by communities to identify all hazards facing a community and develop long-term strategies to mitigate their impacts on people and property. FEMA requires communities to develop and adopt an HMP as a condition to receive certain types of non-emergency disaster assistance (FEMA 2025). An HMP can be used to collect points for the FMP if it meets the requirements and planning steps related to flood hazards as outlined in the CRS Manual (FEMA 2025).

The CRS program credits communities that have a comprehensive plan that addresses stormwater runoff for the community and the watershed that covers it. A watershed master plan provides a tool for making decisions that will reduce the increased flooding from future conditions which include new development, re-development, and climate change. Plans that are credited by the CRS program have detailed hydrologic modeling done to understand the runoff of stormwater under both present and future conditions and the mitigation measures that are appropriate to address future flooding (FEMA 2025).

Preserving and restoring the natural floodplain functions of a community is part of the comprehensive floodplain management goal of the CRS program. Floodplains in their natural conditions provide the necessary flood water conveyance and storage to control flood velocities and peak, improve water quality by filtering runoff, and provide a habitat fish and wildlife. The CRS program has activities that focus on preserving or restoring the natural state of floodplains. The CRS program provides credits for any adopted plans that the community has for protecting one or more natural floodplain functions within the community's floodplain. Examples include habitat conservation plans that explain and recommend actions to protect aquatic or riparian species, habitat protection or restoration plans that identify critical habitat in the floodplain and actions to protect or restore the habitat, and plans or sections of a comprehensive community plan that include an inventory of the ecological attributes of the watershed or floodplain and the actions that can be taken to protect them (FEMA 2025).

## 1.3.3 Orange County CRS Program

### Current Status

Orange County has been a participant in the CRS program since October 1991 and pursues a number of CRS activities under the program. According the most recent FEMA Community Status Book, the County has a Class 5 rating, which means that residents of unincorporated County areas who live in the SFHA can receive up to a 25 percent discount on flood insurance premiums. This equates to an annual savings ranging from $52 to $772 per policy, for a total Countywide premium savings approaching $62,254. To maintain or improve its rating, the County will go through an annual CRS recertification, and a reverification every five years.

Orange County has continued to take a proactive approach to improve its floodplain management practices and effectively reduce flood risk. Table 1-3 lists activities the County currently undertakes. These activities, and the credits obtained, are updated during the County's annual CRS recertification, with revisions made accordingly.

**Table 1-3. Orange County CRS Activities by Category**

| CRS Activity Category | CRS Activity | Maximum Credits | Total Number of Possible Actions in Activity |
|---|---|---|---|
| **Public Information** | Elevation Certificate Maintenance | 116 | 3 |
| **Public Information** | Flood Map Information Service | 150 | 7 |
| **Public Information** | Flood Hazard Disclosure | 80 | 4 |
| **Public Information** | Flood Protection Information | 125 | 3 |
| **Public Information** | Flood Protection Assistance | 120 | 4 |
| **Public Information** | Flood Insurance Promotion | 190 | 7 |
| **Public Information** | Flood Outreach Projects | 300 | 4 |
| **Mapping and Regulations** | Open Space Preservation | 3,720 | 8[a] |
| **Mapping and Regulations** | Higher Regulatory Standards | 3,762 | 16[b] |
| **Mapping and Regulations** | Flood Data Maintenance | 222 | 4 |
| **Mapping and Regulations** | Stormwater Management | 755 | 4 |
| **Flood Damage Reduction** | Drainage System Maintenance | 470 | 5 |
| **Flood Damage Reduction** | Floodplain Management Planning | 762 | 4 |
| **Warning and Response** | Flood Warning and Response | 395 | 6 |
| **Warning and Response** | Dam Monitoring and Safety | 160 | 5 |

Source: (FEMA 2025)
a. Preserved Open Space (OSP) activity accounts for 1,450 pts. or approximately 39 percent of total pts. for activity.
b. Development Limitations (DL) activity accounts for 1,330 pts. or approximately 35 percent of the pts. for the activity.

### Higher Regulatory Standards that Contribute to Risk Reduction

One of the activities listed above deals with implementing regulations that go above and beyond the NFIP minimum. These higher regulatory standards can take multiple forms, and can include building codes, subdivision development, site plan design standards, etc. Orange County implements several floodplain zoning districts to further regulate floodplain development. Each district contains specific design standards and flood protection criteria for all building sites in these districts:

- The FP-1 district regulates development in the FEMA regulatory floodway

- The FP-2 district regulates development in the FEMA SFHA—Zones A, A1 through A30, AO, AE, AH, A99, and Zone M
- The FP-3 district regulates development within FEMA Coastal High Hazard Areas—Zones V, V1 through V30, and VE.

The County's FP districts apply to new construction and substantial improvement of existing structures in the designated zones and often require that dry-floodproofing be achieved at or above 1 foot above the base flood elevation (BFE) and that wet-floodproofing be achieved with proper anchoring to prevent improvements from being damaged by high-velocity flows, reducing hydrologic and hydrostatic forces on the structure by allowing water to pass through the lower levels.

## 1.3.4 CRS and FMP Participation for Jurisdictions in the County

Table 1-4 lists CRS status information for the County and all incorporated cities within it. Note that CRS participation does not equate to FMP participation, as the two programs are independent from each other. It is also important to mention that insurance premium discounts made possible through the CRS program do not uniformly apply to policy holders who already have a planned phasing of premium changes (upward or downward), often referred to as a glidepath. The intent of glidepaths is to balance the changing affordability of flood policies with the increasing need to keep programs sustainable and solvent.

**Table 1-4. Orange County Communities FMP and CRS Participation**

| Jurisdictions | FMP Participant; Annex Included | Date of CRS Entry | Current Effective CRS Date | CRS Class Rating | Flood Premium Discount |
|---|---|---|---|---|---|
| **Orange County (unincorporated)** | X | 10/01/1991 | 05/01/2017 | 5 | 25% |
| **City of Anaheim** | X | 10/01/1991 | 04/01/2023 | 6 | 20% |
| **City of Fountain Valley** | | 10/01/1996 | 05/01/2015 | 9 | 5% |
| **City of Huntington Beach** | | 10/01/1995 | 10/01/2020 | 7 | 15% |
| **City of Irvine** | | 10/01/1991 | 10/01/2012 | 9 | 5% |
| **City of Laguna Woods** | X | Not Currently Participating in CRS | | | |
| **City of Mission Viejo** | | 10/01/2005 | 05/01/2015 | 7 | 15% |
| **City of Newport Beach** | X | 10/01/1993 | 10/01/2024 | 6 | 20% |
| **City of Orange** | | 10/01/1992 | 10/01/1992 | 9 | 5% |
| **City of San Juan Capistrano** | X | 10/01/1991 | 05/01/2017 | 8 | 10% |
| **City of Santa Ana** | X | Not Currently Participating in CRS | | | |
| **City of Yorba Linda** | | 10/01/1993 | 10/01/2004 | 10 | 0% |

Source: (FEMA NFIP 2025)

## 1.4 HOW WAS THE PLAN PREPARED?

Developing a comprehensive FMP is a creditable activity under the CRS program if its development follows the steps below:

- Phase 1: Planning Process:
  - Step 1. Organize
  - Step 2. Involve the public
  - Step 3. Coordinate
- Phase 2: Risk Assessment:
  - Step 4. Assess the hazard
  - Step 5. Assess the problem
- Phase 3: Mitigation Strategy:
  - Step 6. Set goals
  - Step 7. Review possible activities
  - Step 8. Draft an action plan
- Phase 4: Plan Maintenance:
  - Step 9. Adopt the plan
  - Step 10. Implement, evaluate, and revise

The 2026 Orange County FMP incorporates the CRS 10 steps as follows:

- **Organize and Coordinate Review (Steps 1 and 3):** A Steering Committee, consisting of representatives from the County as well as participating jurisdictions, was assembled to oversee the development of the plan. The Steering Committee met eight times over a 10-month period to provide guidance and oversight to the Core Planning Team, comprised of County Staff and a technical consultant. This team was responsible for the development of the plan. Coordination with regional, state and federal agencies involved in floodplain management occurred throughout the plan's development. A comprehensive review of existing plans and programs that can support floodplain management was completed.
- **Involve the Public (Step 2)**: The Steering Committee developed a public involvement strategy that was implemented by the Core Planning Team which included holding public meetings to allow the general public to actively engage in the planning process. In addition to live meetings, the public involvement strategy provided opportunities to learn and engage with the FMP via electronic flood preparedness surveys, floodplain management surveys, and a dedicated County-maintained website (https://storymaps.arcgis.com/stories/9cb5a60b07ad4ffb843177a8e4cdaee2) with updated information on the FMP process, as well as multiple media releases. In order to ensure public involvement was integrated into the planning process and mitigate against the possibility of reduced attendance rates during public meetings, a Planning Committee (PC) was introduced. Separate and distinct from the Steering Committee, the PC was comprised of *non-government stakeholders* to bolster public involvement. Furthermore, the PC was activated specifically during the FMP's plan development stage and deployed during the draft FMP's public review.
- **Risk assessment (RA) (Step 4)**: A Risk Assessment is the process of identifying the types of hazard risks that a community is exposed to, including their frequency of occurrence, intensity, duration, speed of onset, temporal scale (daily, diurnal, annual, seasonal, random, etc.), and spatial distribution.

- **Vulnerability Assessment (Step 5)**: Vulnerability assessment is the process of assessing potential for loss of life, personal injury, damage to property, damage to business, damage to critical facilities, damage to infrastructure, as well as to vulnerable population groups.
- **Repetitive Loss Area Analysis (Steps 4 and 5):** The risk assessment includes a repetitive loss area analysis (RLAA) for areas of the County that experience repeated flood insurance losses per NFIP criteria. The RLAA for Orange County is being prepared at the same time as this FMP but as a separate document.
- **Draft FMP Assembly (Steps 5, 7, and 8):** The Core Planning Team and Steering Committee assembled key information from Phases 1 and 2 into a draft FMP document meeting the CRS requirements. The FMP including a description of the planning process, the risk assessment, a mitigation strategy (inclusive of goals, objectives, consideration of mitigation actions, and a review of alternatives), and a prioritized floodplain management action plan.
- **FMP Plan Review (Step 9)**: A pre-adoption review draft of the plan was sent for review and comment to the Insurance Services Office (ISO), the contractor for the CRS. After pre-adoption approval was granted by the ISO, the County Board of Supervisors convened and formally adopted the final plan. This plan includes an implementation and maintenance section detailing the process for ensuring that the plan remains an active and relevant document. The maintenance process includes an annual schedule for monitoring and evaluating the plan's progress as well as its revision every five years. Implementation and maintenance include continued public involvement and incorporation of the recommendations of this plan into existing County functional plans, including the General Plan, Capital Improvement Program (CIP), and Hazard Mitigation Plan (HMP).
- **Formal Adoption by the Governing Body (Step 9):** The FMP was adopted by the County Board of Supervisors, whereby the Final Approved FMP included documentation of the legislative action taken by the Board of Supervisors.
- **Implementation and Maintenance (Step 10):** The adopted FMP contained a plan maintenance section, allowing the document to be updated and revised in a consistent and logical manner.

## 1.5 PLAN ORGANIZATION

The Orange County FMP is organized in the following chapters, aligning with the CRS Steps for floodplain management planning:

- **Chapter 1, Introduction**—Overview and summary of the Orange County FMP.
- **Chapter 2, Plan Adoption**—A description of the plan adoption process.
- **Chapter 3, Planning Process**—A description of the planning methodology and plan development process, involvement of the Steering Committee, Planning Committee, and stakeholders, and how this FMP will be incorporated into existing programs.
- **Chapter 4, Orange County Profile**—An overview of Orange County, including: (1) general information, (2) geologic setting, climate, land cover and land use; (3) population and socio-demographics; (4) general building stock inventory, and (5) development trends.
- **Chapter 5, Risk and Vulnerability Assessment**—Identification of flood hazard risks and results of the vulnerability assessment (estimates of the impact of flood events on vulnerable populations, general building stock, critical facilities, the economy, physical environment, land cover, future growth and development). Description of the status of local data and planned steps to improve local data to support mitigation planning.

- **Chapter 6, Mitigation Strategies**—Information regarding the mitigation goals, objectives, capability assessment, and mitigation action items identified by Orange County in response to flood problems in the County.
- **Chapter 7, Plan Maintenance Procedures—**The system established by the County to monitor, evaluate, maintain, and update the FMP.

# 2. PLAN ADOPTION

Formal adoption of the FMP by the Orange County Board of Supervisors demonstrates the commitment of the County to fulfill the identified goals and objectives. Adoption legitimizes the plan and authorizes responsible agencies to execute their actions identified in the FMP. The resolution to adopt the FMP is included as Appendix G. For this FMP to be used by a participating jurisdiction, that jurisdiction must also formally adopt it.

# 3. PLANNING PROCESS

This chapter describes the Orange County FMP planning process, organized by the following planning steps from the 2017 CRS Coordinators Manual:

1. Step 1. Organize to prepare the plan
2. Step 2. Involve the public
3. Step 3. Coordinate
4. Step 4. Assess the hazard
5. Step 5. Assess the problem
6. Step 6. Set goals
7. Step 7. Review possible activities
8. Step 8. Draft an action plan
9. Step 9. Adopt the plan
10. Step 10. Implement, evaluate, revise

## 3.1 ORGANIZE TO PREPARE THE PLAN

The Orange County FMP Steering Committee initiated and oversaw the planning project. The Steering Committee was established by Orange County Board of Supervisors when the Board hired Tetra Tech, Inc. (Tetra Tech) to assist in the development and implementation of the FMP. The resolution and the Steering Committee charter are included in Appendix D. The Steering Committee is comprised of the individuals listed in Table 3-1.

**Table 3-1. Steering Committee Members**

| Name | Organization | 1st Alternate | 2nd Alternate | 3rd Alternate |
|---|---|---|---|---|
| **Government Representatives** | | | | |
| Keith Linker | City of Anaheim | William Grigsby | Jannine Wilmoth | Charles Guiam |
| Nadia Cook | City of Laguna Woods | Chris Macon | - | - |
| Melissa Kubischta | City of Newport Beach | Tonee Thai | - | - |
| Shawn Mousavi | City of San Juan Capistrano | Justin Inducil | Paul Meshkin | Noreen Swiontek |
| Rudy Rosas | City of Santa Ana | Craig Foster | Stephen Rhyner | - |
| Joyce Drysdale | Unincorporated Orange County | Giatho Tran | - | - |
| **Non-Government Representatives** | | | | |
| Jayme Laber | NOAA | | - | - |

Orange County Public Works is the County agency responsible for land use and comprehensive planning. Representatives of Orange County Public Works attended each meeting of the Steering Committee. The six categories of activities reviewed in Step 7 of the planning process were also represented by members of the Steering Committee, as shown in Table 3-2.

**Table 3-2. Steering Committee Activity Category Representation**

| Name | Preventive Measures | Property Protection | Natural Resource Protection | Emergency Services | Structural Flood Control Projects | Public Information |
|---|---|---|---|---|---|---|
| Keith Linker, City of Anaheim, Principal Civil Engineer | X | X | | | X | |
| William Grigsby, City of Anaheim, Principal Civil Engineer Inspections | X | X | | | X | X |
| Jannine Wilmoth, City of Anaheim, Emergency Manager | X | X | | X | | X |
| Charles Guiam, City of Anaheim, Planner | X | X | X | X | X | X |
| Nadia Cook, City of Laguna Woods, Conservation Administrator | X | X | X | | | X |
| Chris Macon, City of Laguna Woods, City Manager | X | X | | | | X |
| Melissa Kubischta, City of Newport Beach, Principal Engineer Plan Check | X | X | | | X | |
| Tonee Thai, City of Newport Beach, Chief Building Official | X | X | | | X | |
| Shawn Mousavi, City of San Juan Capistrano, Senior Civil Engineer | X | X | | | X | |
| Justin Inducil, City of San Juan Capistrano, Engineering Technician | X | X | | | X | |
| Paul Meshkin, City of San Juan Capistrano, Senior Civil Engineer | X | X | | | X | |
| Noreen Swiontek, City of San Juan Capistrano, Environmental Programs Analyst | X | | X | | | X |
| Rudy Rosas, City of Santa Ana, Deputy Public Works Director | X | X | | X | X | X |
| Craig Foster, City of Santa Ana, Public Works Construction Services, NPDES Coordinator. | X | X | X | | X | |
| Joyce Drysdale, Unincorporated Orange County, Orange County Public Works, Civil Engineer | X | X | X | X | X | X |
| Giatho Tran, Unincorporated Orange County, Orange County Public Works, Senior Civil Engineer | X | X | X | X | X | X |
| Jayme Laber—NOAA, Senior Service Hydrologist; NWS, Oxnard Field Office | | | X | | | |

# 3.2 INVOLVE THE PUBLIC

## 3.2.1 Meetings

Orange County prioritized public involvement throughout the planning efforts. There are many advantages to public involvement in the planning process. One of the biggest advantages is the educational opportunity given to the public, providing a venue for continual feedback of diverse viewpoints, not to mention participation and engagement provides attendees with a sense of plan ownership, which in turn creates greater public support for the planning effort.

The planning process began with the development of the Steering Committee, which includes representatives from County government as well as the jurisdictions participating in the FMP. At least one Steering Committee meeting was held for each step in the planning process from Step 4 (assess the hazard) through Step 8 (draft an action plan). A quorum of Steering Committee members was present at each meeting.

Coordinating participation from outside local government was accomplished using a two-tiered approach: general public and a non-governmental Planning Committee. The general public were invited to attend meetings held at the beginning of the planning process (October 2024) and at the latter stages of the planning process (August 2025). In addition, a Planning Committee was formed to ensure non-governmental stakeholders were actively involved in the FMP plan review and feedback. All meetings described in this sub-section were advertised on the County's website as being open to the general public.

Table 3-3 lists the topics addressed at each meeting. The meetings are summarized in alignment with the CRS steps in Table 3-4. Meeting documentation is provided in Appendix D.

**Table 3-3. FMP Meeting Dates and Topics**

| Date | Meeting Title | Purpose of Meeting |
|---|---|---|
| **April 24, 2024** | Core Planning Team Meeting | Coordinate and discuss FMP development, Steering Committee membership, PPI, RLAA, and public outreach strategy |
| **August 14, 2024** | FMP / RLAA Informational / Q&A Meeting | Overview of FMP Process, Scope of Project, Detailed discussion on RLAA PPI, and structure of participants across all groups (Core Planning Team, Steering Committee, General Public, FEMA/ISO). |
| **October 23, 2024** | FMP Steering Committee Kick-Off Meeting | Informational meeting on FMP, Project Organization, Steering Committee responsibilities, schedule of plan phases. |
| **January 29, 2025** | FMP Goal Setting and Objectives Review Meeting | Informational meeting on FMP, Program for Public Information (PPI), goal setting, and solicit feedback on revisions to goals and objectives. |
| **April 30, 2025** | Risk Assessment / Mitigation Action Workshop | Review risk assessment results, identify mitigation strategies, develop new mitigation actions. |
| **May – July, 2025** | Jurisdictional Mitigation Action "1-on-1" Meeting(s) | Individual meetings with FMP participating jurisdictions to review mitigation catalog(s), and to collect additional information for the FMP. |
| **August 20, 2025** | Risk Ranking / Risk Assessment Data Review Meeting #1 | Review flood risk rankings, outcomes from risk assessment |

| Date | Meeting Title | Purpose of Meeting |
|---|---|---|
| **August 25, 2025** | Public Open House #1 (10:00 AM – 1:00 PM) Public Open House #2 (4:00 PM – 6:00 PM) | Review Draft FMP, answer questions and receive feedback on the FMP for review, consideration, and potential change to the FMP Draft. |
| **August 25, 2025** | Risk Ranking / Risk Assessment Data Review Meeting #2 | Review flood risk rankings, outcomes from risk assessment |
| **August 26, 2025** | Public Open House #3 | Review Draft FMP, answer questions and receive feedback on the FMP for review, consideration, and potential change to the FMP draft. |
| **August 26, 2025** | Risk Ranking / Risk Assessment Data Review Meeting #3 | Review flood risk rankings, outcomes from risk assessment |
| **October 9, 2025** | Draft FMP Review Meeting | Presentation and overview of draft FMP document for public posting and feedback from participant jurisdictions. Content guidelines and overview. |

**Table 3-4. FMP Meetings: Alignment with CRS Steps**

| Meeting Type | Meeting Title | Meeting Date |
|---|---|---|
| **CRS Step 4: Assess the Hazard** | | |
| Steering Committee | Core Planning Team Meeting | April 24, 2024 |
| Steering Committee | Q&A Meeting | August 14, 2024 |
| Public | FMP Kick-Off Meeting | October 23, 2024 |
| Steering Committee | Risk Assessment / Mitigation Action Workshop | April 30, 2025 |
| **CRS Step 5: Assess the Problem** | | |
| Steering Committee | Core Planning Team Meeting | April 24, 2024 |
| Steering Committee | Q&A Meeting | August 14, 2024 |
| Public | FMP Kick-Off Meeting | October 23, 2024 |
| Steering Committee | Risk Ranking / Risk Assessment Data Review Meeting | August 20, 2025 |
| **CRS Step 6: Set Goals** | | |
| Steering Committee | Goal Setting and Objectives Review | January 29, 2025 |
| **CRS Step 7: Review Possible Activities** | | |
| Steering Committee | Mitigation Action Workshop and Risk Assessment Review Meeting | April 30, 2025 |
| **CRS Step 8: Draft an Action Plan** | | |
| Participating jurisdictions met separately to review mitigation actions for their FMP annexes | Jurisdictional Mitigation Action “1-on-1” Meetings | May-July 2025 |
| Public | Draft Plan Review Meeting(s) / Public Open House(s) | August 2025 |
| Steering Committee | Draft Plan Review Meeting | October 9, 2025 |

### 3.2.2 Outreach to Organizations

In addition, the Steering Committee sent a survey to the following organizations, providing information about the planning process and requesting any relevant input:

- National Weather Service
- Orange County Water District
- Floodplain Management Association
- Orange County Sanitation District
- Red Cross of Orange County
- Q3 Consulting
- UC Irvine
- HomeSmart Evergreen Realty
- CRS Program

## 3.3 COORDINATE

Most communities' flood problems have been studied already, with existing plans, studies, and reports on flooding available for review in the development of an FMP. There also may be flood protection activities being considered or implemented by other agencies. Coordination involves incorporating these other plans and other agencies' efforts as appropriate into the FMP. It begins with contacting other agencies and organizations to determine if they have studies, plans, or information pertinent to the FMP and to see if they can support the community's efforts.

Throughout the planning process, several studies, reports, technical information and data from a wide variety of federal, state, county, and local sources were used to analyze the flood hazard in Orange County and determine a strategy for reducing vulnerability to flooding. These sources are cited throughout the FMP and listed as references at the end of this volume.

### 3.3.1 Collection and Incorporation of Existing Information

Plans, reports, and other technical information were provided directly by the County, jurisdictions, Steering Committee members, and stakeholders involved in the planning effort, as well as through independent research by the planning consultant. Table 3-5 lists plans, reports, and technical documents reviewed while preparing this FMP.

Other agencies at various levels of government and regional planning agencies or entities also have data, plans, or other information that can be used to understand flooding in Orange County. The following sections summarize key agencies and the type of information they maintain.

Table 3-5. Selected Plans and Reports Reviewed

| Document | Year Published | Jurisdictional Applicability |
|---|---|---|
| **Orange County The General Plan** | | Unincorporated County |
| **County of Orange and Orange County Fire Authority Local Hazard Mitigation Plan** | 2021 | Countywide |
| **The OC Plan Integrated Regional Water Management for the North and Central Orange County Watershed Management Areas** | 2018 | Portion of County |
| **Integrated Regional Water Management Plan for South Orange County** | 2018 | Portion of County |
| **One Water One Watershed Plan** | 2018 | Portion of County Covered by the Santa Ana Watershed |
| **California State Hazard Mitigation Plan** | 2023 | Statewide |
| **State of California Sea Level Rise Guidance** | 2024 | Statewide |
| **California's Fourth Climate Change Assessment** | 2019 | Statewide |
| **Indicators of Climate Change in California** | 2022 | Statewide |

## Municipal Water District of Orange County

The Municipal Water District of Orange County (MWDOC) is a wholesale water supplier and resource planning agency that services all of Orange County through 27 retail water agencies (MWDOC n.d.-b). Over 50 percent of Orange County's water demand is met by local water supplies, and the MWDOC purchases the rest from the Colorado River and State Water Project in northern California through the Metropolitan Water District of Southern California (MWDOC n.d.-c).

The MWDOC administers the Water Emergency Response Organization of Orange County. This organization supports and manages countywide emergency preparedness, planning, response, and recovery efforts among Orange County water and wastewater utilities. and provides essential resources, trainings, and exercises to member agencies and to coordinating partners (MWDOC n.d.-a).

The MWDOC also has a multi-jurisdictional hazard mitigation plan that provides a framework for participating water and wastewater utilities to plan for natural and human-cause hazards in Orange County that could impact the county's water utilities (MWDOC 2024).

## Santa Ana Watershed Project Authority

The Santa Ana Watershed Project Authority handles water resources for the Santa Ana watershed. The watershed covers 2,840 square miles and includes Orange County, Riverside County, San Bernardino County, and a small portion of Los Angeles County. The Santa Ana Watershed Project Authority created the One Water One Watershed Plan to manage the water resources in the Santa Ana Watershed, with the following goals (Santa Ana Watershed Project Authority n.d.):

- Maintain reliable and resilient water supplies and reduce dependency on imported water.
- Manage at the watershed scale for preservation and enhancement of the natural hydrology to benefit human and natural communities.
- Preserve and enhance the ecosystem services proved by open space and habitat within the watershed.
- Protect beneficial uses to ensure high quality water for human and natural communities.
- Accomplish effective, equitable, and collaborate integrated watershed management.

## Southern California Wetlands Recovery Project

The mission of the Southern California Wetlands Recovery Project (SCWRP) is to expand, restore, and protect wetlands in Southern California's coastal watersheds. SCWRP covers the counties of Los Angeles, Orange, Santa Barbara, San Diego, and Ventura (SCWRP n.d.). Improving and restoring wetlands can lead to reduced flooding, improved water quality, and healthy habitats for wildlife (FEMA 2021). The projects that this group undertakes include wetland restoration, planning, and land acquisition (SCWRP n.d.).

## California Department of Water Resources

The California Department of Water Resources (DWR) was established to protect, conserve, develop, and manage much of the state's water supply (DWR n.d.-a). DWR houses the Floodplain Management program, which handles floodplain management and the NFIP for California (DWR n.d.-f). The DWR Division of Safety of Dams (DSOD) handles the safety of jurisdictional dams in the state (DWR n.d.-e). DWR also has websites to download important water source datasets and a web viewer of the jurisdictional dams that have dam failure inundation boundaries (DWR n.d.-c); (DWR n.d.-d).

## California Department of Conservation

The California Department of Conservation has the California Geological Survey's Forest and Watershed Geology program, which provides technical information and advice about erosion, sedimentation, landslides, and other geologic hazards on California's forested lands and watersheds (California Department of Conservation n.d.).

## California Governor's Office of Emergency Services

The California Governor's Office of Emergency Services (Cal OES) is the state office responsible for mitigating the effects of disaster and protecting the property of California's residents. Cal OES serves as the states leadership hub during all major emergencies and disasters, which includes responding, directing, and coordinating state and federal resources and mutual aid assets across California. Cal OES supports local jurisdictions through the planning and preparedness activities, training, and facilitating the immediate response to an emergency through the recovery phase (Cal OES n.d.).

## California Ocean Protection Council

The mission of the California Ocean Protection Council is to protect California's coasts and ocean by advancing innovative, science-based policy and management, making strategic investments, and catalyzing action through partnerships and collaboration. The strategic goals of the Council is to safeguard coastal and marine ecosystems and communities from the impacts of climate change, advance equity across ocean and coastal policies, enhance the biodiversity of coastal and marine ecosystems, and support ocean health through a sustainable economy (California Ocean Protection Council 2025).

## California Coastal Commission

The California Coastal Commission (CCC) is another agency whose mission is to protect and enhance California's coasts and ocean. The CCC does this through careful planning and regulation of environmentally-sustainable development, rigorous use of science, public participation, public education, and intergovernmental coordination (California Coastal Commission n.d.). The CCC also has a GIS portal so that its data can be accessed by the public (California Coastal Commission n.d.).

### California Office of Environmental Health Hazard Assessment

The California Office of Environmental Health Hazard Assessment (OEHHA) is tasked with protecting and enhancing the health of California's residents and the environment through scientific studies that inform, support, and guide regulatory actions (California OEHHA n.d.). The OEHHA also studies the climate change indicators in the state (California OEHAA 2022).

### Federal Agencies

The following federal agencies provide information regarding flooding:

- The National Weather Services (NWS) San Diego office provides weather and flood forecasts for Orange County (NWS n.d.).
- The National Center for Environmental Information (NCEI) is the nation's data center for environmental data, products, and services covering the oceans, the land surface, and the atmosphere (NOAA NCEI n.d.). The NCEI also has the Storm Events Database which is a database of all historical weather events that impact communities in the United States (NOAA NCEI n.d.).
- The U.S. Geological Survey (USGS) provides information on the water resources in California through its California Water Science Center. The California Water Science Center provides reliable, impartial, foundational data and scientific analysis to address the water issues in California. The California Water Science Center achieves this mission by performing hydrologic monitoring and investigative studies (USGS-California Water Science Center n.d.).
- The US Army Corps of Engineers (USACE) provides engineering and project management services for the United States (USACE n.d.). The Los Angeles District covers Orange County and provides services that include planning, designing, building, and operating water resources and other civil works projects for navigation, flood-risk management, ecosystem restoration and disaster response (USACE n.d.). The USACE also has the California Silver Jackets program which brings together federal, state, regional, and local agencies to focus on the state's priorities for flood risk management (USACE n.d.). The USACE also develops the National Inventory of Dams that allow for users to search for information regarding the dams that are located within the United States (USACE n.d.).

## 3.3.2 Surveys of Local Governments

Three surveys were sent to local governments in Orange County to solicit input for use in developing the FMP:

- A **goals and objectives survey** asked for feedback on the FMP goals and objectives: Goal 1 Protect Life, Goal 2 Public Awareness, Goal 3 Natural Systems, Goal 4 Partnerships and Implementation, and Goal 5 Emergency Services. Most of the responses indicated that the goals and objectives can be kept as is but there were several objectives that a couple of respondents identified as could be modified.
- A **mitigation action development survey** asked the communities of Orange County to list their strengths and weaknesses for mitigating local flood hazards (riverine flooding, coastal flooding, tsunami, dam failure, and sea level rise) and any new mitigation measure that they are planning. Only three communities completed the survey.
- A **social media and outreach capabilities survey** asked communities about the outreach capabilities they have and what sources they use often for outreach. Only five communities completed the survey.

## 3.4 ASSESS THE HAZARD

Orange County assessed the types of flood hazards it is exposed to. This included hazard sources, frequency of occurrence, speed of onset, time-scale or duration, and the hazard's spatial extent. The Orange County FMP Steering Committee used the best-available technical information, plans, studies, and reports throughout the planning process to support flood hazard profiling. A full description of the methodology used to assess the flood hazard in the County is provided in Section 5.1.

Hazard assessment data collected from state and federal sources was used to assess the flood hazard in the County. Federal sources included FEMA, the U.S. Army Corps of Engineers (USACE), the U.S. Geologic Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and the National Weather Service (NWS). The County also requested public input on past flood experiences at the public information meetings on August 14, 2024, and October 23, 2024, and the public risk assessment review meeting on April 30, 2025.

## 3.5 ASSESS THE PROBLEM

For an FMP, assessing the problem means determining the impact that flooding will have on people and assets in the community. It requires inventories of assets, maps of population density, assets, and flood hazard areas, and tools for assessing likely impacts of the known hazards on the identified community assets. The Orange County FMP Steering Committee used the best-available technical information, plans, studies, and reports throughout the planning process to support a risk and vulnerability assessment and the identification of appropriate floodplain management actions to address current and potential future problems.

The asset and inventory data used for the risk and vulnerability assessments are presented in Chapter 4. Details regarding data sources—along with technical information on how the data were used to develop the risk and vulnerability assessment—are presented in Section 5.1.

The assessment of impacts made use of geographic information system (GIS) technology as well as FEMA's Hazus risk assessment software. GIS helped to identify the number and value of people and assets at risk from flooding, and Hazus helped to identify the extent of potential damage and harm flooding could inflict on them. A full description of the methodology used to assess the problems caused by flooding in the County is provided in Section 5.1. Further sources of technical information are listed in the references at the end of this volume.

## 3.6 SET GOALS

The County used the information gathered from the risk assessment, the public and Steering Committee meetings, and the County's most recent hazard mitigation planning process to identify a set of goals and objectives for the FMP. Goal setting and objectives were discussed at the Planning and Steering Committee meetings on January 29, 2025. The survey to collect feedback on the draft goals and objectives was disseminated during the committee meetings. A copy of the survey responses can be found in Appendix E. Table 3-6 presents the finalized goals and objectives for the Orange County FMP. Further description of the process used to develop goals and objectives is provided in Chapter 6 (Mitigation Strategies).

**Table 3-6. Orange County Floodplain Management Plan Goals and Objectives**

| Goal | Objective |
|---|---|
| **Protect Life and Property from the flood hazards through planning, preparing, and mitigating.** | • Objective 1.a—Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.<br>• Objective 1.b—Reduce losses and repetitive damage for chronic hazard events, while promoting insurance coverage for catastrophic hazards.<br>• Objective 1.c—Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.<br>• Objective 1.d—Discourage new development in the flood hazard area, that if development does occur, ensure that it is done in a way that minimizes flood risk. |
| **Enhance community resilience through Public Awareness opportunities such as outreach programs to provide resources to the public on flood risks, resilience strategies, and safety measures.** | • Objective 2.a—Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.<br>• Objective 2.b—Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.<br>• Objective 2.c—Utilize the best available data and technologies to improve understanding of potential impacts and location of flood hazards. |
| **Protect Natural Systems from flooding impacts through sustainable watershed planning and coordinated resource management practices across public and private sectors.** | • Objective 3.a—Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.<br>• Objective 3.b—Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.<br>• Objective 3.c—Provide the highest degree of flood hazard protection by prioritizing prevention and when practical, consider natural systems that enhance floodplain functions.<br>• Objective 3.d—Consider climate change implications in planning for and mitigating flood or inundation hazards. |
| **Encourage, expand, and strengthen the Partnerships and Implementation of flood mitigation strategies between government agencies, private sector businesses, and non-profit organizations before, during, and after flood events.** | • Objective 4.a—Strengthen communication and coordinate participation among and within public agencies, residents, non-profit organizations, business, and industry to gain a vested interest in implementation.<br>• Objective 4.b—Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.<br>• Objective 4.c—Provide flood protection by maintaining and enhancing flood control systems. |
| **Enhance Emergency Services planning to include flood hazard event planning impacts on populations and property.** | • Objective 5.a—Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.<br>• Objective 5.b—Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.<br>• Objective 5.c—Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures. |

## 3.7 REVIEW POSSIBLE ACTIVITIES

The Steering Committee met to review available mitigation activities. The FMP contract consultant compiled a list of mitigation activities to for the committee's consideration. The Steering Committee reviewed the list and grouped them into the six CRS-defined floodplain management activity categories (FEMA 2025):

- **Preventive—**Preventative measures are activities that keep flood problems in communities from getting worst. This is typically done through the use of planning, land acquisition, or regulations and this is typically administrated by a community's building, zoning, or code enforcement office. Examples of preventative activities include floodplain mapping and data, open space preservation, floodplain regulations, stormwater management, and building codes.
- **Property Protection—**Property protection measures include building relocation, building elevation, building retrofitting, land acquisition, sewer backup protection, and insurance. These types of activities are implemented by property and building owners on a building-by-building, or parcel basis.
- **Natural Resource Protection—**Natural resource protection measures are activities focused on preserving or restoring natural areas, natural floodplain function, or watershed areas, and are typically implemented by public sector agencies such as parks, recreation, or conservation. Examples of natural resource protection activities include wetlands protection, erosion and sediment control, natural area preservation and restoration, and water quality improvement.
- **Emergency Services—**Emergency service measures are activities that are taken during an emergency event to minimize its impact. They are the responsibility of the community's emergency management department in cooperation with owners and operators of critical facilities. Emergency service measures include hazard threat recognition, hazard warning, hazard response, critical facilities protection, health and safety maintenance, and post-disaster mitigation actions.
- **Structural Flood Control Projects—**Structural projects are measures to keep flood waters away from certain areas with levees, reservoirs, floodwalls, diversion channels, channel modifications, storm drain improvements, or other structural flood controls. Structural projects measures are designed by engineers and are managed and maintained by a community's public works department or similar department.
- **Public Information—**Public information measures are activities that advise property owners, potential property owners, and the public about hazards in the community, how to protect people and property from the hazards, and the natural and beneficial functions of floodplains. These activities are usually undertaken by the community's public information office. Examples include map information, outreach projects, real estate disclosures, information about flooding and flood preparedness, and education.

Catalogs of possible mitigation activities are listed in Chapter 6, along with a detailed description of the review process for those possible activities. Documentation is provided in the meeting materials in Appendix D.

## 3.8 DRAFT AN ACTION PLAN

Orange County's contract consultant, Tetra Tech, developed a set of actions based on the Steering Committee's review of the possible activities and the catalog of mitigation actions. These actions align with the Orange County Hazard Mitigation Plan by including flood mitigation actions included in the County HMP. The Steering Committee reviewed the set of actions and provided feedback at a Mitigation Action Workshop held on April 30, 2025, for the purpose of this FMP. Documentation of the meeting is provided in Appendix D. The contract consultant finalized the action plan based on the committee's feedback. The action plan consists of actions which represent all six of the mitigation categories.

The content of the draft FMP was reviewed with the public at a meeting on August 2025, where the committee solicited feedback on the information provided. The action plan and more information regarding the process used to develop it are provided in Chapter 6.

## 3.9 ADOPT THE PLAN

Once the FMP was finalized in draft form, a copy was provided to ISO for a courtesy review. Following ISO's review of this FMP, Orange County updated the FMP to address ISO's comments and presented the final version of the FMP to the residents and business owners of the County at a public meeting held in August 2025. At this meeting, the County residents were invited to provide final feedback on the FMP in preparation for the presentation of the FMP to the County Board of Supervisors.

The FMP was submitted to the County Board of Supervisors on TBD. Orange County Board of Supervisors voted to adopt the FMP on TBD. A copy of the adoption resolution is provided in Appendix G. Each jurisdiction participating in this FMP will need to adopt its own individual FMP annex.

## 3.10 IMPLEMENT, EVALUATE, REVISE

The final CRS step (Step 10) is carried out after the FMP is adopted by Orange County Board of Supervisors. The process the County will use to carry out Step 10 is described in Chapter 7. After completion of the FMP, implementation and ongoing maintenance will become a function of the Steering Committee. The Steering Committee will review the FMP and accept public comment as part of an annual review and as part of 5-year FMP updates.

### 3.10.1 Integration With Existing Planning Mechanisms and Programs

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making processes. Orange County maintains many existing plans and programs that support flood risk management; therefore, it is critical that this FMP integrate, coordinate with, and complement those existing plans and programs.

The Capability Assessment section of Chapter 6 of this FMP (Mitigation Strategy) provides a summary and description of the existing plans, programs, and regulatory mechanisms at different levels of government (federal, state, county, and local) that support floodplain management within the County.

A summary of continued efforts to develop and promote a comprehensive and holistic approach to floodplain management and mitigation is presented in Chapter 7 (Plan Maintenance).

### 3.10.2 Continued Public Involvement

Orange County is committed to the continued involvement of the public. Therefore, copies of the FMP are available for review on the County's public website (https://ocip.ocpublicworks.com/fmp) as well as at County Administration South, 601 N. Ross Street, Santa Ana, CA 92701. A notice regarding annual updates of the FMP and the location of FMP copies will be publicized annually after the Steering Committee's annual evaluation and posted on the public web site.

Joyce Drysdale, PE, Orange County Public Works, has been identified as the ongoing FMP Coordinator (Chapter 7), and is responsible for receiving, tracking, and filing public comments regarding this FMP. Contact information is listed below:

> Joyce Drysdale, PE, Orange County Public Works – Floodplain Management Plan Coordinator
> 601 N. Ross Street
> Santa Ana, CA 92701
> Phone: (657) 248-6350

The public will have an opportunity to comment on the FMP as a part of the annual plan evaluation process and the 5-year plan update. The FMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the 5-year plan update as appropriate; however, members of the Steering Committee will assist the FMP Coordinator. Additional meetings may also be held as deemed necessary by the FMP Coordinator. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the FMP.

# 4. ORANGE COUNTY PROFILE

Profile information for Orange County is provided here to develop an understanding of the County's flood hazard vulnerability. This includes an examination of geo-physical, climatic, hydrological, economic, and socio-demographic characteristics. The profile also looks at the built environment, including critical facilities.

## 4.1 GENERAL INFORMATION

### 4.1.1 Location

Orange County covers 948 square miles in southern California. The County is bounded by the Counties of Los Angeles to the north, San Berardino and Riverside to the east, and San Diego to the south. Orange County has 42 miles of coastline along its western border. Major landmarks include the Santa Ana Mountain Range, the Pacific Ocean, Newport Bay, Seal Beach National Wildlife Refuge, and Cleveland National Forest. Figure 4-1 is a general reference map of the County.

Unincorporated county represents about 35 percent of the total land area. Jurisdictions participating in this FMP (Anaheim, Laguna Woods, Newport Beach, San Juan Capistrano, and Santa Ana) account for about 15 percent. The remaining 50 percent of the County's land area is in jurisdictions not participating in this FMP.

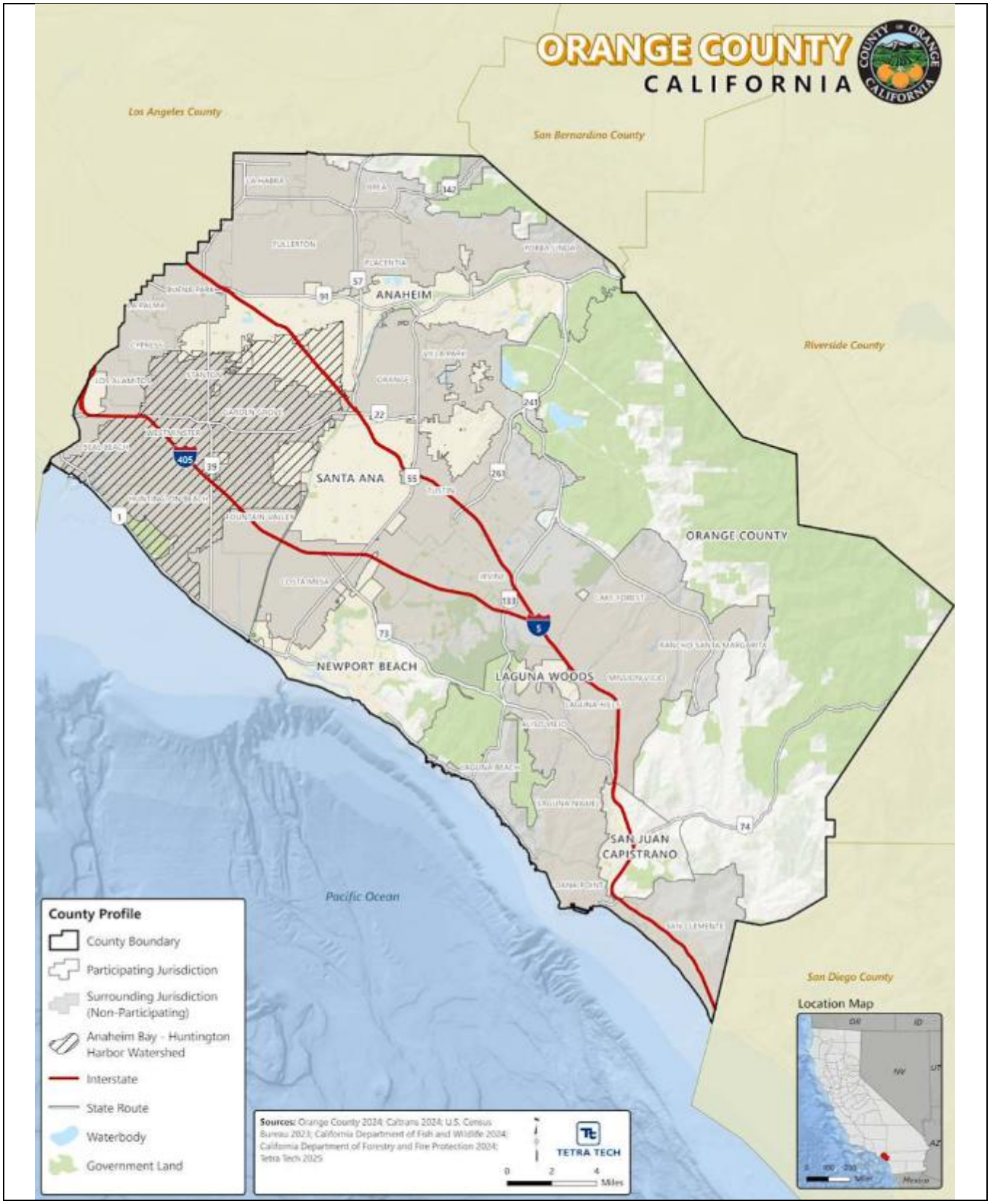
### 4.1.2 History

Orange County was established in 1889 from what was originally the southern portion of Los Angeles County. At that time, Orange County had an approximate population of 15,000 people, with three incorporated municipalities (Brigandi 2010). Since then, the County population has increased rapidly with the southward growth of the Los Angeles region. As of April 2020, the U.S. Census Bureau's decennial census placed the County population at 3,186,989 persons, inclusive of 34 incorporated cities (U.S. Census Bureau n.d.).

### 4.1.3 Government

The County's administrative and legislative functions are performed by a five-member Board of Supervisors, who are elected to four-year terms. Elections are held in offsetting years based on the supervisory district (Orange County Board of Supervisors n.d.). The Board of Supervisors is the body that reviews and adopts this FMP. The Board of Supervisors also is responsible for enacting policies and regulations aimed at implementing the floodplain management activities prescribed by this document. For each jurisdiction participating in this FMP, the legislative body with funding and implementation authority must adopt the plan separately.

**Figure 4-1. Orange County General Reference Map**



### 4.1.4 Transportation Systems

Orange County transportation network offers residents and employees various options for transportation throughout the county and the region:

- **Roads**—The streets and highways in Orange County are maintained by the various levels of municipal government, including the California Highway Department and Orange County Department of Public Works.
- **Transit Facilities—**The Orange County Transit Authority (OCTA) is responsible for projects, programs and services that include bus and rail transit, rideshare, environmental programs, active transportation and express lanes and freeways.
- **Railroads—**Amtrak Rail service supports Orange County and the surrounding region. The 351-mile Los Angeles—San Diego—San Luis Obispo Rail Corridor travels through a six-county coastal region in Southern California and is the second busiest intercity passenger rail corridor in the United States and the busiest state-supported Amtrak route. The corridor service includes 41 stations and more than 150 daily passenger trains, with an annual ridership of nearly 3 million on intercity trains and 5 million on Metrolink and COASTER commuter trains.
- **Airports—**The John Wayne/Orange County Airport serves 11.7 million passengers annually, with flights to more than 40 non-stop destinations in the U.S., Mexico, and Canada. The airport property consists of unincorporated land between the cities of Irvine, Santa Ana, and Newport Beach, approximately 35 miles south of Los Angeles. The airport is owned and operated by Orange County. The three-letter Federal Aviation Administration assigned designator to the airport is “SNA.” The Airport is served by 11 commercial airlines and two air cargo airlines. It is home to nearly 500 general aviation (private, non-commercial) aircraft, representing 60 percent of total operations, and includes two full-service fixed base operators and one limited use general aviation facility. The Airport spans more than 510 acres and operates two runways. The 2,887-foot runway serves general aviation, and the 5,700-foot main runway serves both commercial and general aviation aircraft.

## 4.2 PHYSICAL SETTING

This section describes Orange County’s topography, water resources, climate, land use, and land cover. These physical attributes influence the flooding hazards that the community experiences. For example, because Orange County is located on the coast in a seismically active area, it is exposed to high tide flooding, storm surge, sea level rise, and tsunamis. Land cover can influence flooding exposure because impervious land cover prevents rainfall from infiltrating into the ground, increasing runoff and flooding. Steep terrain can influence flooding as it causes rainfall to run off more quickly, leading to instances of flash flooding.

### 4.2.1 Topography and Geology

#### Topography

The topography of Orange County is dominated by the Los Angeles Basin and the Santa Ana Mountains. The Los Angeles Basin covers much of the northern and western portion of the county and the topography increases in elevation toward the southeast toward the Santa Ana Mountains. The elevation ranges from sea level where the county meets the Pacific Ocean to 5,689 feet in the Santa Ana Mountains (Orange County Sheriff's Department 2021). The coastal landform ranges from sandy beaches and marshes in the northern part of the county to coastal bluffs and rocky or sandy beaches in the south (Orange County n.d.). Most of the county is alluvial plain

with low elevation but transforms into rocky ridgeline and canyon terrains associated with the Santa Ana Mountains (Orange County n.d.). The most prominent coastal landforms include Bolsa marshland, Seal Beach National Wildlife Refuge, Anaheim Bay, San Juan Cheek coastal bluff, and Newport Bay (Orange County, CA n.d.). Inland from the coastal regions, prominent landform features include the Saddleback in the Santa Ana Mountains, the ridgelines of Lomas De Santiago and San Joaquin Hills, and numerous canyons throughout the county (Orange County, CA n.d.).

Flash flooding is more common in portions of the County with steeper terrain such as the canyonlands and eastern portions of the County as stormwater flows move rapidly down the slopes. Conversely, the more gradual slopes and surface features in central and western portions of the County are conducive to gradual flooding events (i.e., riverine, overbank flooding). Further, the flatter terrain causes associated floodplains to be more expansive and thus need a greater volume of runoff to create flooding conditions.

### Geology

Several faults surround Orange County. These faults include the San Andreas Fault Zone, Newport-Inglewood Fault Zone, Elsinore Fault Zone, the San Jacinto Fault Zone, San Joquin Hills Fault, and Puente Hills Thrust Fault. Seismic hazards from earthquakes on these faults can have a cascading effect on flooding because earthquakes and resulting landslides can cause dams to fail or create natural dams that alter the flow of floodwaters. Underwater earthquakes can lead to tsunamis that impact coastal communities (Orange County Sheriff's Department 2021, USGS 2008)

## 4.2.2 Water Resources

### Watersheds

A watershed is an area of land that drains all of the streams, creeks, tributaries, and rivers within it, as well as the rain that falls in it, to the same outlet location or discharge point (USGS Water Science School 2019). Watersheds are a principal aspect of how water moves along and through the earth's surface. This FMP identifies Orange County watersheds previously studied and recommended for improvements—inclusive of structural flood control measures—and the overall flood hazard vulnerability within those watersheds.

Orange County includes all or part of 11 watersheds and 30 sub-watersheds, as delineated by the USGS nationwide Hydrological Unit Code (HUC) classification system (USGS n.d.). Figure 4-2 and Figure 4-3 show the County's watersheds and sub-watersheds, respectively. Table 4-1 lists the 11 watersheds in Orange County.

**Table 4-1. Orange County Watersheds**

| Watershed Name | Total Land Area (Acres) | Watershed Name | Total Land Area (Acres) |
|---|---|---|---|
| **Santa Ana River** | 210 | **San Mateo Creek** | 20 |
| **Newport Bay** | 154 | **San Clemente Coastal Streams** | 18 |
| **San Juan Creek** | 125 | **Newport Coastal Streams** | 14 |
| **Anaheim Bay/Huntington Harbor** | 80 | **Laguna Coastal Streams** | 11 |
| **Coyote Creek** | 41 | **Dana Point Coastal Streams** | 6 |
| **Aliso Creek** | 36 | | |

Source: (H2OC 2025)

**Figure 4-2. Orange County HUC-10 Watersheds**



**Figure 4-3. Orange County HUC-12 Sub-Watersheds**

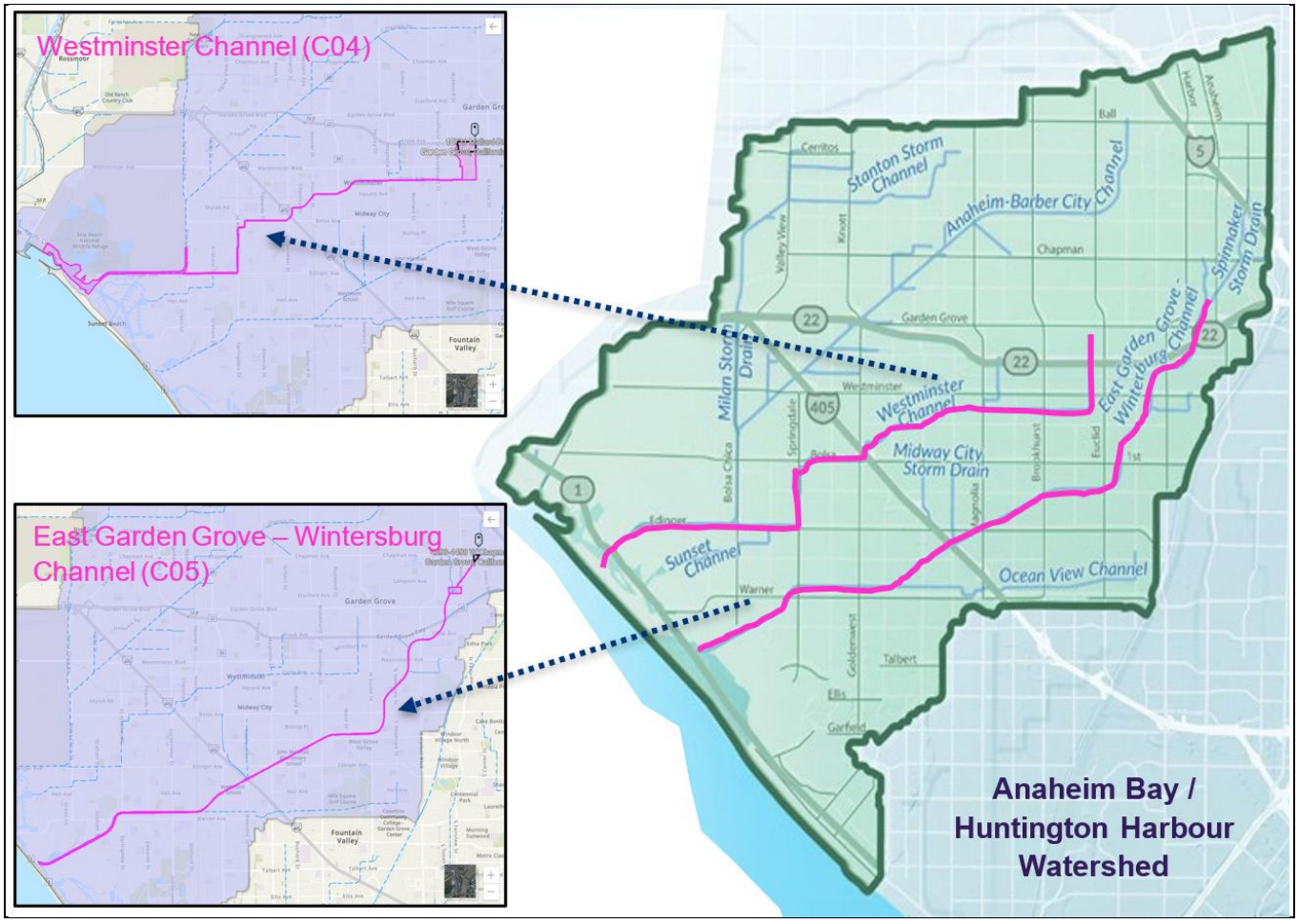


Urbanization tends to result in a highly engineered and channelized stormwater network. Orange County is highly urbanized with extensive stormwater and flood control infrastructure. This affects the response a watershed has to rainfall and flooding, which includes increasing the peak discharge and increasing the frequency of flooding. Urbanization also affects the natural benefit of floodplains to store floodwaters and slow the runoff from rainfall.

## Anaheim Bay/Huntington Harbour Watershed

One of the County's 11 watersheds is the Anaheim Bay/Huntington Harbour watershed (AB/HH). This 80-square-mile watershed includes all or portions of various municipalities, including the Cities of Anaheim, Santa Ana, Orange, Buena Park, Huntington Beach, and Garden Grove. While not the largest watershed in the County, it contains a number of significant structural stormwater and flood control channels. These include the Stanton Storm, Sunset, Bolsa Chica, Anaheim-Barber City, Ocean View, Midway City, Westminster, and East Garden Grove-Wintersburg (EGGW) channels. Figure 4-4 shows the AB/HH watershed as well as the general alignments of the 7.8-mile-long Westminster Channel and 11.6 mile-long EGGW Channel.

**Figure 4-4. Anaheim Bay/Huntington Harbour Watershed and Primary Channels**




*Source: (H2OC 2025)*

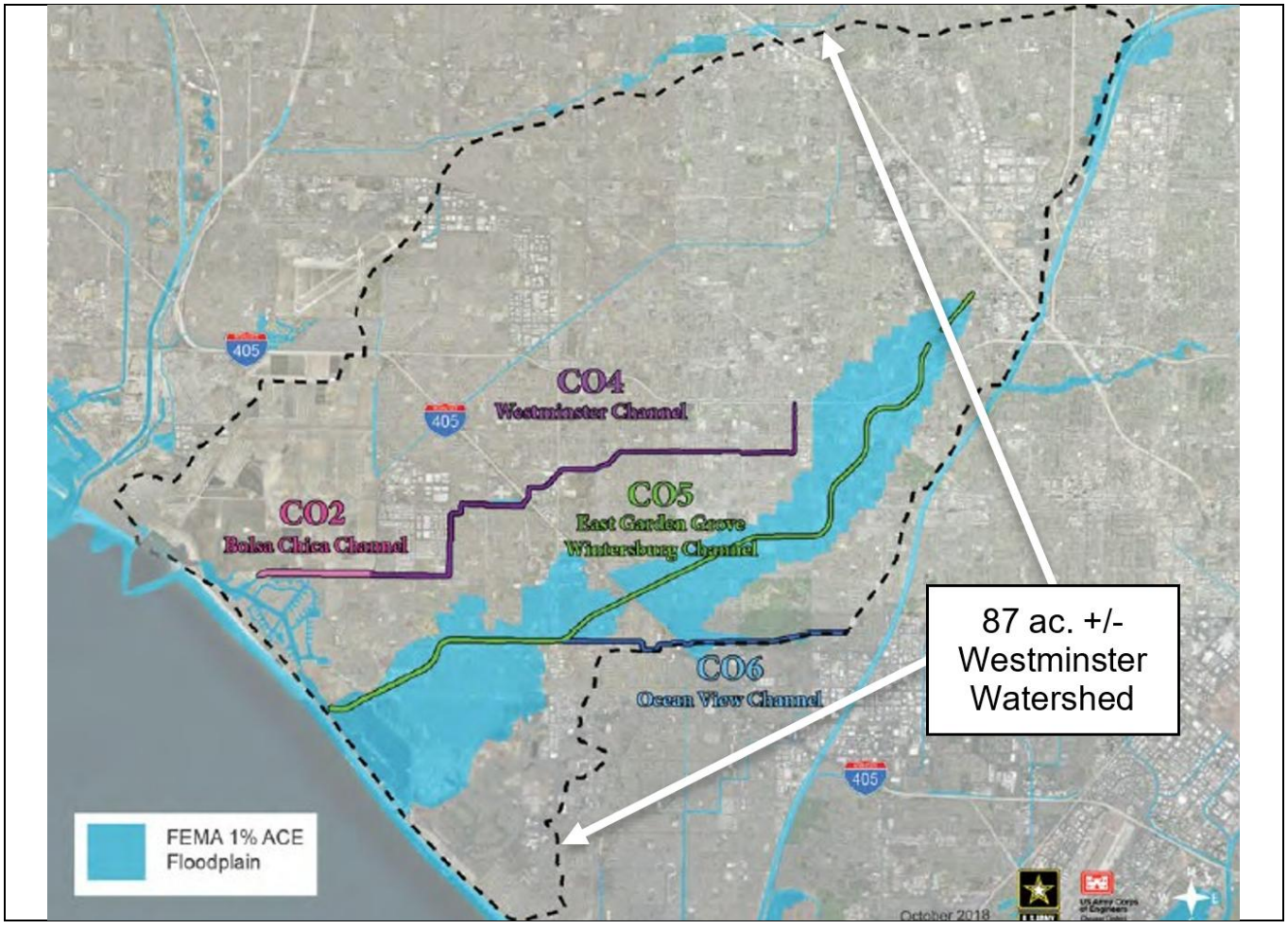
Prior floodplain and stormwater management studies have been performed for the AB/HH watershed and portions of surrounding drainage areas. The impetus for studying the AB/HH watershed was to increase the ability for its structural drainage and flood control measures to capture, convey, and discharge stormwater flows and to reduce flood related impacts on life and property affected by historical deficiencies.

## USACE Flood Risk Management Study

The U.S. Army Corps of Engineers (USACE) and the Orange County Department of Public Works (OCPW) collaborated on the "*Westminster-East Garden Grove (CA), Flood Risk Management Feasibility Study*" (USACE 2019). The purpose of the study was to perform a comprehensive analysis of the watershed and produce a list of possible mitigation actions to reduce flood risk in the study area. The USACE study evaluated four targeted drainage channels, including the Westminster Channel (County Facility ID C04) and the EGGW Channel (County Facility ID C05).

The USACE study referred to what is presently the AB/HH watershed as the "*Westminster Watershed*," as shown in Figure 4-5. Since the USACE study was conducted, the boundaries of the Westminster Watershed have been revised based on updates to adjacent watershed boundaries. This resulted in the initial 87-acre Westminster watershed being partitioned into two areas: the 80-acre AB/HH watershed and a 7-acre southwestern portion of the Coyote Creek watershed.

**Figure 4-5. USACE Westminster Watershed and FEMA Floodplain**



Appendix K of the USACE study—produced by the U.S. Fish and Wildlife Service (USFWS)— provides an environmental assessment of the floodplain management alternatives reviewed in the study. The USFWS documented that the C04 and C05 facilities were both constructed in the 1960s and designed to contain a 25-year flood event, with some segments designed to carry only up to 65 percent of the 25-year flood event (USFWS 2019). Appendix M of the study (Conceptual Mitigation Plan) lists floodplain management alternatives for the four facilities studied. USACE provides a Maximum Channel Modification Plan, also referred to as a Locally Preferred Plan (LPP), listing a series of channel modifications to contain a 1 percent annual chance of exceedance (USACE) storm event (USACE 2019). Table 4-2 is taken from the USACE list of recommended LPP/Maximum Channel Modification Plan actions for the EGGW C05 facility.

**Table 4-2. Channel Modifications within C05/C06 under the Maximum Channel Modifications Plan**

| C05/C06 Channels | | | |
|---|---|---|---|
| **Channel** | **Reach** | **Existing Conditions** | **LPP Modifications** |
| C05 | 1 | Earthen levee from tide gates to Warner Ave. w/ some SSP on south bank near Graham St.;<br>SSP rectangular from Graham St. to Warner Ave.;<br>Earthen levees from Warner Ave. to 1,300 ft upstream of Edwards Ave. | Sheet pile/soft bottom/splash walls (various heights) from tide gates to existing rectangular channel west of Goldenwest St.<br>3 crossings replaced of different sizes. |
| C05 | 2 | Concrete lined rectangular | Concrete lined rectangular with 1' splash walls from Golden West St. to Gothard St.;<br>Concrete lined rectangular from Gothard St. to C05/C06 confluence; |
| C05 | 3 | Riprap lined trapezoidal from C05/C06 confluence to Woodruff St.;<br>Concrete rectangular from Woodruff St. to I-405 | Concrete lined rectangular;<br>Some sections of 1' splash wall between Beach Blvd. and Woodruff Rd.;<br>2 crossings replaced of different dimensions. |
| C05 | 4 | Concrete lined rectangular from I-405 to Quartz St.;<br>Riprap lined trapezoidal from Quartz St. to Bushard St. | Concrete lined rectangular with splash walls (various heights);<br>3 crossings replaced of different dimensions. |
| C05 | 5 | Riprap lined trapezoidal from Bushard St. to Brookhurst St.;<br>1,300 ft of concrete lined trapezoidal upstream of Brookhurst St.;<br>Riprap lined trapezoidal to 3rd St. | Concrete lined rectangular with splash walls (various heights);<br>6 crossings replaced of different dimensions. |

Source: (USACE 2019)

The 2019 USACE study underscores the urbanized character of the many of the flooding sources in the County, particularly structural channelization and stormwater runoff. As this FMP will identify in later sections, frequency and duration of flood hazards in the County are highly influenced by structural flood mitigation measures. Maintaining, optimizing and improving these structures is critical for effective drainage system management—inclusive of both floodplain and stormwater management planning.

The OCPW has been working to implement portions of the LPP. Presently, the County 2024-25 to 2030-31 Capital Improvement Program (CIP) lists six projects addressing targeted segments of the EGGW Channel (C05) aimed at increasing the overall capacity and ability to convey a 1 percent annual chance event flood frequency. The inclusion of these targeted projects (and other County stormwater and flood management facilities) in the CIP signals the County's commitment to effective stormwater management and floodplain management planning. Full implementation of the projects will depend on funding in the CIP outyears.

## Orange County Local Hazard Mitigation Plan (HMP)

The Orange County Local Hazard Mitigation Plan (2021) identifies the Westminster Watershed (presently the Anaheim Bay / Huntington Harbor Watershed)—which includes the Westminster Channel (C04) and the East Garden Grove - Wintersburg Channel (C05)—as being at high-risk of flooding. Despite ongoing flood control efforts, these two channel facilities continue to pose significant flood hazards. The HMP provides historical flooding accounts of this area whereby overtopping and widespread inundation has impacted the communities of Huntington Beach, Westminster, Seal Beach, and Garden Grove. Further, the HMP cites several major storm events, occurring in 1938, 1969, and 1997 that overwhelmed these channel facilities. These accounts underscore the recurring nature of countywide flood events. The HMP identifies the Westminster Watershed as highly susceptible to both riverine and coastal flooding, noting that current protective facilities are insufficient to fully mitigate large-scale flood risks.

Actions identified in the HMP that apply to this watershed include structural improvements to the C04 and C05 channels, ongoing levee and tide-gate upgrades, and integration of watershed-based stormwater best management practices through Orange County Public Works. By aligning these HMP findings with the Floodplain Management Plan, the community ensures that flood risks within the Westminster Watershed are recognized, mitigation actions are prioritized, and long-term resilience is coordinated through both hazard planning and the capital improvement process. Two priority mitigation projects from the County's LHMP are OCPW2 (East Garden Grove–Wintersburg Channel) and OCPW5 (Westminster Channel) which are located in Watershed C, targeting critical flood control corridors that have historically driven flood risk in the Anaheim Bay–Huntington Harbour basin. Table 4-3 highlights their project scope, current status, and communities served.

**Table 4-3 Mitigation Projects Located in Watershed C (Anaheim Bay–Huntington Harbour)**

| Plan Project Number | Mitigation Action Item | Lead Agency | Status | Communities Affected |
|---|---|---|---|---|
| **OCPW2** | East Garden Grove–Wintersburg Channel (Facility No. C05) – Design and Construction of Flood Control Improvements | Orange County Public Works (OCPW) | Ongoing. Six projects within the County's 7-Year Flood Control Capital Improvement Plan are undergoing various stages of study or design. This reach is also part of a USACE–OCPW feasibility study completed in 2020. OCPW has committed to continue with projects even if Congressional authorization is delayed. | Westminster, Huntington Beach (inland/Harbour areas), unincorporated Orange County |
| **OCPW5** | Westminster Channel (Facility No. C04) – Design and Construction of Flood Control Improvements | Orange County Public Works (OCPW) with USACE partnership | Ongoing. The Westminster Watershed Study was completed in July 2020 with a Chief's Report; federal authorization was received in December 2020. Facility reaches are planned to move into design and implementation phases beginning April 2025. | Westminster, Garden Grove, Huntington Beach, Seal Beach |

Source: County of Orange and Orange County Fire Authority. Local Hazard Mitigation Plan, 2021

## Orange County Capital Improvement Program (CIP)

Presently, the Orange County Public Works has an adopted CIP for Fiscal Years 2026/27 through 2032/33, effective July 1, 2026. The CIP includes planned capital projects for flood control, transportation, and related public infrastructure and demonstrates the County's long-term commitment to reducing flood risk and improving public safety. Of the flood mitigation projects identified within the current CIP, seven are located within the Westminster Watershed and are focused on implementing improvements to the East Garden Grove-Wintersburg Channel facility (C05). These planned and funded improvements support the County's ongoing efforts to mitigate flood hazards and help satisfy the CRS Activity 530 requirements for capital improvement planning. Table 4-4 lists these projects, along with their description as well as a column showing how the USACE 2019 Study references these projects.

**Table 4-4. Orange County CIP Projects – East Garden Grove / Wintersburg Channel (C05)**

| Project Name | Project Description | 2019 USACE Reference |
|---|---|---|
| **Bolsa Bay Outlet Flood Control Improvements (C05) / Warner Avenue Bridge (d/s)** | The project consists of improving the flood control facility to convey a 100-year storm | Min. Channel Modifications: Table 97, Reach 13 (p. 639) |
| **East Garden Grove-Wintersburg Channel (C05) / From Tide Gates to u/s Graham Street** | | Max. Channel Modifications: Table 99, Reach 5 (p. 646) |
| **East Garden Grove-Wintersburg Channel (C05) / From u/s Quartz Street to u/s Bushard Boulevard** | These projects consist of reconstructing the existing trapezoidal earthen rip rap channels to concrete rectangular channels, allowing the channels to reach to convey a 100-year storm. | Min. Channel Modifications: Table 97, Reach 4 (p. 639) |
| **East Garden Grove-Wintersburg Channel (C05) / From u/s Bushard Street to u/s McFadden Avenue /Brookhurst Street** | | Max. Channel Modifications: Table 99, Reach 1 (p. 646) |
| **East Garden Grove-Wintersburg Channel (C05) / From u/s McFadden Avenue / Brookhurst Street to Ward Street** | | Alternative: LPP, Channels 05/06, Direct Impact Analysis (p. 464) |
| **East Garden Grove-Wintersburg Channel (C05) / From the confluence with Ocean View Channel (C06) to d/s Woodruff Street** | | Present & Future Projects for Flood Risk Mngt. (FRM) Emphasis (p. 605) |
| **East Garden Grove-Wintersburg Channel (C05) / Bridges at Warner Avenue (u/s), Springdale Street, and Edwards Street.** | Modify the three bridge structures along C05 facility to remove the hydraulic constriction caused by upstream channel improvements. | Warner, LPP; (p. 644); Sec. 2.3.2, historic flooding events (p. 31, 5th bullet) |

Source: (OCPW 2026)

The linkages between the earlier 2019 USACE study and the 2026-27 to 2031-32 County CIP with respect to the East Garden Grove-Wintersburg channel facility is a testament to the successes that long-term planning efforts have had on implementing improvements to this key piece of flood control infrastructure. Each CIP project was analyzed and designed at the preliminary stages to attain or surpass the 1 percent annual chance flooding event. Each project has engineering funding (A&E) appropriated within the CIP planning time horizon. In particular, when a CIP project reaches the time-period where A&E expenditures are appropriated, higher-level flood engineering analysis is performed for the project, which will then inform how each project will need to achieve a minimum 1% annual chance flood capacity and conveyance.

After review of the Orange County Public Works Capital Improvement Program (CIP), the planning team identified FEMA CRS program credit potential for Activity 540 – Drainage System Maintenance. Specifically, Activity 542.c – Capital Improvement Program (CIP). Credit Points for CIP are;

CIP = CIP1 + CIP2

CIP1 = 30 pts. if the community has an ongoing program, such as a capital improvement plan, that meets the credit criteria

CIP2 = 40 pts. if the community has an acceptable engineering analysis of the entire drainage system for one or more watersheds that includes an evaluation of the 1% annual chance (100-year) flood at all problem sites.

## Regulatory Environment for Water Resources

The U.S. Environmental Protection Agency's (EPA) Municipal Storm Water Program (MSWP) regulates stormwater discharges from any Municipal Separate Storm Sewer System (MS4). The EPA defines an MS4 as a "conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains) owned or operated by a State" (CWRCB 2025). MS4 permits are issued in phases based on population—Phase 1 Permit Program for municipalities serving over 100,000 people, and a Phase 2 Permit Program for municipalities serving less than 100,000 people. Given its highly urbanized characteristics, and the size of its population, Orange County's stormwater conveyance system is regulated under a Phase 1 MS4 permit.

The California Water Resources Control Board (CWRCB) oversees state compliance with the federal Clean Water Act by appointing nine Regional Water Quality Control Boards (RWQCB). Each RWQCB has stormwater permitting authority. Orange County is under the purview of the Santa Ana RWQCB and the San Diego RWQCB. The County has organized itself into three watershed management areas (WMA); North, Central and South. The North and Central WMA are permitted by the Santa Ana RWQCB, whereas the South WMA is permitted by the San Diego RWQCB. Figure 4-6 shows the extent of the RWQCB and the Orange County WMA boundaries.

The OCPW manages regional watershed planning programs and is responsible for coordinating the multiple public, private, and non-profit organizations completing projects that implement program policies. These water resource projects work collectively under a single, unified goal—to achieve compliance with the federal Clean Water Act through maintenance of their CWRCB-issued stormwater general permits.

## Integrated Regional Water Management

While the federal Clean Water Act and associated stormwater permits aim to reduce pollutants into a given area's watershed, there are inherent benefits to floodplain management planning as well. This is particularly true given the channelized nature of Orange County's drainage and conveyance system, where increasing watershed capacity and controlling water volume and peak flows are also ways to reduce flood hazard risks.

From a floodplain management perspective, watersheds provide a logical lens through which to examine regional level strategies that reduce flood hazard vulnerabilities. A watershed plan can help achieve regional as well as countywide floodplain management goals and objectives, including policies aimed at preserving and enhancing the functionality of floodplains. To this end, Integrated Regional Water Management (IRWM) is a collaborative effort to identify and implement water management solutions on a regional scale (DWR n.d.-g).

**Figure 4-6. Orange County RWQCB and WMA Boundaries**




*Source: (OC DPW n.d.)*

Orange County has two IRWM groups that coordinate water resource planning in the County. OCPW formulates and updates IRWM Plans for both WMAs to assist with identifying water resource needs and help to determine which localized projects have the highest benefit to the regions overall. The priorities contained in the IRWM plans are based on input from partnering organizations.

The North Orange County (OC) IRWM Group spans the North and Central Watershed Management Areas (WMAs) and represents a diverse group of stakeholders that are engaged in integrating water resource planning across multiple sectors. The North OC IRWM group has a plan to address water resource issues in the North and Central WMAs (North OC IRWM n.d.). The most recent IRWM plan was prepared in 2018. The water management issues covered by the IRWM plan are water supplies, water quality, ecosystem and native habitat, flood management, quality of life in orange county, and climate change. Goal 4 of the North OC IRWM plan is integrate flood management, with objectives of reducing risk to public and private property, improving public safety, and improving floodplains (North OC IRWM 2018).

The South OC IRWM Group covers the southern part of Orange County. Similar to the North OC IRWM, the South OC IRWM Group represents a diverse group of stakeholders that are engaged in integrating water resource planning across multiple sectors (South OC IRWM n.d.). The South OC IRWM group also has a plan to address water resource issues which include water supply, water system reliability, water conservation, recycled water, recycled water quality, groundwater management, water quality management, flood management, and wastewater system (South OC IRWM 2018). The objectives to address flood management issues are as follows:

- Improve conveyance and/or reliability of channelized flood control systems.
- Remove properties from the FEMA 100-year floodplain.
- Reduce scour and erosion to rivers, streams, and channel banks.
- Improve sub-regional facilities and local storm drain systems where historical flooding exists where the regional system has the capacity to accept additional flows.
- Preserve or return floodplains as open space.
- Perform planning, studies, and research to acquire best data to assess climate change impacts.

The Orange County Flood Control District (OCFCD) is one of the strategic partners contributing to the IRWM. Flood control activities are regulated under the MS4 permit but are also coordinated and prioritized from a stormwater conveyance stance within the IRWM and associated WMAs (OC-IRWM 2018).

## 4.2.3 Climate

### Historical Norms

Table 4-5 shows the 30-year (1991 – 2020) climate normal for Orange County based on weather stations located throughout the county. The data shows that the mean temperature for January ranges from 55.6 degrees Fahrenheit (°F) at Tustin Irvine Ranch to 59.9 °F at Anaheim. For July, the mean temperature ranges from 68.2 °F at Newport Beach to 76.2 °F at Anaheim. The mean precipitation for Orange County shows distinct seasonality, with the county experiencing much of its rainfall in the winter months. The January mean precipitation ranges from 2.20 inches in Newport Beach Harbor to 3.16 inches in Anaheim. The July mean precipitation ranges from 0.01 inches at Tustin Irvine Ranch to 0.11 inches at both Anaheim and Laguna Beach. Currently, Orange County receives an average of 13 to 14 inches of precipitation each year (climatedata.org n.d.)

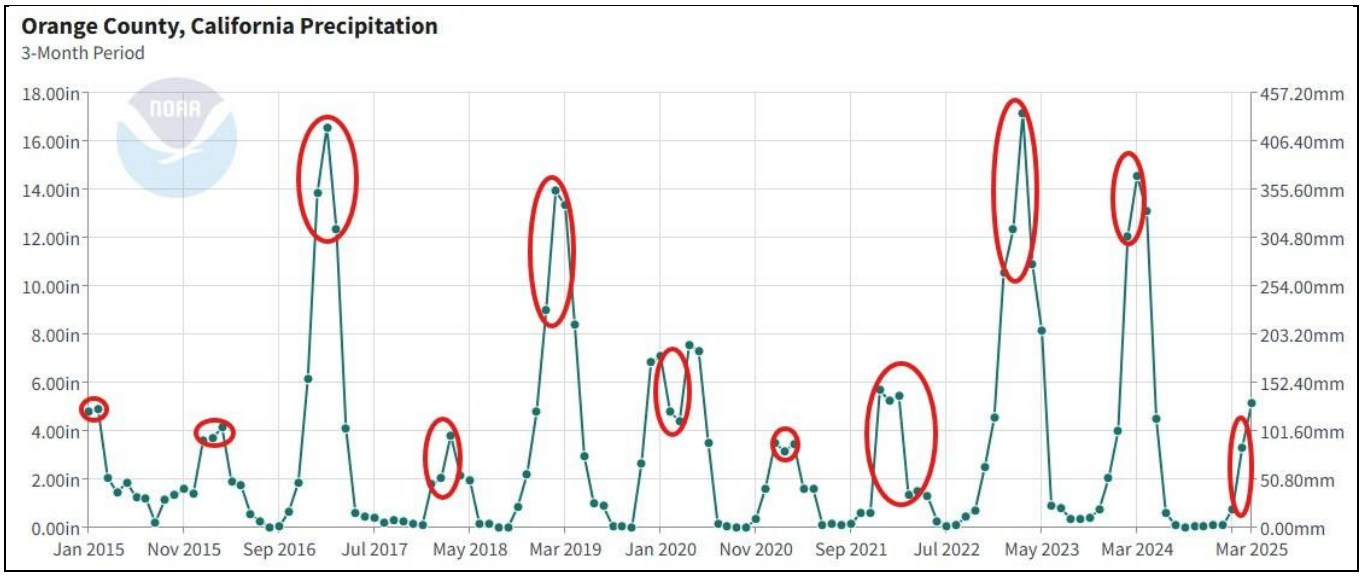
**Table 4-5. 30 Year (1991 – 2020) Climate Normal for Orange County, California**

| Station Name | Mean Temperature (°F) | | Mean Precipitation (inches) | |
|---|---|---|---|---|
| | January | July | January | July |
| **Santa Ana Fire Station** | 59.0 | 73.6 | 2.88 | 0.03 |
| **Irvine Ranch** | 58.8 | 75.0 | 2.67 | 0.09 |
| **Anaheim** | 59.9 | 76.2 | 3.16 | 0.11 |
| **Laguna Beach** | 56.3 | 69.8 | 2.78 | 0.11 |
| **Newport Beach Harbor** | 57.4 | 68.2 | 2.20 | 0.02 |
| **Santa Ana John Wayne Airport** | 57.8 | 72.5 | 2.59 | 0.04 |
| **Tustin Irvine Ranch** | 55.6 | 73.3 | 3.09 | 0.01 |
| **Fullerton Municipal Airport** | 57.6 | 75.2 | 2.85 | 0.02 |

Source: Palecki, et al. 2021

Figure 4-7 shows precipitation from 2015 through the first two months of 2025 (NOAA NCEI n.d.). There is a clear increase in precipitation beginning in late fall and early winter and continuing through the early spring (shown with red annotations). This precipitation pattern is also reflected in the FEMA disaster declaration and previous flooding event shown in Section 5.7. Most FEMA disaster declarations and previous flood events in Orange County occurred between October and April.

Figure 4-7. Precipitation Pattern—Orange County (2015 – March 2025)




*Source: NOAA NCEI n.d.*

### Climate Change Projections

A warmer atmosphere means storms have the potential to be more intense and occur more often. In the State of California, extreme storms typically include spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between June and October.

Temperatures in California are expected to increase by 2.5 °F to 2.7 ° F by 2040 and as much as 8.8° F by late century (2070-2100). The state can expect average annual temperatures warmer than any to date. The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves and fewer sub-freezing days (California Climate Change Assessment 2019).

As temperatures increase, the atmosphere can hold more water vapor, which leads to a greater potential for precipitation. Climate models suggest that the northern part of the state is likely to become wetter, and the southernmost regions are expected to become drier (California Climate Change Assessment 2019).

California's climate is influenced by global changes. Over the past few decades, the Arctic has warmed faster than any other region, leading to significant sea ice loss. A recent study estimated that Arctic sea ice loss could reduce winter precipitation in California by up to 15 percent on average, although some years might become wetter. More research is needed to confirm the link between reduced Arctic sea ice and dry conditions in California (California Climate Change Assessment 2019).

## 4.2.4 Land Cover

Land cover is a description of the physical attributes covering the land's surface. Figure 4-8 shows the county's land cover using classifications from the National Land Cover Database (NLCD-MRLCC n.d.). Table 4-6 shows these land cover categories and their percentage of land distribution within all of Orange County. The County as a whole is classified as 61 percent urban areas, which includes all types of developed lands. The next highest coverage type is the rangeland classification at 32 percent. This classification includes grasslands, sedge grasses, shrubs, and scrub grasses.

**Figure 4-8. Orange County Land Cover Map (2023)**

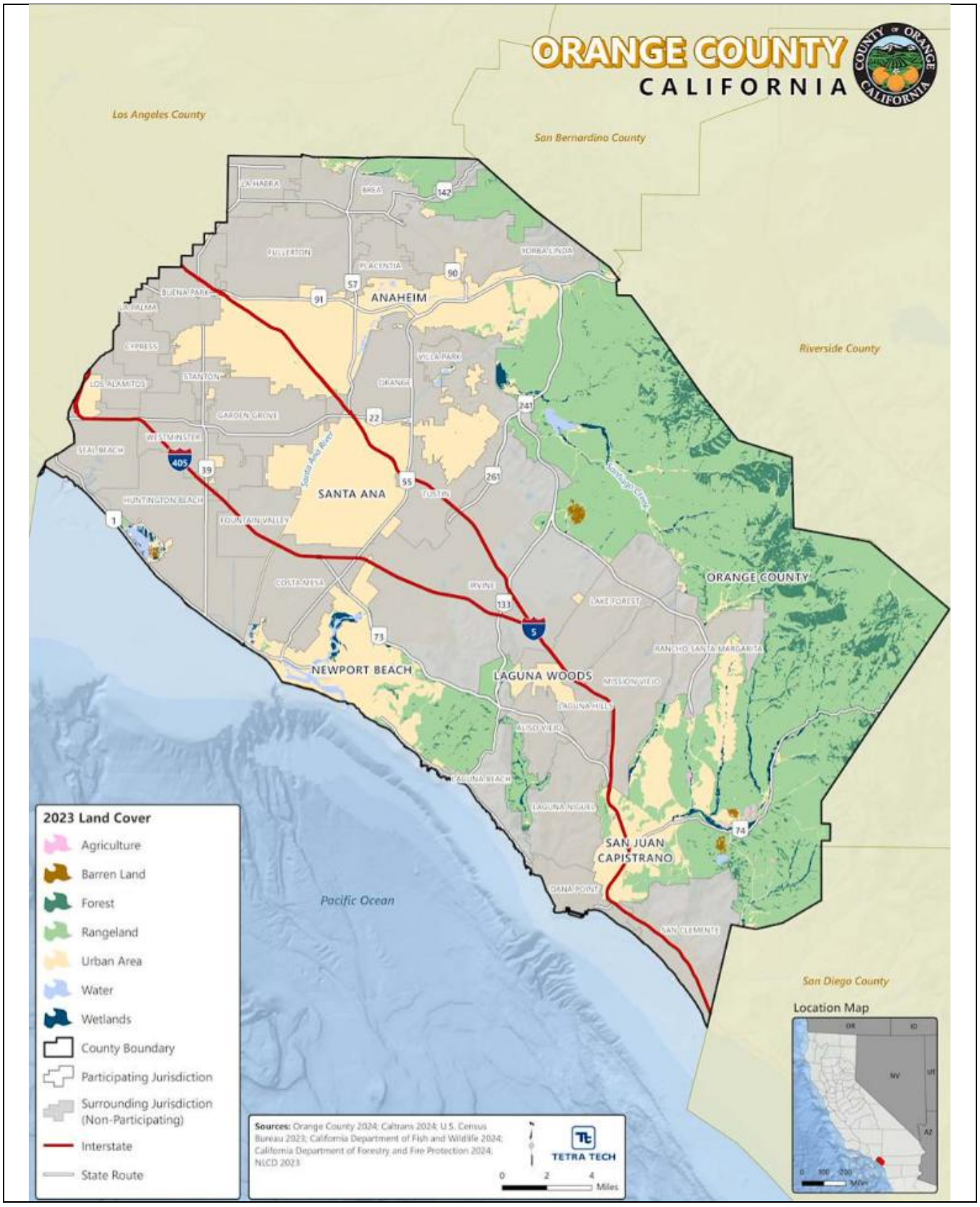


**Table 4-6. Orange County Land Cover**

| Land Cover Category | 2023 Orange County Land Cover | |
|---|---|---|
| | Acreage | % of County |
| **Agriculture** | 3,966.1 | 0.8% |
| **Barren Land** | 1,037.0 | 0.2% |
| **Forest** | 17,903.8 | 3.5% |
| **Rangeland** | 164,369.0 | 32.1% |
| **Urban Area** | 313,299.1 | 61.3% |
| **Water** | 3,889.7 | 0.8% |
| **Wetland** | 6,815.1 | 1.3% |
| **Orange County (Total)** | **511,279.7** | **100.0%** |

Source: (NLCD-MRLCC n.d.)

The land cover data reinforces the urbanized character of the FMP participating jurisdictions (see Table 4-7), with all of the cities having urban area land use classifications between 70 percent (San Juan Capistrano) and nearly 100 percent (Santa Ana) of their total area. The greatest amount of forest land cover is in the unincorporated County, at 9.5 percent of total area. Agricultural lands and barren lands are relatively low across all participating FMP jurisdictions, with an average coverage of 0.12 percent. Water and wetland land cover classifications are slightly higher rates, accounting for 7.8 percent and 5.9 percent of the FMP participating jurisdictions.

**Table 4-7. Orange County Land Cover—FMP vs. Non-FMP Jurisdictions**

| Jurisdiction | Land Cover (2023) | | | | | | | Total | % of County |
|---|---|---|---|---|---|---|---|---|---|
| | Agriculture | Barren Land | Forest | Rangeland | Urban Area | Water | Wetlands | | |
| **Anaheim** | 0.2 | 12.5 | 25.7 | 3,635.5 | 28,511.1 | 346.8 | 37.3 | 32,569.2 | 6.4% |
| **Laguna Woods** | 0.0 | 0.0 | 0.0 | 207.1 | 1,907.1 | 0.8 | 1.1 | 2,116.1 | 0.4% |
| **Newport Beach** | 12.3 | 78.3 | 88.9 | 2,062.4 | 12,719.0 | 1,009.9 | 543.6 | 16,514.5 | 3.2% |
| **San Juan Capistrano** | 22.3 | 8.3 | 0.0 | 2,644.1 | 6,520.6 | 1.0 | 24.8 | 9,221.1 | 1.8% |
| **Santa Ana** | 0.0 | 0.0 | 0.0 | 0.0 | 17,529.7 | 1.0 | 0.0 | 17,530.7 | 3.4% |
| **Unincorporated County** | 323.7 | 703.0 | 16,875.8 | 130,091.5 | 22,783.9 | 1,322.1 | 3,827.9 | 175,927.9 | 34.4% |
| **Non-Participating Jurisdictions** | 3,607.6 | 234.8 | 913.3 | 25,728.4 | 223,327.7 | 1,208.0 | 2,380.5 | 257,400.3 | 50.3% |
| **Orange County (Total)** | **3,966.1** | **1,037.0** | **17,903.8** | **164,369.0** | **313,299.1** | **3,889.7** | **6,815.1** | **511,279.7** | **100.0%** |

Source: (NLCD-MRLCC n.d.)

Table 4-8 shows the distribution of land cover for unincorporated portions of Orange County exclusively. Unincorporated areas differ most from the overall county in urban area (13 percent in unincorporated areas and 61 percent countywide) and rangeland (74 percent in unincorporated areas and 32 percent countywide).

**Table 4-8. Unincorporated Orange County Land Cover**

| | Land Cover (2023) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Agriculture | Barren Land | Forest | Rangeland | Urban Area | Water | Wetlands | TOTAL |
| **Acreage** | 323.7 | 703.0 | 16,875.8 | 130,091.5 | 22,783.9 | 1,322.1 | 3,827.9 | 175,927.9 |
| **% of County** | 0.2% | 0.4% | 9.6% | 74.0% | 13.0% | 0.8% | 2.2% | 100% |

Source: (NLCD-MRLCC n.d.)

## 4.3 LAND USE

Land use describes how people are using or are permitted to use land. The mechanism for a jurisdiction to regulate the type and intensity of land use stems from its adopted land development regulations. Land use maps typically show where certain types of uses are either existing or planned for the area under review. Land use maps tend to function as a way to drive policy decisions and ultimately, where to implement certain land development regulations. Land use policies and how they are implemented (through development, subdivision, site development, stormwater, flood control, and building codes) ultimately dictate the type of surface coverage a given area has.

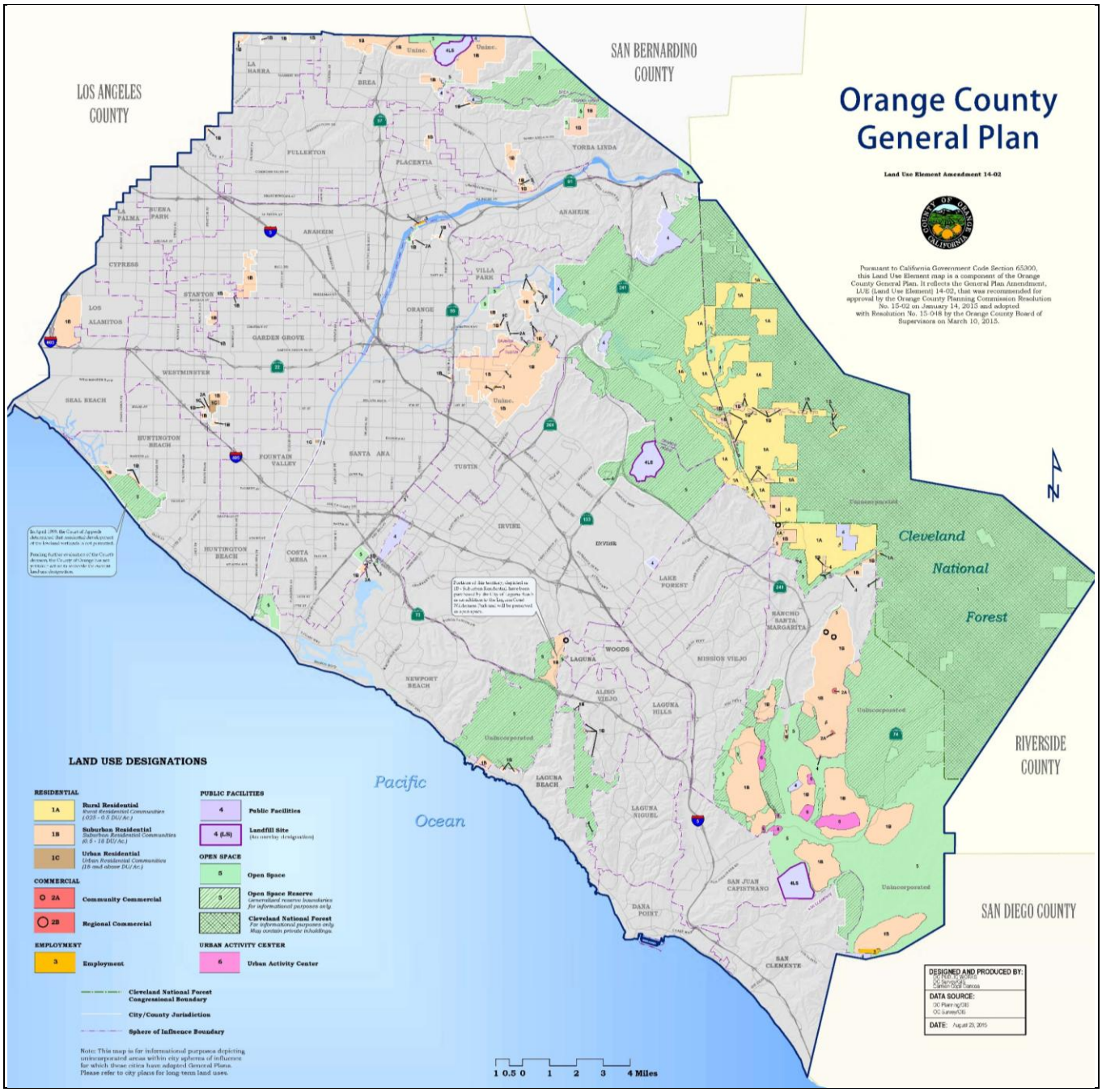
The Orange County General Plan Land Use Element contains policies on land use in unincorporated Orange County. The Land Use Element lists six land use categories: Residential, Commercial, Employment, Public Facilities, Open Space, and Urban Activity Center. According to the General Plan, 74 percent of unincorporated Orange County is classified as Open Space land use, with most of the remaining area classified as Residential (23 percent). Table 4-9 shows the aggregated land use categories by percent coverage for the County. A map of county land uses is provided in Figure 4-9. With respect to flood hazards, the Land Use Element points out the need to consider water quality and watershed protection principals during site planning and stormwater facility design processes (Orange County, CA n.d.).

**Table 4-9. Orange County Aggregate Land Use Categories**

| Land Use | Acres | % of County |
|---|---|---|
| **Rural Residential [1a]** | 13,421 | 7.6 |
| **Suburban Residential [1b]** | 26,705 | 15.1 |
| **Urban Residential [1c]** | 136 | 0.08 |
| **Community Commercial [2a]** | 52 | 0.03 |
| **Employment [3]** | 113 | 0.06 |
| **Public Facilities [4]** | 2,460 | 1.4 |
| **Landfill Site [4ls]** | 2,057 | 1.2 |
| **Open Space [5]** | 130,433 | 74 |
| **Urban Activity Center [6]** | 932 | 0.53 |
| **Total** | **176,309** | **100** |

Source: Orange Co. General Plan—Land Use Element

**Figure 4-9. Orange County Land Use—2024 General Plan Update**




*Source: Orange Co. General Plan Land Use Element*

In Orange County, there are stark differences in the percentage of urbanized land cover between the relatively rural, unincorporated County and the highly urbanized incorporated jurisdictions portion of the County. As the highly urbanized development pattern persists in the western portions of the County, the functionality of natural floodplains is significantly reduced. Unincorporated Orange County benefits in terms of relatively lower flood risk because more of its land cover is classified as open space. The more urbanized western portion of the County has a much higher percentage of its land classified as urban and correlates to high amounts of impervious coverages, which cause those areas to be more vulnerable to stormwater related flooding.

The residential land use category are areas suitable for residential development. The category has three subcategories (Orange County n.d.):

- The **Rural Residential** subcategory is applied to areas in which limited residential use is compatible with the natural character of the terrain and development will require special consideration due to topography and other factors. The building intensity standard ranges from 0.025 to 0.5 dwelling units per gross acre.
- The **Suburban Residential** subcategory is characterized by a wide range of housing types of which range from estates on large lots to attached dwelling units like apartments. The building intensity ranges from 0.25 to 43.5 dwelling units per gross acre.
- The **Urban Residential** subcategory is applied to areas with intensive residential development that is compatible with urban development. Development in this category is characterized by intensive residential development and has a building intensity of 30 dwelling units per gross acre and above.

The Open Space land use category includes two sub-categories (Orange County, CA n.d.).

- The **Open Space (OS)** category indicates the current and near-term use of the land which is zoned primarily for agricultural and provides for limited land uses that do not require a commitment of significant urban infrastructure. There are maximum building height and site coverage associated with the OS category, and this includes a maximum building height of 35 feet and a maximum site coverage of the area covered by structures or parking should not exceed 20 percent. The reason for these restrictions is to allow for the development to blend into natural surroundings.
- The **Open Space Reserve (OSR)** category identifies lands of scenic and natural attractions, areas of ecological, cultural, historical, and recreational significance that are permanently preserved as and restricted to open space. These areas include major parks, beaches, forest, harbors, and other area that will remain open space (Orange County, CA n.d.). OSR has building restrictions that include maximum building height of 18 feet and maximum coverage of 100 percent.

## 4.4 POPULATION AND DEMOGRAPHICS

### 4.4.1 Statistics

An understanding of the County's population and other demographic characteristics provides a foundation for deciphering the impacts of the flood hazards in Orange County. For this FMP, population data and related socio-demographic data were obtained from the United States Census Bureau (USCB). As noted in Section 5.1 (Methodology) of this plan, modeling the impacts of flood hazards on the population was conducted using FEMA's Hazus risk modeling software. This software incorporates the USCB's decennial census population data. Given that the USCB only conducts full population counts once every 10 years through the Decennial Census, the USCB also offers annual population estimates, such as the American Community Survey (ACS). The ACS offers both 1-year estimates as well as 5-year estimates.

This FMP will primarily use the USCB data to ensure consistency in sourcing, timing of data, and their associated methodologies. It is important to note that decennial census data is collected and calculated differently than annualized estimate data. Moreover, this FMP will document which instances Decennial Census versus the American Community Survey (ACS) are used. For economic related data (i.e., unemployment and labor force), this study will utilize the U.S. Bureau of Labor and Statistics. Access to economic data is available through the Census Bureau, however, the BLS offers a more efficient means to access and capture economic related data. Similarly, to capture consistent income thresholds, the U.S. Dept. of Housing and Urban Development (HUD) Area Median Income (AMI) data finder will be used during the income vulnerability section.

## 4.4.2 Population Trends

This section discusses population trend information used to estimate future shifts that could significantly change the character of the area. Population trends can provide a basis for making decisions on the type of mitigation approaches to be considered and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

Table 4-10 summarizes the population counts for Orange County and those jurisdictions participating in the FMP. Orange County's official 2020 decennial population count was 132,877, and an estimated 131,037 in 2023 according to the ACS. As a percentage of those FMP participating jurisdictions, the County has accounted for just over 14 percent, with the largest share of population within the City of Anaheim at approximately 37 percent, followed closely thereafter by the City of Santa Ana at approximately 33 percent. The smallest participating jurisdiction in terms of total population distribution is Laguna Woods, with only 1.9 percent of the total participating jurisdictions population count.

**Table 4-10. Participating Jurisdictions Populations for 2020 Decennial and 2023 ACS**

| Jurisdiction | 2020 Decennial | | 2023 American Community Survey | |
|---|---|---|---|---|
| | Total Population | % of Jurisdiction Total | Total Population | % of Jurisdiction Total |
| **Anaheim** | 346,824 | 37.4% | 344,553 | 37.3% |
| **Laguna Woods** | 17,644 | 1.9% | 17,342 | 1.9% |
| **Newport Beach** | 85,239 | 9.2% | 84,304 | 9.1% |
| **San Juan Capistrano** | 35,196 | 3.8% | 34,998 | 3.8% |
| **Santa Ana** | 310,227 | 33.4% | 311,639 | 33.7% |
| **Unincorporated County** | 132,877 | 14.3% | 131,037 | 14.2% |
| **Total** | **928,007** | **100.0%** | **923,873** | **100.0%** |

Source: U.S. Census Bureau, 2020 Decennial; U.S. Census Bureau, 2023 American Community Survey

Figure 4-10 provides a graphical display of how the population within the County is distributed. Specifically, the figure is a population density map, whereby the spatial unit of measure is at the U.S. Census Tract level of geography. Using the 2020 U.S. Census data count and mapping the data using by the Census Tract square miles provides an efficient way to show where the population density is the greatest.

The density in Orange County is greatest in the cities of Anaheim and Santa Ana, the two most populous jurisdictions in the County, both situated along the Interstate 5 and 405 corridors. The population density is far lower to the east in unincorporated portions of the County. The lower density unincorporated regions are within lands protected from significant development—open space reserves and or national forest lands.

Table 4-11 compares Orange County's population changes to the region and to the state. The time-period shown uses 2013 as a base year due to Metropolitan Statistical Area (MSA) data not being available prior to then. To this end, the data collected shows the County and State have a similar yearly growth rate between 2013 and 2023, whereby the two rates differ by only 0.53 percent (3.68 percent vs. 4.21 percent). This trend is different when comparing the county growth rates to the region. Specifically, the Los Angeles-Long Beach-Anaheim MSA grew by 0.52 percent for this 10-year period. This would indicate that Orange County growth is not only modest and consistent, but also at a greater rate relative to the surrounding metropolitan region.

**Figure 4-10. Total Population by Census Tract per Square Mile for Orange County**

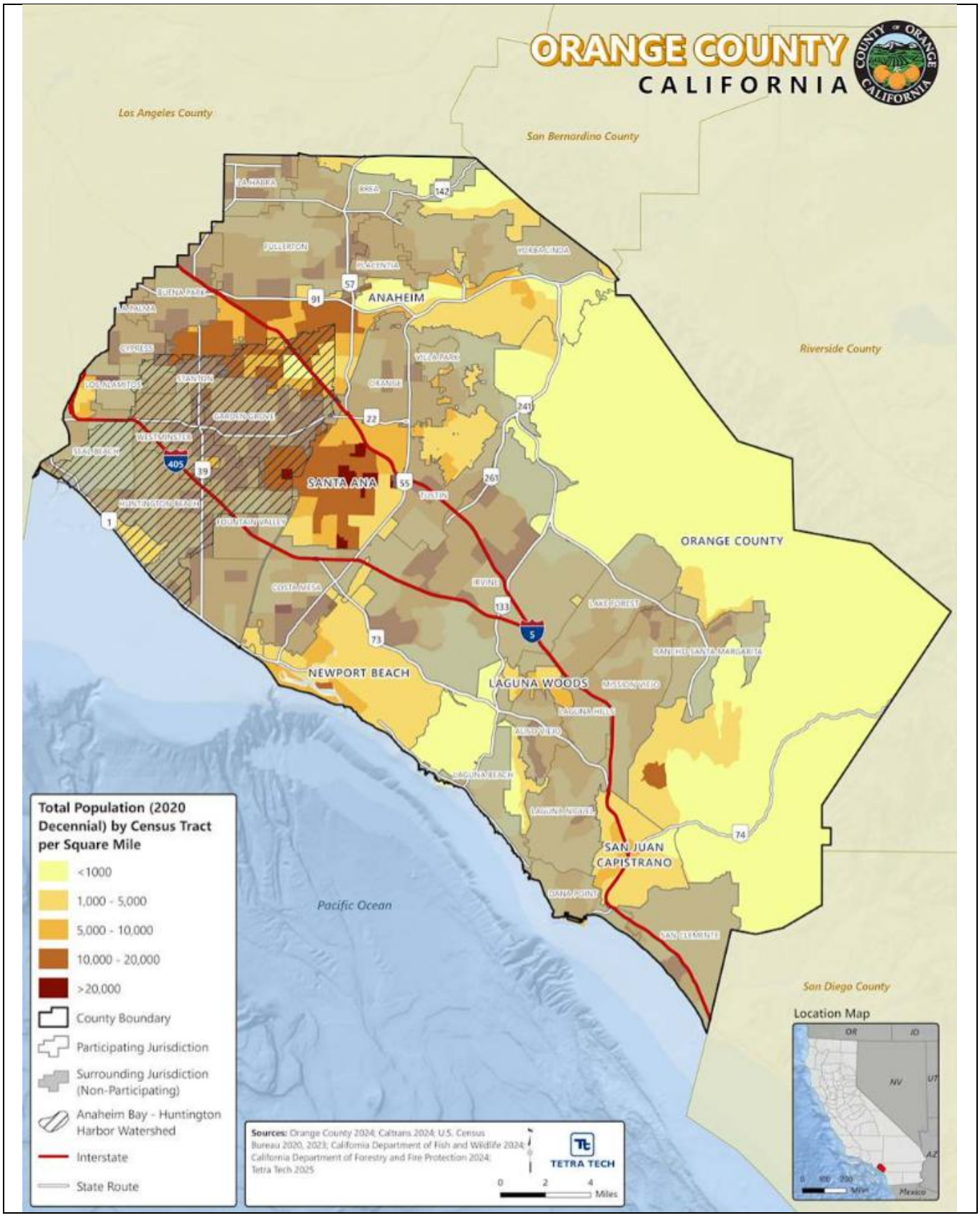


**Table 4-11. Orange County, Regional MSA, and State Population Comparison**

| | Orange County | | LA-Long Be.-Anaheim MSA | | California | |
|---|---|---|---|---|---|---|
| | Population | % Change from Previous Year | Population | % Change from Previous Year | Population | % Change from Previous Year |
| **2013** | 3,051,771 | Base | 12,945,252 | Base | 37,659,181 | Base |
| **2014** | 3,086,331 | -0.95 | 13,060,534 | 0.89 | 38,066,920 | 1.08 |
| **2015** | 3,116,069 | 2.11 | 13,154,457 | 0.72 | 38,421,464 | 0.93 |
| **2016** | 3,132,211 | 1.49 | 13,189,366 | 0.27 | 38,654,206 | 0.61 |
| **2017** | 3,155,816 | 1.28 | 13,261,538 | 0.55 | 38,982,847 | 0.85 |
| **2018** | 3,164,182 | 1.02 | 13,262,234 | 0.01 | 39,148,760 | 0.43 |
| **2019** | 3,168,044 | 0.39 | 13,249,614 | -0.1 | 39,283,497 | 0.34 |
| **2020** | 3,170,345 | 0.19 | 13,211,027 | -0.29 | 39,346,023 | 0.16 |
| **2021** | 3,182,923 | 0.47 | 13,202,558 | -0.06 | 39,455,353 | 0.28 |
| **2022** | 3,175,227 | 0.15 | 13,111,917 | -0.69 | 39,356,104 | -0.25 |
| **2023** | 3,164,063 | 0.59 | 13,012,469 | -0.76 | 39,242,785 | -0.29 |
| **% Change, 2013 – 2023** | | **3.68%** | | **0.52%** | | **4.21%** |

Source: (U.S. Census Bureau n.d.)

Table 4-12 offers an insight into how the population is distributed in Orange County with respect to those municipalities who are participants in this FMP. Orange County in total saw an increase of 6.9 percent in its population from 2010 to 2020, with the unincorporated portions having the largest percentage of increase (10.46 percent) relative to those FMP participating jurisdictions. Of the five FMP participating jurisdictions, Anaheim shows the greatest percentage of growth between 2010 and 2020 with an estimated 6 percent increase in its population. The table provides a calculation for each jurisdiction's percent share of the overall County population in 2010 and 2020. Comparing the two time periods across each jurisdiction, their respective share of the County remains generally the same over the time period. This indicates that the participating jurisdictions population relative to the County overall remains steady and balanced.

**Table 4-12. Orange County Population Change and Municipal Distribution**

| | 2010 | | 2020 | | 2010 – 2020 |
|---|---|---|---|---|---|
| Jurisdiction | Population | % of County Population | Population | % of County Population | Population Change (%) |
| **Anaheim** | 333,039 | 11.23 | 353,085 | 11.14 | 6.02 |
| **San Juan Capistrano** | 34,263 | 1.16 | 35,976 | 1.13 | 5.00 |
| **Newport Beach** | 83,571 | 2.82 | 86,694 | 2.73 | 3.74 |
| **Santa Ana** | 325,216 | 10.97 | 332,610 | 10.49 | 2.27 |
| **Laguna Woods** | 16,295 | 0.55 | 16,056 | 0.51 | (1.47) |
| **Unincorporated County** | 115,933 | 3.91 | 128,057 | 4.04 | 10.46 |
| **Orange County (ALL)** | 2,965,525 | 100.00 | 3,170,345 | 100.00 | 6.91 |

(U.S. Census Bureau n.d.)

## 4.4.3 Economic Indicators

Table 4-13 summarizes employment count data by sector from the 2022 U.S. Census Bureau's County Business Patterns data. According to this dataset, there were 106,249 business establishments employing 1,561,560 people in Orange County. The Health Care and Social Assistance sector had the highest number of employees with 194,903, followed closely by the Accommodation and Food Service sector with 175,861. Retail Trade, Professional Scientific/Technical Service, and Manufacturing sectors all employed between 140,000 and 150,000. Other significant employment industries include Wholesale Trade (107,239); Waste Management and Remediation (107,118); Construction trades (106,008); and Finance and Insurance (98,897). Employment sectors including Arts and Entertainment, Management Companies, and Real Estate/Rental all employ between 45,000 and 65,000 people. The Transportation and Warehousing, Information, and Educational Services sectors employ between 30,000 to 40,000 people, with the remaining sectors employing less than 3,000 persons (U.S. Census Bureau n.d.).

**Table 4-13. Orange County Employment—2022**

| | Business Establishments | Number Employed |
|---|---|---|
| Health care and social assistance | 13,951 | 194,903 |
| Accommodation and food services | 8,853 | 175,861 |
| Retail trade | 9,811 | 149,287 |
| Professional, scientific, and technical services | 18,302 | 147,378 |
| Manufacturing | 4,357 | 140,348 |
| Wholesale trade | 7,538 | 107,239 |
| Administrative and support and waste management and remediation services | 4,935 | 107,118 |
| Construction | 7,651 | 106,008 |
| Finance and insurance | 6,929 | 98,897 |
| Arts, entertainment, and recreation | 1,749 | 61,983 |
| Other services (except public administration) | 7,659 | 58,835 |
| Management of companies and enterprises | 689 | 54,352 |
| Real estate and rental and leasing | 7,800 | 48,600 |
| Transportation and warehousing | 2,095 | 39,763 |
| Information | 1,811 | 34,418 |
| Educational services | 1,861 | 32,961 |
| Utilities | 95 | 2,969 |
| Agriculture, forestry, fishing and hunting | 52 | 344 |
| Mining, quarrying, and oil and gas extraction | 31 | 184 |
| Industries not classified | 80 | 112 |
| **Total for all sectors** | **106,249** | **1,561,560** |

Source: U.S. Census Bureau n.d.

Orange County enjoys a large, diverse, and dynamic workforce. The County boasts the second largest workforce in California and is host to many top private companies. Chief among them is the Walt Disney Company, employing approximately 34,000 as of 2024 (Orange County Business Council n.d.). The Healthcare Industry is a

large contributor to the overall economy of the County. Companies such as Providence, Kaiser Permanente, Hoag Memorial Hospital, Memorial Care, and Children's Hospital of Orange County account for over 45,000 employees. The County is home to two institutes of higher learning: University of California Irvine, and California State University Fullerton, as well as large presences by companies such as Bank of America, Boeing, and Edwards Life science (Orange County Business Council n.d.).

The County historically has an unemployment rate that is below both the national and State average. Table 4-14 compares the unemployment rates of the County to the state and the nation. The county's unemployment rates were generally below the state and national averages between 2014 and 2024. The noticeable spike in unemployment rates in 2019 and 2020 are indicative of the global COVID-19 pandemic and the resulting impacts on the U.S. and worldwide economies.

**Table 4-14. Unemployment Rates**

| | Orange County, CA | California | United States |
|---|---|---|---|
| **2014** | 5.6% | 7.6% | 8.24% |
| **2015** | 4.5% | 6.2% | 6.61% |
| **2016** | 4.0% | 5.5% | 6.4% |
| **2017** | 3.5% | 4.8% | 5.5% |
| **2018** | 2.9% | 4.3% | 4.5% |
| **2019** | 2.8% | 4.1% | 4.2% |
| **2020** | 8.9% | 10.1% | 12.8% |
| **2021** | 6.0% | 7.4% | 9.3% |
| **2022** | 3.2% | 4.3% | 4.7% |
| **2023** | 3.5% | 4.7% | 4.8% |
| **2024** | 3.9% | 5.3% | 5.6% |

Source: U.S. Bureau of Labor Statistics n.d.

However, since 2020, unemployment rates in Orange County have declined steadily to pre-2016 levels. This is due in large part to the County having significant regional economic stability. Factors that fuel the regional economic engine for the County include relatively good proximity to major population centers, a vast multi-modal transportation network, several large tourism destinations, robust business growth, and a well-educated workforce upon which to pool from (O.C. Community Investment Division n.d.). Even with proven growth and metrics that support it, Orange County does have its economic challenges. As with any major metropolitan region, increased demand for higher paying jobs combined with a dwindling supply of land leads to large inequities in housing affordability. As will be discussed in the next section, lower income individuals and/or households tend to be more vulnerable to flood hazards given they typically do not have the same level of financial resources to recover as that of their higher income household counterparts.

In 2023, the USCB estimates Orange County having 1,074,654 total households, with approximately 354,636 households (33 percent) earning less than $75,000 annually. Given that the Orange County threshold for low-income household falls within USCB income classification between $75,000 and $99,999 annually, the exact percentage of low-income households is not available.

However, the data shows that 34 percent of County households (816,737) earn less than $75,000 annually. This is well below the 80 percent AMI that the U.S. Government uses to define low-income for federal lending

purposes. Acknowledging that there are indeed other factors contributing to a group's vulnerability, future floodplain management strategies should certainly consider targeting the aging population as well as households with less financial resources overall.

According to the U.S. Department of Housing and Urban Development, a household is considered low-income if it earns less than 80 percent of a locations given Area Median Income (AMI). The U.S. Census Bureau calculates the AMI for Orange County at approximately 110,042 as of 2023 (USCB n.d.), with 80 percent of that being approximately $88,033 per year. Table 4-15 shows the percentage distribution of households by income classification in Orange Co.

**Table 4-15. Orange County Household Income—2023 (inflation adjusted)**

| Income Classification | % Total Households | Income Classification | % Total Households |
|---|---|---|---|
| Less than $10,000 | 4.40% | $75,000 to $99,999 | 11.30% |
| $10,000 to $14,999 | 1.90% | $100,000 to $149,999 | 18.80% |
| $15,000 to $24,999 | 4.40% | $150,000 to $199,999 | 12.70% |
| $25,000 to $34,999 | 4.00% | $200,000 or more | 23.00% |
| $35,000 to $49,999 | 7.10% | Mean income (dollars) | $146,635 |
| $50,000 to $74,999 | 12.30% | Median income (dollars) | $110,042 |

Source: (U.S. Census Bureau 2017)

## 4.5 GENERAL BUILDING STOCK

According to 2023 U.S. Census estimates, over one million households are located in Orange County (U.S. Census Bureau 2023). A household includes all the people who occupy a housing unit as their usual residence. A housing unit is a house, apartment, mobile home or trailer, a group of rooms, or a single room occupied as separate living quarters (or if vacant, intended for occupancy as separate living quarters) (U.S. Census Bureau 2023). According to the 2017 American Community Survey 5-year estimates, the majority of housing units (567,073) in Orange County are classified as one-unit detached homes. The median price of a single-family home in Orange County was estimated at $961,400 based on the 2017 American Community Survey 5-year estimates (U.S. Census Bureau 2017).

For the purposes of this plan, approximately 198,051 structures were identified by the tax data and spatial data available for the total of participating jurisdiction. These structures account for a replacement cost value of approximately $265 billion for structure alone, and over $465 billion including contents. There are approximately 174,404 total buildings in participating jurisdictions which are residential. Up to 33,171 of these residential buildings are located in unincorporated portions of Orange County. The participating jurisdiction with the highest residential building count is the City of Anaheim with 57,596 buildings at a total replacement cost value of over $81 billion. The participating jurisdiction with the lowest residential building count is the City of Laguna Woods with 3,347 buildings at a total replacement cost value total of over $6 billion. Table 4-16 presents building stock statistics by occupancy class for the County. Note here that the number of structures exposed to identified flood hazards will be detailed in Chapter 5 of this FMP.

**Table 4-16. Building Stock Count and Replacement Cost Value (RCV) by Occupancy Class**

| Jurisdiction | Residential | | Commercial | | Industrial | | Other[a] | |
|---|---|---|---|---|---|---|---|---|
| | Building Count | Total Replacement Cost Value | Building Count | Total Replacement Cost Value | Building Count | Total Replacement Cost Value | Building Count | Total Replacement Cost Value |
| **Anaheim** | 57,596 | $81,320,030,063 | 6,211 | $62,464,697,794 | 2,185 | $26,261,862,547 | 561 | $8,297,013,410 |
| **Laguna Woods** | 3,347 | $6,006,780,819 | 144 | $3,115,357,789 | 16 | $805,695,619 | 12 | $189,401,760 |
| **Newport Beach** | 27,583 | $47,687,555,890 | 2,965 | $30,056,284,634 | 385 | $4,572,889,469 | 185 | $2,659,665,512 |
| **San Juan Capistrano** | 9,309 | $10,934,699,253 | 870 | $6,302,683,865 | 185 | $968,639,312 | 101 | $1,415,045,220 |
| **Santa Ana** | 43,398 | $48,223,435,191 | 6,054 | $56,892,607,182 | 1,501 | $16,506,790,495 | 498 | $7,326,500,722 |
| **Unincorporated County** | 33,171 | $36,205,870,042 | 1,309 | $5,863,009,978 | 312 | $898,883,627 | 153 | $1,007,316,514 |
| **Total** | **174,404** | **$230,378,371,258** | **17,553** | **$164,694,641,241** | **4,584** | **$50,014,761,069** | **1,510** | **$20,894,943,138** |

Source: USACE 2022; Orange County 2021; RS Means 2024
a. Other = Government, Religion, Agricultural, and Education

Figure 4-11, Figure 4-12, and Figure 4-13 show the total replacement cost value per census block for each of the building stock classes. The densities are shown in units of $1,000 ($K) per square mile. Viewing building stock distribution maps, such as those used in these figures, can assist the County and participating jurisdictions in visualizing areas of high vulnerability and replacement cost value. The highest replacement cost value totals (>$100,000) for commercial buildings are more concentrated in the participating jurisdictions of City of Anaheim, City of Santa Ana, City of Newport Beach, and City of San Juan Capistrano. The lowest replacement cost value totals (<$10,000) for commercial buildings are more concentrated in the unincorporated portions of Orange County. For industrial buildings, the highest replacement cost value totals (>$100,000,000) are more concentrated in the participating jurisdictions of City of Anaheim, City of Santa Ana, and City of Newport Beach. The lowest replacement cost value totals (<$10,000) for industrial buildings are more concentrated in the unincorporated portions of Orange County. For residential buildings, the highest replacement cost value totals (>$100,000,000) are more concentrated in the participating jurisdictions of City of Anaheim, City of Santa Ana, City of Newport Beach, and City of San Juan Capistrano. The lowest replacement cost value totals (<$10,000) for residential buildings are more concentrated in the unincorporated portions of Orange County.

Figure 4-14 illustrates the total replacement cost value per census block. The densities are shown in units of $1,000 ($K) per square mile. The highest replacement cost value totals (>$5,000,000) per census block is more concentrated in the participating jurisdictions of City of Anaheim, City of Santa Ana, City of Newport Beach, City of San Juan Capistrano, and City of Laguna Woods. The lowest replacement cost value totals (<$100,000) per census block is more concentrated in the unincorporated portions of Orange County.

## 4.5 DEVELOPMENT TRENDS

Land use regulations are vested with and enforced by each specified jurisdiction in the State of California. However, many development and preservation issues transcend a particular locations political boundary. Communities should certainly evaluate land use trends as they can impact the need for, and prioritization of, floodplain management activities over time. This section provides information on general land use trends and types of development occurring within the County. An understanding of these development trends can assist in planning for further development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

### 4.5.1 Present Development Policy

As mentioned in the Chapter 4 of this FMP, 61 percent of the land cover in Orange County (including municipalities) is classified as urban area. This includes all types of developed land surfaces (NLCD-MRLCC n.d.) and correlates generally to properties with high percentages of impervious surfaces, established development intensities and few instances of newly established development projects. For highly urbanized areas such as Orange County, the intersection of high land value, limited site inventory, and high-population density creates a growth and development environment that changes gradually, one parcel or site at a time. While non-urbanized and/or less urbanized parts of the Country will see large-scale development on otherwise unimproved land, in Orange County and its municipalities, development projects tend to be submitted through a variety of land development, including lot consolidation, conditional use permits, redevelopment of or expansion to existing uses. A typical example is the creation of more developable land by combining adjacent lots, which will often lead to intensification of existing uses—i.e., the demolition of established four single-family dwellings and replaced with fifty-plus multi-family dwelling units.

**Figure 4-11. Total Commercial RCV per Census Block ($1000s/Square Mile)**

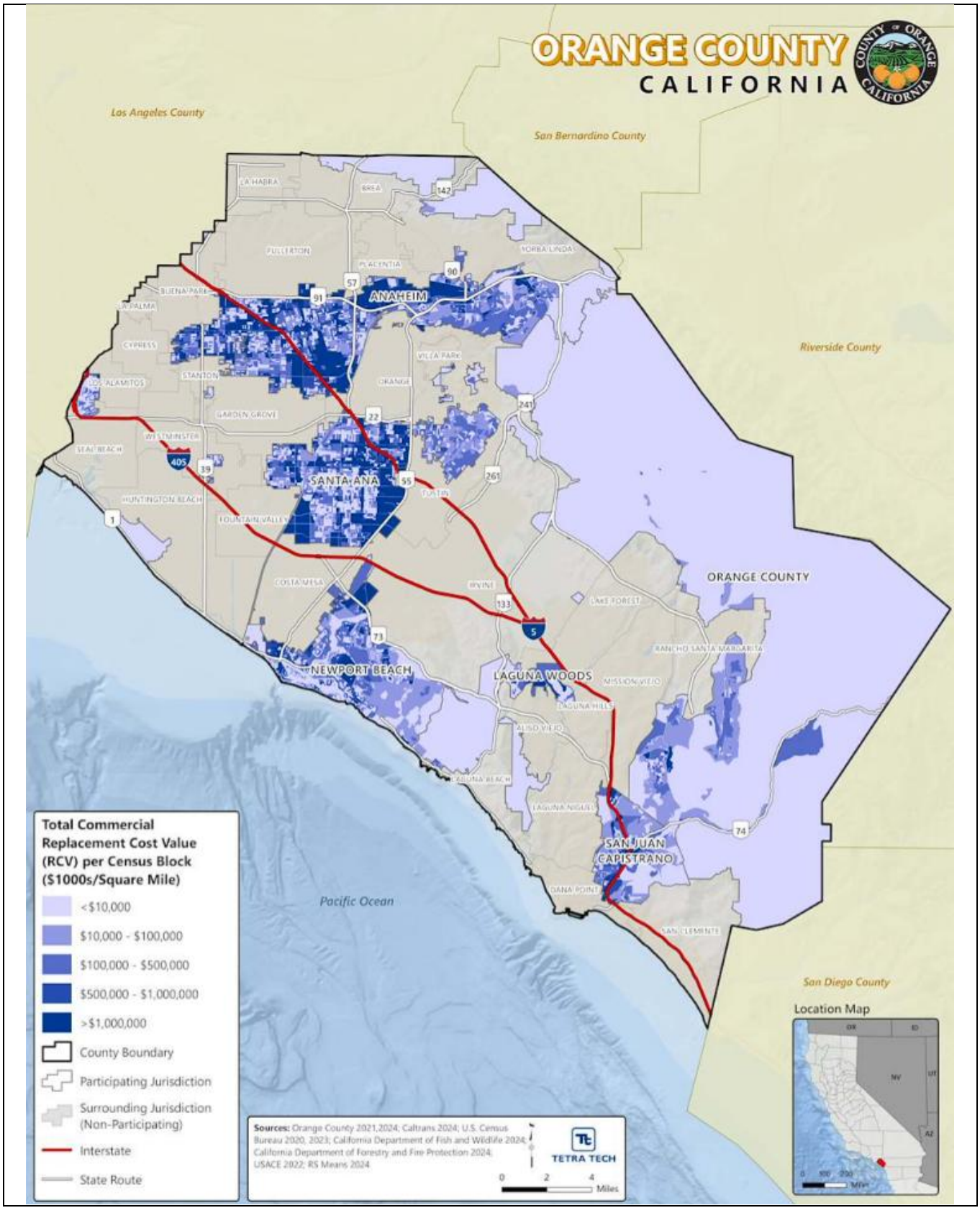


**Figure 4-12. Total Industrial RCV per Census Block ($1000s/Square Mile)**

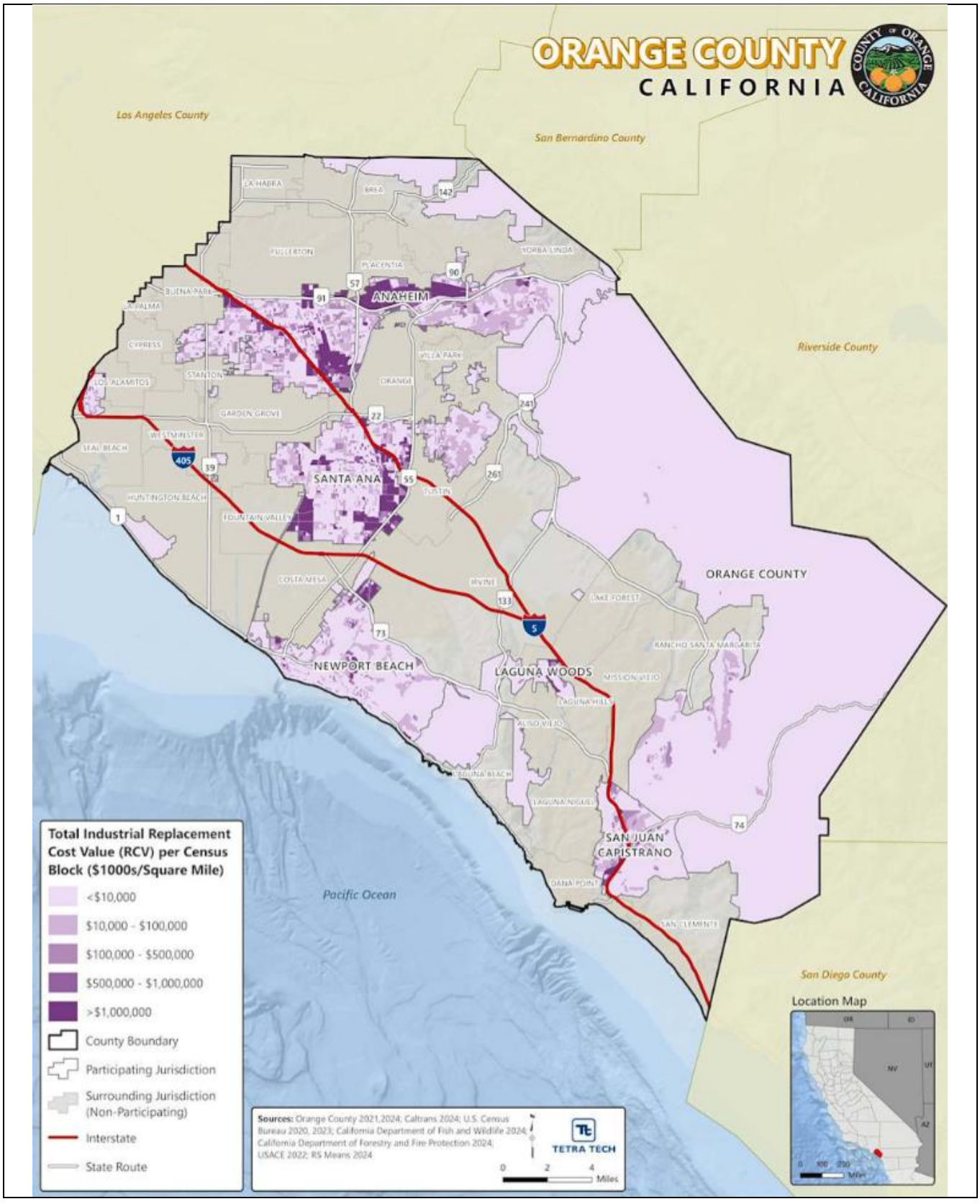


**Figure 4-13. Total Residential RCV per Census Block ($1000s/Square Mile)**

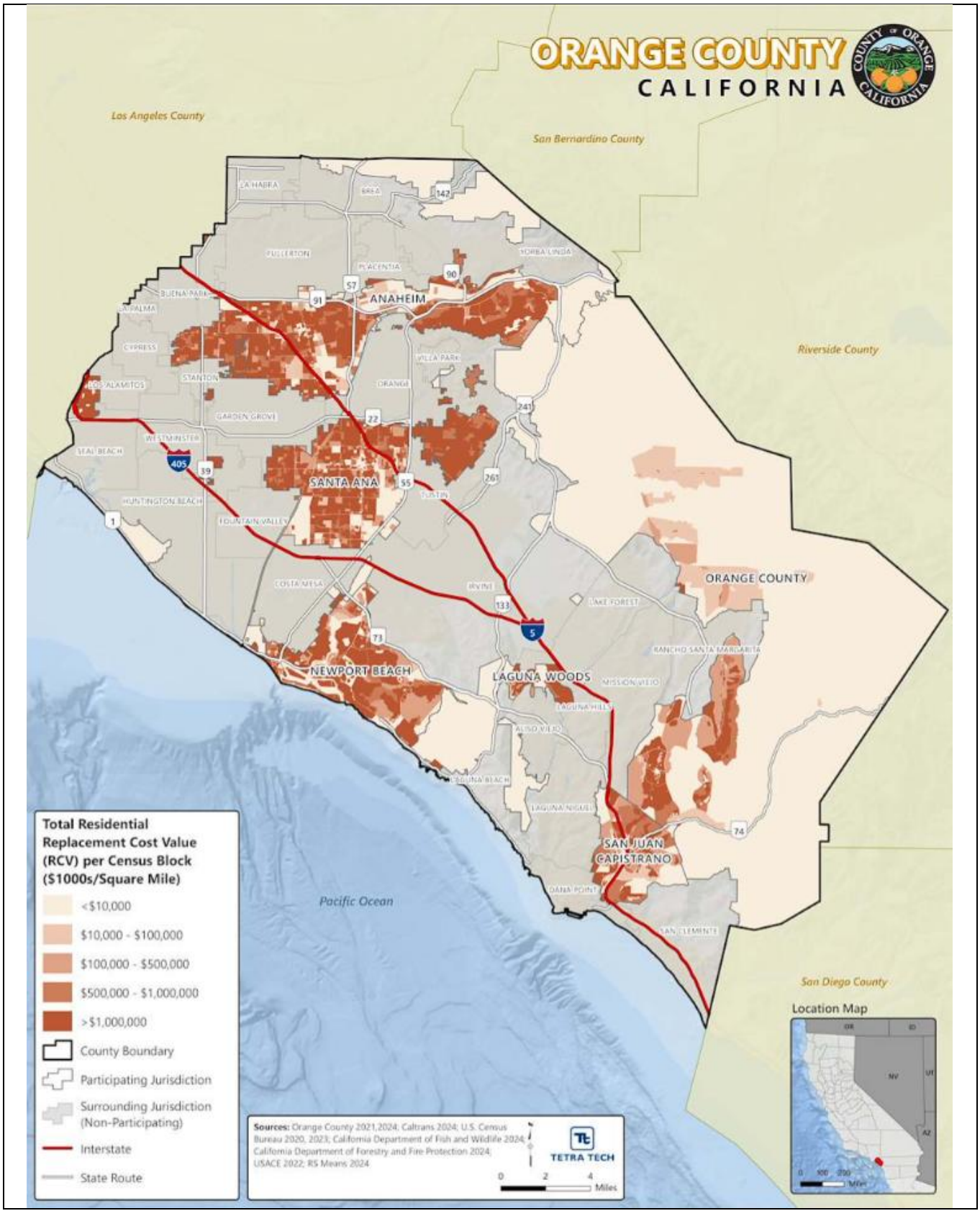
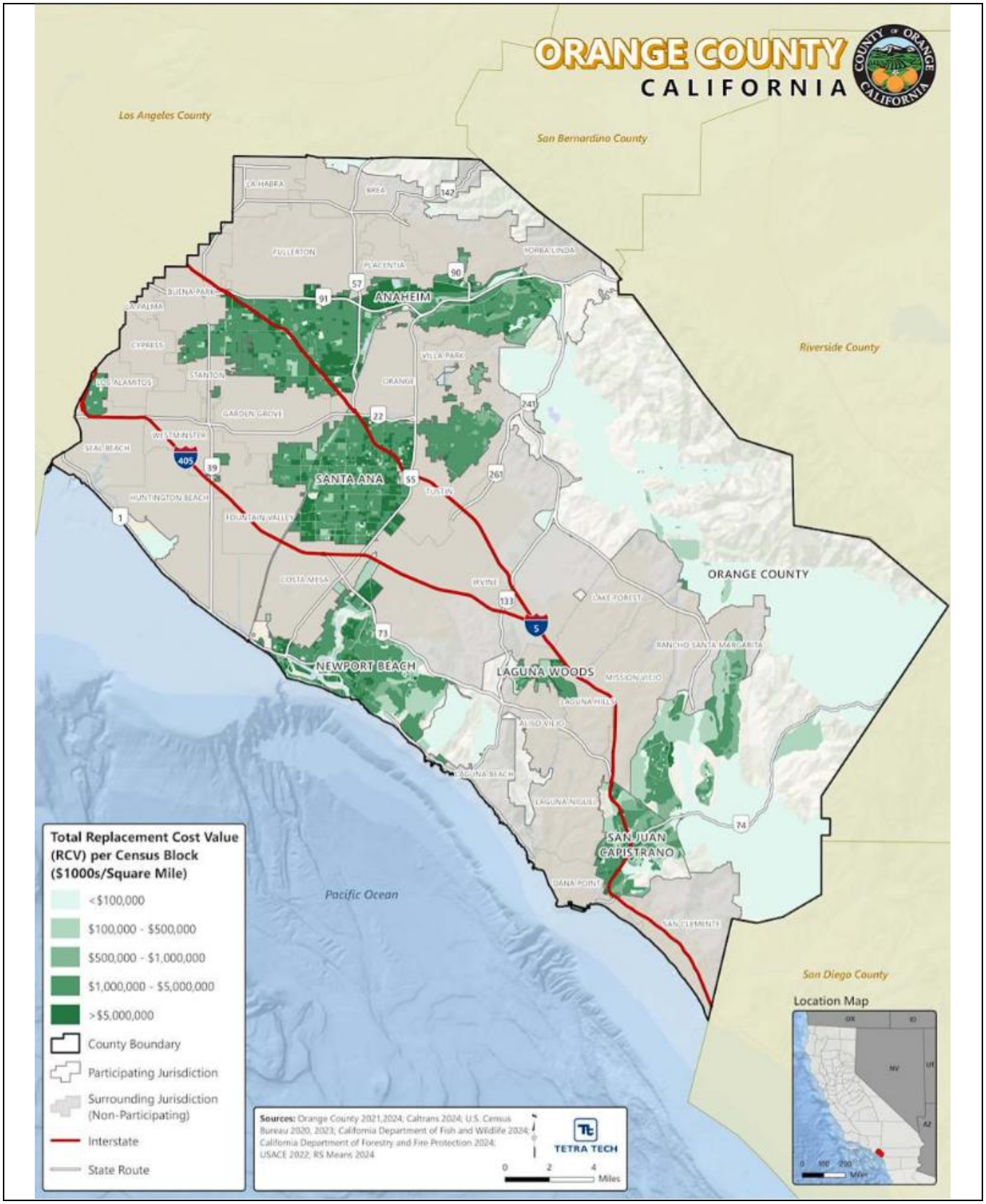


**Figure 4-14. Total RCV per Census Block ($1000s/Square Mile)**



Rising land values and cost-of-living pressures have also led to a rise in demand for Alternative Dwelling Units (ADU's). Popularity of ADU's has created a regulatory environment where municipal governments have been compelled to update zoning codes to accommodate construction of ADU's within existing, single-family lots in established neighborhoods. State and local regulations have needed to evolve to keep pace with present development types. The State of California has adopted a Green Building Code requiring on-site stormwater management for sites less than one-acre (ICC 2023), with some cities adopting these codes to accompany their locally adopted stormwater ordinances. Local stormwater ordinances regulate on-site stormwater management through the use of Low Impact Development (LID) practices such as roof-top disconnecting from the guttering systems, green roofs, rain barrels, etc. This said, upward pressure will continue to be exerted on the region's stormwater and floodplain management infrastructure based on the type of development pattern seen in highly urbanized areas such as Orange County.

## 4.5.2 Future Development Policy

The Orange County General Plan (GP) speaks to a variety of factors that impact the type, intensity and method of future development in the County. The GP Land Use Element (LUE) was updated in 2024 and categorizes development constraints from both an environmental and fiscal sustainability basis. With respect to floodplain development, the GP acknowledges that additional development is still possible within FEMA's Special Flood Hazard Area (SFHA). However, such developments will most certainly cost more and rely heavily on proper site planning. The County's land use plan, contained in the LUE, is used to assign future development policy decision. Areas listed as Planned Community, Specific Plan or Local Coastal Program area provide a more detailed context of those areas particular development potential and policies. Table 4-17 lists community plans adopted by the County (Orange County Public Works n.d.). While there have been multiple development cycles since the adoption of many of these plans, future development patterns are still influenced by both existing and prior land use policies.

**Table 4-17. Orange County Community Plans**

| Community Plan Name (Adoption Year) | Planned Community | Specific Plan | Local Coastal Program |
|---|---|---|---|
| Coto de Caza (1995) | | X | |
| Cowan Ranch (1985) | X | | |
| Emerald Bay (1989) | | | X |
| Esperanza Hills (2018) | | X | |
| Foothill/Trabuco (1991, amended 2002 and 2012) | | X | |
| Ladera (1995, amended 2003) | X | | |
| Las Flores (1990) | X | | |
| The Ranch Plan (2004, amended 2006) | X | | |
| Newport Coast (1996) | | | X |
| North Tustin (1986, amended 2018) | | X | |
| Santa Ana Heights (1986, last amended 2001) | | X | |
| Silverado-Modjeska (1977) | | X | |
| Sunset Beach (1990) | | X | X |

Source: (Orange County Public Works n.d.)

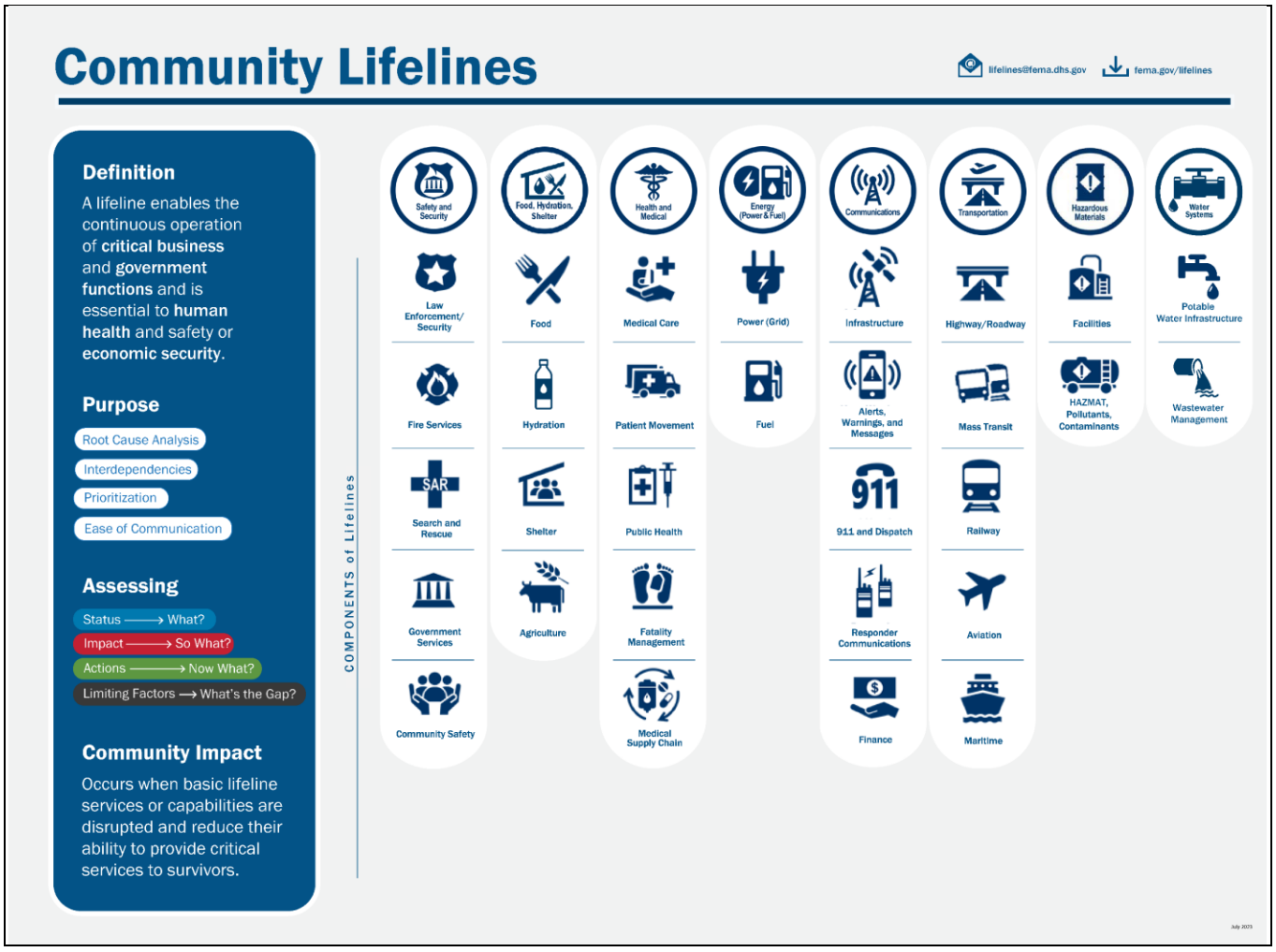
## 4.6 CRITICAL FACILITIES

Critical Facilities are community assets that are essential to the health and welfare of the population and that maintain essential, and emergency functions. These facilities typically will include police and fire stations, schools, emergency operations centers, and infrastructure assets such as roads, bridges and utilities that provide water, electricity, and communications.

Facilities that use or store hazardous materials are classified by the Environmental Protection Agency (EPA) as having the potential for toxic release and are included by the EPA on their Toxic Release Inventory (TRI) list. These TRI facilities are amongst those critical facilities identified in this FMP. All of these critical facilities are critical after any hazard event (FEMA 1997).

FEMA defines certain types of critical facilities, as well as public services or activities, as "community lifelines." Community lifelines provide the fundamental services in a community that, when stabilized, enables all other aspects of society to function accordingly. Following a disaster, intervention is required to stabilize community lifelines. As such, FEMA defines eight categories of community lifelines and is summarized in Figure 4-15.

**Figure 4-15. FEMA Community Lifelines Overview**




(FEMA 2023)

A comprehensive inventory of critical facilities in Orange County was developed from various sources, including input from the Steering Committee. Table 4-18 summarizes the number of critical facilities across the entire FMP area categorized by FEMA community lifeline. The critical facilities listed are based on the best data available at the time of FMP publication. This information is subject to change as new information about critical facilities becomes available during the performance period for this plan. General locations of critical facilities in the planning area are shown on Figure 4-16 through Figure 4-21.

**Table 4-18. Planning Area Critical Facilities**

| Community Lifeline Category | Community Lifeline Critical Facility Types | Planning Area Count |
|---|---|---|
| **Communications** | Paging Transmission Towers, Cellular Towers | 7 |
| **Energy** | Electrical Power Plants, Electrical Substations, Petroleum Storage Terminal | 20 |
| **Hazardous Materials** | Landfills, Toxic Release Inventory (TRI) Facility | 195 |
| **Health and Medical** | Hospitals, Medical Centers, Assisted Living Facilities, Nursing Homes, EMS Services, Ambulatory Services | 85 |
| **Safety and Security** | Police Stations, Fire Stations, Flood Monitoring Stations, Dams, Jails, Public Works Facilities, Administrative Services, County Facilities, County Parks, Educational Facilities | 428 |
| **Transportation** | Bridges, Rail Stations, Airports | 372 |
| **Other Critical Facilities** | Libraries, Zoo | 17 |
| **TOTAL** | | **1,124** |

Figure 4-16. FEMA Communication Lifelines in Orange County



**Figure 4-17. FEMA Energy Lifelines in Orange County**

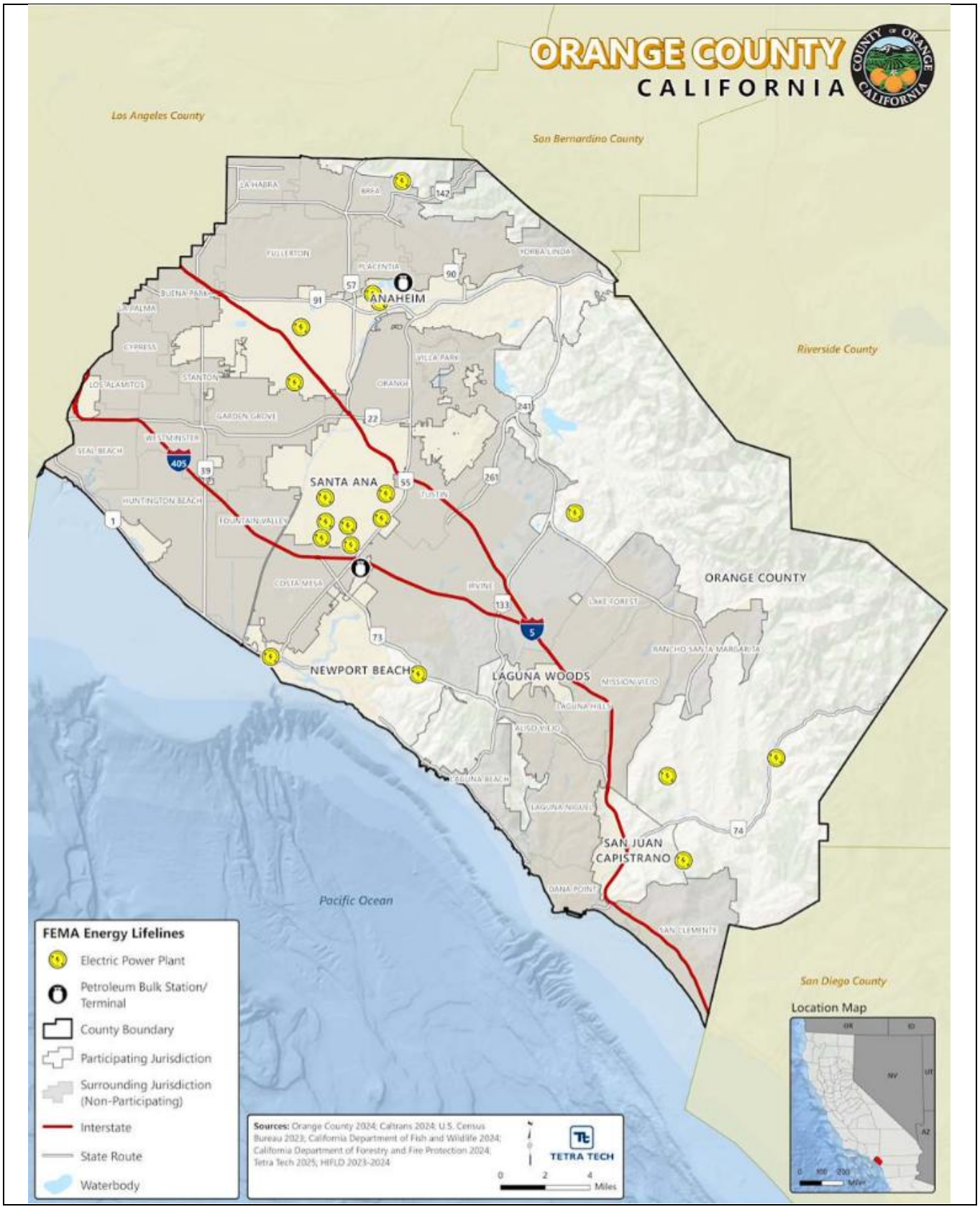


Figure 4-18. FEMA Hazardous Material Lifelines in Orange County

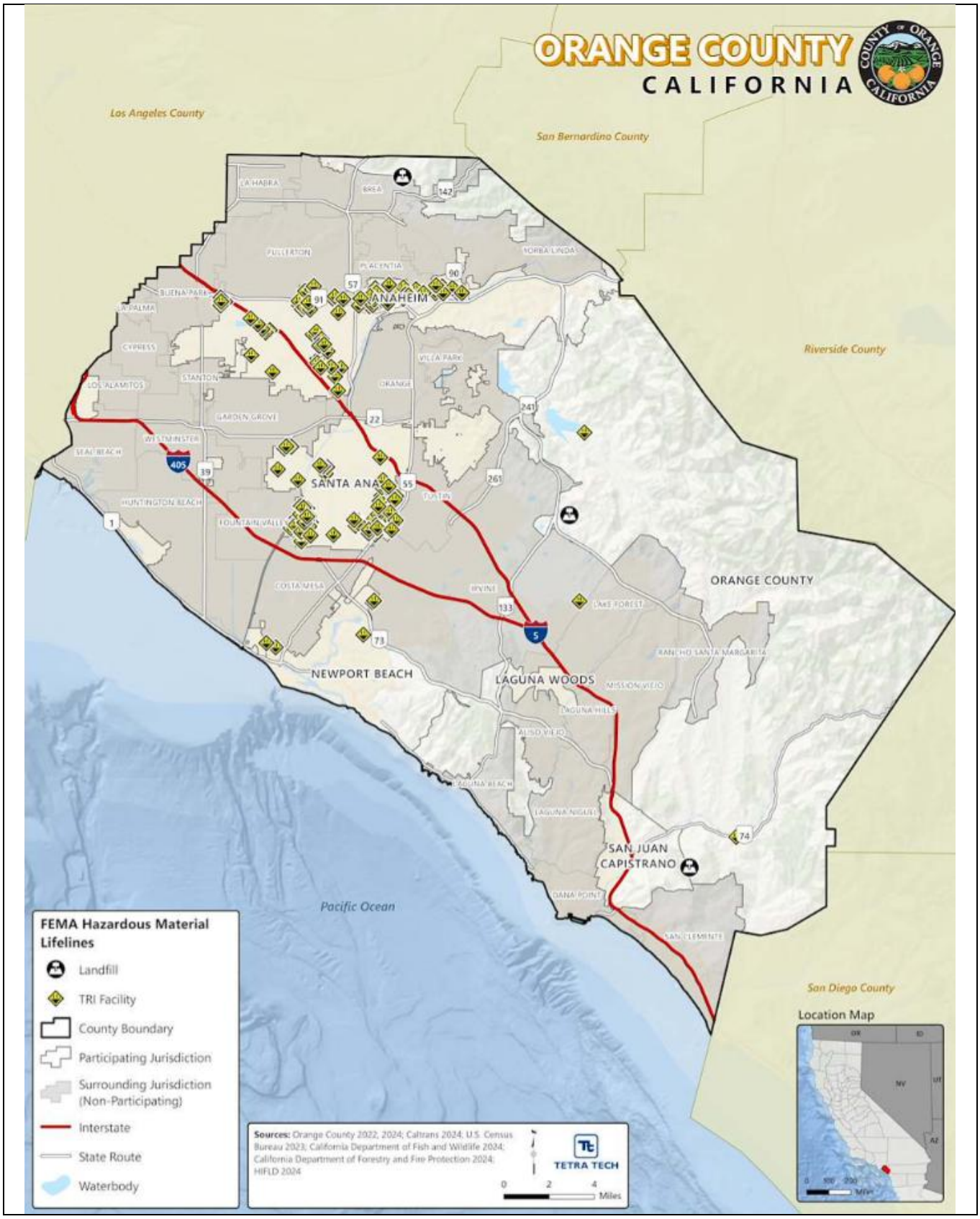


**Figure 4-19. FEMA Health and Medical Lifelines in Orange County**

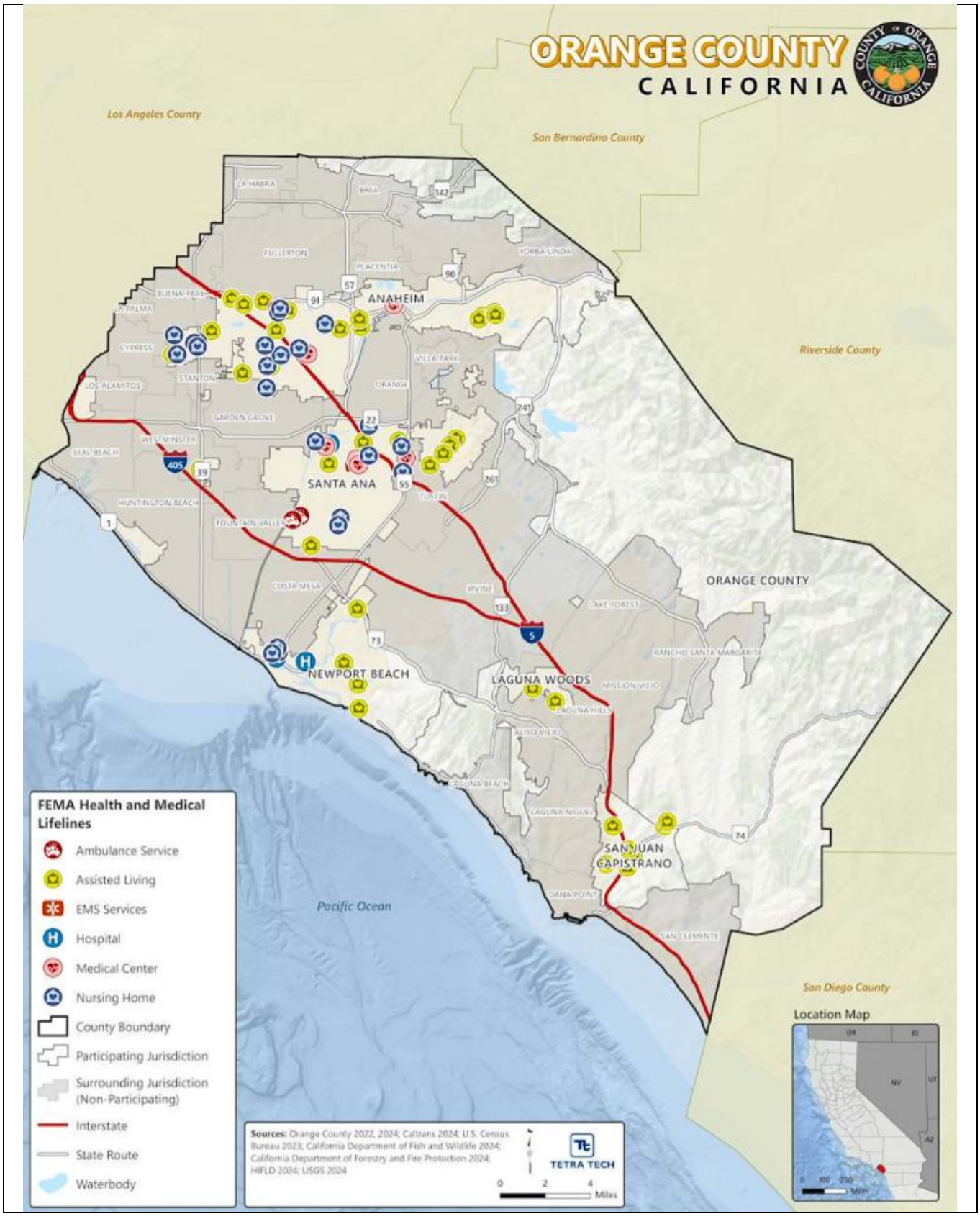


**Figure 4-20. FEMA Safety and Security Lifelines in Orange County**

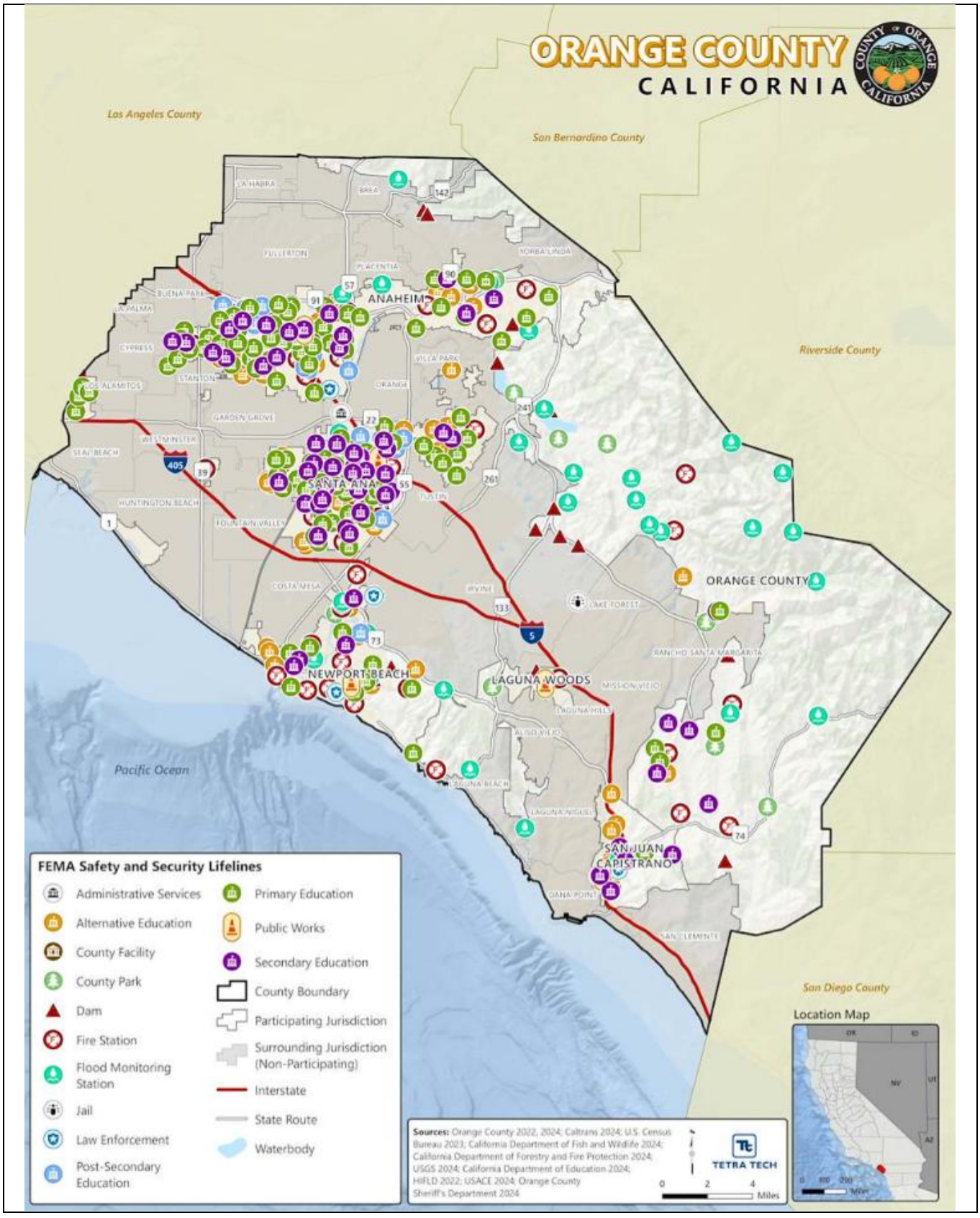
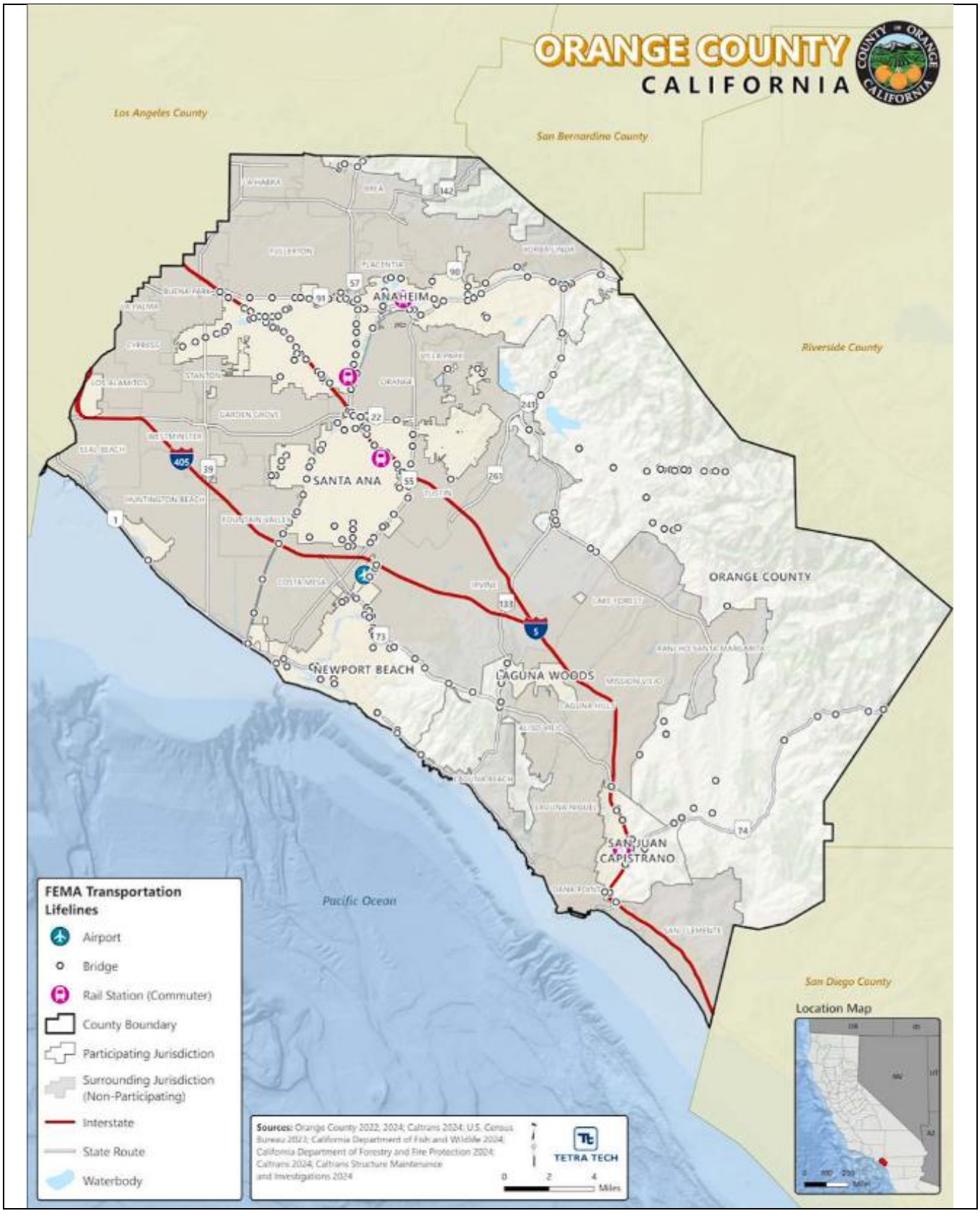


**Figure 4-21. FEMA Transportation Lifelines in Orange County**



# 5. RISK ASSESSMENT

A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water. Flooding is a natural hazard that can occur during any season. Floods can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines, multiple counties, or states) (FEMA 2007). Floods can be very costly in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of major water sources.

Flooding in Orange County can be the result of heavy rainfall that can overwhelm drainage systems, cause rivers to overflow, and high tides and storm surges which cause coastal areas to flood (FEMA FIS 2020). This chapter provides a risk and vulnerability assessment for flood hazards, describing hazard location, severity, and frequency, warning time and evacuation, the exposure of community assets to the various types of floodings, and the potential impacts of flooding on those assets. For the purpose of this FMP and as deemed appropriate by the Orange County Steering Committee, the main flood types of flood assessed are riverine, coastal, dam failure, tsunami, and sea level rise.

## 5.1 DATA AND METHODOLOGY

The risk assessment was conducted using the following organizational structure;

- Identify Flood Hazard Types—Use all available information to determine the type of flood hazards may pose a risk to the planning area
- Profile Each Hazard—Understand each hazard in terms of:
  - Location—Geographic area most likely to be affected by the hazard
  - Severity—Intensity range for the hazard
  - Frequency—Previous occurrence and losses
  - Warning Time—Speed of onset
  - Secondary Hazards—Hazard events triggered by the primary event.
- Assess Vulnerability—Use all available information to estimate to what extent populations and assets may be adversely affected by a hazard:
  - Determine exposure to the hazard—Estimate the total number of assets in the jurisdiction that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
  - Estimate potential impacts—Assess the impact of hazard events on the vulnerable populations, building stock, economy, and lands of the region, including cost estimates of potential damage or costs that can be avoided by mitigation actions.
  - Evaluate future changes that may affect vulnerability and impacts—Analyze how demographic changes, projected development, and climate change impacts can alter current vulnerability and potential impacts.

A vulnerability assessment is the process of evaluating those assets and/or population groups the jurisdiction wants to mitigate from flood risk. These assets collectively amount to a community's overall risk-of-loss potential—entailing loss of life, personal injury, damage to infrastructure, building damage, and overall impact to land area in general that could result from exposure to flood hazards. By capturing a risk-of-loss, the Core Planning Team and Steering Committee can assess community vulnerability in a targeted, yet comprehensive

manner. The vulnerability assessment informs those specific mitigation actions a community chooses to undertake, which in turn are aimed at reducing the given areas flood vulnerability. Moreover, reducing flood hazard vulnerability assists emergency management personnel in establishing early response priorities that are specific to the flood risk and to the vulnerable assets and/or populations groups.

The vulnerability assessment results are to be utilized in subsequent floodplain management planning processes, including determining and prioritizing mitigation actions that reduce each jurisdiction's vulnerability to each hazard. Past, present, and future conditions must be evaluated to accurately assess the vulnerability to the County and participating jurisdictions.

The Orange County risk assessment for this FMP was conducted using the following best-available information:

- A custom-built building stock inventory was developed using 2021 building footprints proved by Orange County; 2022 U.S. Army Corps of Engineers, National Structure Inventory; and 2024 RS Means cost adjustment values.
- 2020 Decennial Census Population data and 2019 – 2023 American Community Survey 5-Year Population Estimates were utilized.
- Critical facilities were updated and reviewed by Orange County and the participating jurisdictions.
- Community lifelines were identified in the critical facility inventory to align with FEMA's definition.
- FEMA's GIS-based Hazus software was used to estimate potential impacts from the flood hazards.

## 5.1.1 Asset Inventories

Orange County and participating jurisdictions had their various assets identified in order to assess potential vulnerabilities associated with the flooding hazards of concern. FMP participating jurisdictions then examined the following assets and their sub-types: population and specific population groups, buildings and certain occupancy classifications, critical facilities including those designated as community lifelines, and overall land area. Noteworthy to mention, certain assets may be more vulnerable to flood hazards because of their physical characteristics or, in the case of population groups, specific socio-economic conditions. Each asset type is described below. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

### Vulnerable Population

Research has shown that within a larger population, certain socio-demographic groups can be more vulnerable to the negative outcomes associated with flood hazards than others. Populations of concern include those who are more dependent upon others for their care or wellbeing, particularly children under the age of five years, or those who are over the age of 65 years. Furthermore, sub-populations of concern are those who may have underlying disabilities, those who may lack the financial resources to react and/or recover from a flood event, or those persons who may have language barriers—non-English speaking persons for instance. For this FMP, operational definition for populations considered vulnerable entail (1) Persons aged 65 and over, (2) Persons under the age of 5; (3) Persons who are non-English speaking; (4) Persons who have an identified disability; and (5) Persons living below the poverty line. Table 5-1 summarizes USCB American Community Survey (ACS) data for each of the socio-demographic groups considered vulnerable within the context of this FMP.

**Table 5-1. Vulnerable Populations—USCB ACS 5-Year Population Estimates (2023)**

| Jurisdiction | Vulnerable Population Groups: American Community Survey (ACS) 5-Year Population Estimates (2023) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Population Over 65 | | Population Under 5 | | Non-English Speaking Population | | Population with Disability | | Population Below Poverty Line | |
| | Total | % of Jurisdiction Total | Total | % of Jurisdiction Total | Total | % of Jurisdiction Total | Total | % of Jurisdiction Total | Total | % of Jurisdiction Total |
| **Anaheim** | 43,582 | 12.6% | 20,133 | 5.8% | 31,488 | 9.1% | 33,991 | 9.9% | 42,477 | 12.3% |
| **Laguna Woods** | 14,393 | 83.0% | 0 | 0.0% | 3,938 | 22.7% | 5,125 | 29.6% | 1,954 | 11.3% |
| **Newport Beach** | 19,711 | 23.4% | 2,986 | 3.5% | 2,129 | 2.5% | 6,962 | 8.3% | 6,134 | 7.3% |
| **San Juan Capistrano** | 7,124 | 20.4% | 1,592 | 4.5% | 554 | 1.6% | 3,572 | 10.2% | 2,530 | 7.2% |
| **Santa Ana** | 34,612 | 11.1% | 17,114 | 5.5% | 29,038 | 9.3% | 26,434 | 8.5% | 34,155 | 11.0% |
| **Unincorporated County** | 20,221 | 15.4% | 7,265 | 5.5% | 6,873 | 5.2% | 10,421 | 8.0% | 7,972 | 6.1% |
| **Total** | **139,643** | **15.1%** | **49,090** | **5.3%** | **74,020** | **8.0%** | **86,505** | **9.4%** | **95,222** | **10.3%** |

Source: U.S. Census Bureau, 2023 American Community Survey
Note: 2.9 persons per household. This number was used to calculate the Non-English-Speaking populations

The vulnerable populations included throughout this FMP encompass California Government Code § 8593.3 (Access and Functional Needs (AFN)) populations, defined as those who may require additional assistance before, during, and after emergencies due to a variety of factors. For the sake of this FMP planning purposes, vulnerable populations are referring to AFN populations within the planning area.

In the unincorporated portions of Orange County, people over the age of 65 contribute the largest percentage of vulnerable people relative to the other participant jurisdictions, at approximately 15.4 percent. However, this percentage is far lower than the 83 percent shown by this statistic in the City of Laguna Woods. For populations under the age of 5, these percentages relative to all of the FMP jurisdictions are similar, ranging between 0 percent (City of Laguna Woods) to 5.8 percent (City of Anaheim). Non-English Speaking population percentages are relatively highest in the City of Laguna Woods (22.7 percent) with the next highest percentages in the Cities of Santa Ana (9.3 percent) and Anaheim (9.1 percent). People with disabilities as a percentage of the FMP communities are pointedly higher in Laguna Woods (29.6 percent), however, are greater than 8 percent of the total across all of the communities listed. Varying somewhat more across the FMP communities, populations below poverty line range between 6.1 percent in the unincorporated County to over 12 percent in the City of Anaheim.

Identifying vulnerable populations will allow the County to target preparedness, response, and mitigation actions. Vulnerable populations tend to be disproportionately affected by flooding hazards, as these populations have unique needs for public officials to consider and to help ensure adequate safety measures are taken to reduce their vulnerability to the greatest extent practical.

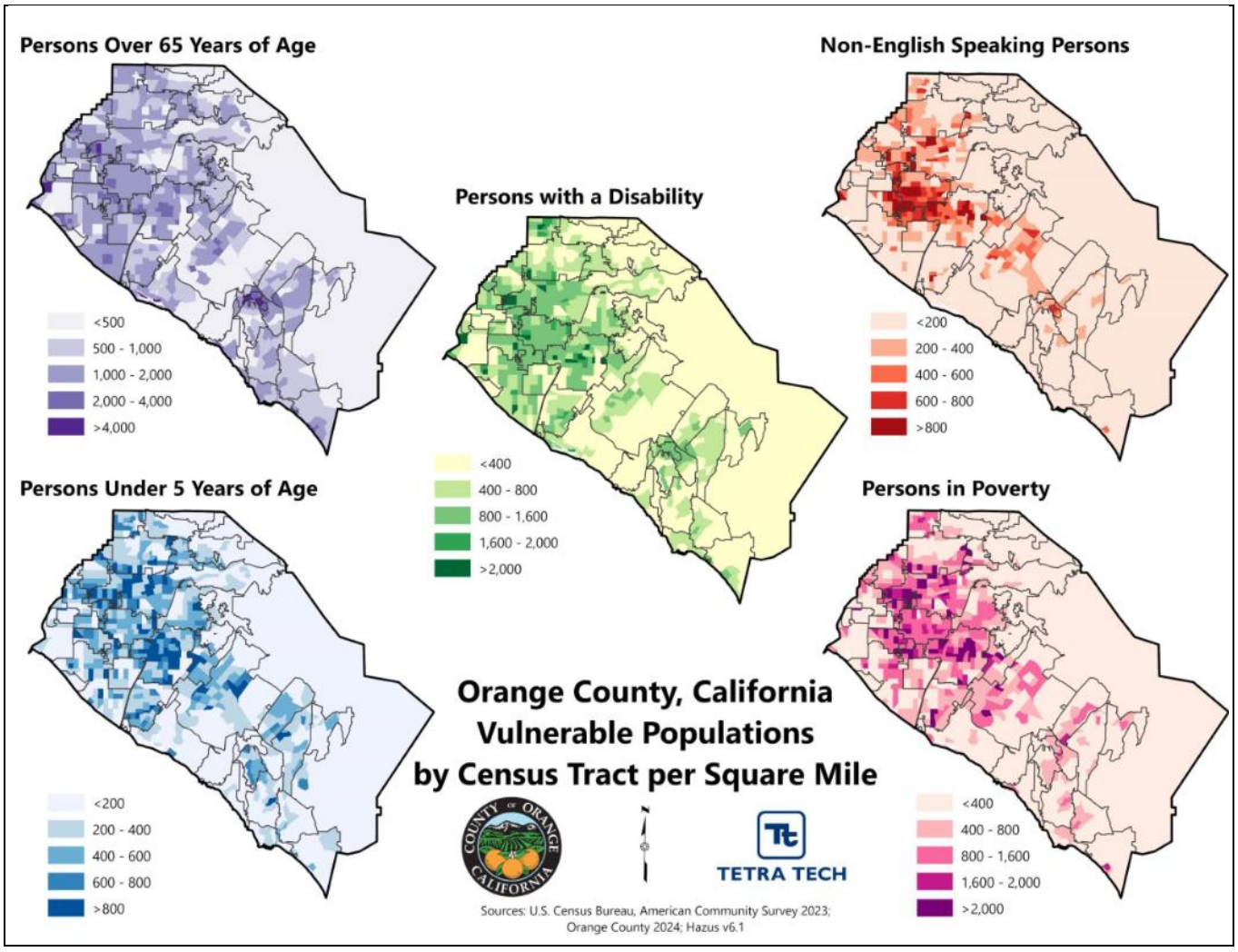
With advances in communication and planning technologies, it is possible to show where the concentration of defined vulnerable population groups, which assist local officials in strategic placing resources where they are needed most placement of resources in those areas that would become threatened by specific flooding events. As shown in Figure 5-1, vulnerable population variables were mapped at the Census Tract geography. This is due to Tract level geography is the smallest spatial unit available from the USCB to show the spatial distribution of the socio-demographic statistics defined as being vulnerable. All of the variables were then normalized based on the size of each census tracts total area, resulting in a density map for each vulnerability statistic. Emergency operations units and response planners should examine the data shown here in further detail to ascertain which specific areas under their response purview are at highest risk of being negatively impacted by flood hazard events.

Vulnerable populations in Orange County and the participating jurisdictions included in the risk assessment are children under the age of five years, persons over the age of 65 years, population below the poverty level, non-English speaking persons, and persons with a disability.

The risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard vulnerability and impacts.

Socio-demographic statistics from the 2020 Decennial Census Population estimates and the 2019 – 2023 American Community Survey (ACS) 5-Year estimate were used to measure the overall vulnerability of the County's population and to assess impacts. Population counts at the jurisdictional level were averaged against the residential structure counts in the Orange County to estimate the population at the structure level. This estimate provides a more precise distribution of population across the county compared to only using the Census block or Census tract boundaries. Limitations of these analyses are recognized, and thus the results are used only to provide general estimates for planning purposes.

**Figure 5-1. Orange County Vulnerable Populations by Census Tract per Square Mile**




*(U.S. Census Bureau n.d.)*

FEMA's Hazus program was used to model estimated potential losses to flood hazard, as discussed later in this section. Hazus contains the 2020 U.S. Census data and was used to estimate shelter needs and injuries as part of the analysis.

## General Building Stock

For this plan, custom-built general building stock was developed using 2021 building footprints provided by Orange County and 2022 National Structure Inventory point dataset sourced from the U.S. Army Corps of Engineers (USACE). Attributes provided in the associated files were used to further define each structure, such as year built, number of stories, basement type, occupancy class, and square footage. The centroid of each building footprint was used to estimate the building location. Structural and content replacement cost values (RCV) were assigned to each building using the available assessor data, the building footprint, and RS Means 2024 values.

A regional location factor for Orange County was applied (1.10 for residential structures located within a Long Beach or Santa Ana zip code; 1.09 for residential structures located in with a Riverside or Anaheim zip code). For

all other structure types that are not residential structures a different location factor was applied (1.09 for non-residential structures located within a Long Beach zip code; 1.08 for non-residential structures located with a Santa Ana zip code; and 1.10 for non-residential structures located within a Riverside or Anaheim Zip code). The location factors residential and non-residential occupancy classes, respectively, are shown in Table 5-2.

**Table 5-2. RCV Regional Location Factor**

| Zip Code | Residential | Non-Residential |
|---|---|---|
| **906-908 (Long Beach)** | 1.10 | 1.09 |
| **925 (Riverside)** | 1.09 | 1.10 |
| **926-927 (Santa Ana)** | 1.10 | 1.08 |
| **928 (Anaheim)** | 1.09 | 1.10 |

Source: RSMeans 2024

RCV is the current cost of returning an asset to its pre-damaged condition using present-day cost of labor and materials. Total RCV consists of both the structural cost to replace a building and the estimate value of contents of a building. The occupancy classes available in Hazus were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

## Critical Facilities

A lifeline provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security (FEMA).

A critical facility inventory, which includes community lifelines (a sub-set of critical facilities utility and transportation features), as well as user-defined critical facilities, was generated using a variety of sources. These sources include the California Department of Education (2024), The California Department of Transportation (2024), Homeland Infrastructure Foundation-Level Data (2022-2024), Orange County (2022), Orange County Sheriff's Department (2024). U.S. Geological Survey (2024), and U.S. Army Corps of Engineers (2024). Developing this inventory of critical facilities involved a review for accuracy, additional assets, removal or relocation of critical assets, identification of backup power for each asset (if known), and whether the critical facility is considered a community lifeline in accordance with FEMA's definition (refer to Chapter 4). To protect individual privacy and the security of assts, information is presented in aggregate, without detail about specific individual properties or facilities. After examination of data and source verification, 1,124 critical facilities classified by FEMA as community lifelines were identified within the planning area and made part of this FMP.

Exposure and impacts to these critical facilities from flood risk involve importing all critical facility points into a GIS and then overlaying each type of flood hazard area, generating a frequency count of all identified critical facilities by hazard type. Exposure analysis and impact analysis was performed on all identified critical facilities and is summarized within each flood hazard type section within this FMP.

## Land Area

Inherent to any communities' asset inventory is its overall of land area base. Expressed in acres, the risk assessment examines flood hazard exposure to land area for each FMP participating jurisdiction. For the purposes of this risk assessment, land cover data was not evaluated based on the types of flood hazard

exposure. Future studies may seek to enhance this portion of the loss-potential through evaluation of existing land cover data, such as that provided in this FMP's physical profile section.

## 5.1.2 Analysis Levels

The analysis for Orange County used standardized tools, combined with local, state, and federal data and expertise to assess potential vulnerability and losses associated with the flood hazards of concern. Three levels of analysis were used, depending on the data available for each hazard:

- Qualitative Analysis (Q)—This analysis includes an examination of historical impacts to understand potential impacts of future events of similar size. Potential impacts and losses are discussed qualitatively using best-available data and professional judgment.
- Exposure Analysis (E)—This analysis involves overlaying available spatial hazards layer, for hazards with defined extent and locations, on asset mapping in GIS to determine which assets are within the hazard area
- Hazus Analysis (H)—The FEMA Hazus model software was used to estimate potential losses or impact for the flooding hazards.

Table 5-3 summarizes the type of analysis conducted for the flooding hazards of concern.

**Table 5-3. Summary of Risk Assessment Analyses**

| Hazard | Population | General Building Stock | Critical Facilities |
|---|---|---|---|
| **Dam Failure** | Q, E | Q, E, H | E, H |
| **Flooding (Riverine)** | Q, E | Q, E, H | E, H |
| **Flooding (Coastal)** | Q, E | Q, E, H | E, H |
| **Sea Level Rise** | Q, E | E, H | E, H |
| **Tsunami** | Q, E | E, H | E, H |

Note: Q = Qualitative; E = Exposure; H = Hazus

## 5.1.3 Hazus

Hazus is a GIS-based software tool developed by FEMA that applies engineering and scientific risk calculations, which have been developed by hazard and information technology experts, to provide defensible damage and loss estimates from multiple hazard types. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

Hazus uses GIS technology to produce detailed maps and analytical reports that estimate the direct physical damage to a communities' building stock, critical facilities—inclusive of transportation and utility systems. To generate this information, Hazus uses default data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. The Hazus open data architecture can be used to manage community GIS data in a central location. The use of this

software also promotes consistency of data output now and in the future and standardization of data collection and storage.

In general, modeled losses were estimated in the Hazus program using what are known as depth grids for the flood analysis. Table 5-4 displays the levels that can be conducted using the Hazus software.

**Table 5-4. Summary of Hazus Analysis Levels**

| | |
|---|---|
| **Level 1** | Hazus provides hazard and inventory data with minimal outside data collection or mapping. |
| **Level 2** | Analysis involves augmenting the Hazus provided hazard and inventory data collection or mapping. |
| **Level 3** | Analysis involves adjusting the built-in loss estimation models used for the hazard loss analysis. This level is typically done in conjunction with the use of local data. |

Hazus estimates the amount of debris generated from a flood event in three categories: 1) finishes (dry wall, insulation, etc.); 2) structural (wood, brick, etc.) and 3) foundations (concrete slab and block, rebar, etc.). The distinction is made because of the different types of equipment needed to handle the debris. The Hazus Flood Model focuses on building-related debris and does not estimate debris generated for building contents such as household appliances (e.g., ovens or refrigerators), electronics and other personal items, or environmental (trees, shrubs, sediment etc.) debris.

## 5.1.4 Estimates for Exposed Population

To estimate the population exposed to the hazard areas, the floodplain boundaries were overlaid upon the U.S. 2020 Decennial Census population data in GIS. The 2020 Census tract data was referenced to assign average number of persons per household based upon the number of residential properties identified within that tract. Next, the analyst overlaid the hazard areas over the building stock to extract out the number of residential household building footprints that intersect the hazard area in each census tract. Then, the average person per household for each census tract was multiplied against the number of exposed residential building footprints to calculate the estimated population exposed.

## 5.1.5 Hazard Specific Methodologies

### Flooding—Riverine and Coastal

The 10-, 2-, 1-, and 0.2 percent annual chance flood event were examined to evaluate the county's risk from the flood hazard. These flood events are generally considered by planners and evaluated under federal programs such as the NFIP.

The following data were used to evaluate vulnerability and determine potential future losses for this FMP:

- The Orange County FEMA effective digital Flood Insurance Rate Map (FIRM) originally dated March 21, 2019, with the latest revision May 9, 2025.
- The 10-, 2-, 1-, and 0.2-percent annual chance flood depth grids generated using the 2019 Effective Flood Insurance Study (FIS) dated March 21, 2019, summary of discharges tables. The FIS flood discharged sources, and 1-meter Digital Elevation Model were combined with data from OCPW detailing the geometry of their flood control channels and combined in HEC-RAS 1-Dimensional hydraulic models to estimate flood extents and depths.

- The 10-, 2-, 1- and 0.2-percent annual chance flood depth grid available from the 1-Dimensional and 2-Dimensional HEC-RAS hydraulic modeling available from the USACE Westminster Watershed Study.
- The 10-, 2-, 1- and/or 0.2-percent annual chance flood depth grids available from other OCPW HEC-RAS modeling projects of specific water course such as the Santa Ana River, Aliso Creek, San Diego Creek, and Talbert Valley.

The resulting vector polygon data of the flooding extent was integrated into ESRI ArcGIS Pro for an exposure analysis and the resulting depth grids were integrated into the Hazus V6.1 riverine and coastal flood model for a loss analysis. The analysis used the Effective FIRM flood boundary, custom-built general building stock inventory, custom-built critical facility inventory, population data using the American Community Survey 5-Year Population Estimates (2019-2023), and the 2020 U.S. Census population data to estimate exposure and losses caused by the flood events. Assets (population, building stock, critical facilities) with their centroid in the floodplain were totaled to estimate the numbers and values exposed to a flooding event.

To estimate potential losses, a Level 2 Hazus riverine flood analysis was performed for the flood events. The Hazus model calculated the estimated potential losses to the population (shelter needs) using the 2020 U.S. Census population data and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default Hazus damage functions in the flood model.

## Tsunami

To assess the vulnerability of a tsunami event, including determining potential future losses, and other exposure-based impacts, a quantitative assessment was conducted. The quantitative impact utilized the 2022 Tsunami Hazard Area Map or Orange County, furnished by the California Geological Survey and California Governor's Office of Emergency Services 2022. Only a Tsunami Hazard area boundary is provided. Modeled depths are not available. A 2-foot depth was applied to the entire hazard area.

The resulting vector polygon of the tsunami hazard area was integrated into ESRI ArcGIS Pro for an exposure analysis and the resulting depth grids were integrated into the Hazus coastal flood model for a loss analysis. This analysis used the tsunami inundation boundary, custom-built general building stock inventory, custom-built critical facility inventory, population data using the American Community Survey 5-Year Population Estimates (2019 – 2023), and the 2020 U.S. Census population data to estimate exposure and losses caused by the tsunami event. Assets (population, building stock, critical facilities) with their centroid in the inundation area were totaled to estimate the numbers and values exposed to a tsunami event.

To estimate potential losses, a Level 2 Hazus coastal flood analysis was performed for the tsunami event. The custom-built building and critical facility inventories were incorporated into Hazus model. The Hazus modeling calculated the estimated potential losses damages to the general building stock and critical facility inventories based on the depth generated and the default Hazus damage functions in the flood model.

## Dam Failure

To assess the vulnerability of the county to dam failure events and its associated impacts, a quantitative assessment was conducted. The dam inundation areas were developed by either the USACE, or by Orange County Public Works (OCPW), using either 1-Dimensional or 2-Dimensional hydraulic analysis with appropriate dam breach modeling compared against empirical data and formulas used for dam failure. Each of the failure scenarios is based on a sunny day failure event with a full dam, which is standard practice and can be found in the dam inundation mapping hosted by the California Division of Safety of Dams (DSOD). The risk assessment considered vulnerability and impacts associated with 28 dams in Orange County owned by the USACE and

regulated by the DSOD. Analyses were performed for the mapped inundation area of each dam individually, as well as for the aggregate inundation area for all 28 dams.

The resulting vector polygon of the dam inundation flooding extent was integrated into ESRI ArcGIS Pro for an exposure analysis and resulting depth grids were integrated into the Hazus v6.1 riverine flood model was used for the loss analysis. This analysis used the dam inundation boundary, custom-built general building stock inventory, custom-built critical facility inventory, population data using the American Community Survey 5-Year Population Estimates (2019 – 2023), and the 2020 U.S. Census population data to estimate exposure and losses caused by the dam failure events. Assets (population, building stock, critical facilities) with their centroid in the inundation area were totaled to estimate the numbers and values exposed to the dam failure event.

To estimate potential losses, a Level 2 Hazus v6.1 riverine flood analysis was performed for the dam failure events. The custom-built building and critical facility inventories were incorporated into the Hazus model. The Hazus model calculated the estimated potential losses to the population (shelter needs) using the 2020 U.S. Census population data and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default Hazus damage functions in the flood model.

## Sea Level Rise

To assess the vulnerability of the County and FMP participating jurisdictions to a sea-level rise event, a rational basis is needed for selecting a specific sea-level rise value. To this end, the *State of California Sea-Level Rise Guidance* was utilized, which contains detailed sea-level rise heights and risk scenarios. From the sea-level rise guidance, the FMP selected the NOAA Los Angeles gage and then selected chose a 70-year time horizon, which gives a sea-level rise target date of 2090. In terms of probabilistic projections, the FMP chose a low-risk aversion due to the extent of coastal housing but also given the lifespan of existing pump stations and coastal defense infrastructure with target replacement times of 20-100 years (pumps replace every 20-30, sea walls, etc. ~100-years). The projected Sea Level Rise target according to the sea-level guidance, using NOAA's Los Angeles gage at this level of risk acceptance, yields an approximately 2.7-feet of sea-level rise. Based on the availability of depth grids from the USGS Coastal Storm Modeling System (COSMOS), the closest grid to 2.7 feet is the USGS 75 centimeters (cm) depth grid. The 75 cm depth equates to approximately 2.5-feet, which is ultimately the sea-level rise height scenario chosen to run analysis against.

The following data were used to evaluate vulnerability and determine potential future losses for this plan update:

- California Natural Resources Agency and California Ocean Protection Council 2018 Sea Level Rise Guidance coupled with the USGS COSMOS 2024.
- The Sea Level Rise depth grid was generated by COSMOS from NOAA coastal LiDAR data with a spatial resolution of 2-meter.

The resulting vector polygon data of the estimate sea level rise inundation area was integrated into ESRI ArcGIS Pro for an exposure analysis and the resulting depth grids were integrated into the Hazus v6.1 coastal flood model for a loss analysis. This analysis used the ~2.5-foot sea level rise inundation boundary, custom-built general building stock inventory, custom-built critical facility inventory, population data using the American Community Survey 5-Year Population Estimates (2019 – 2023), and the 2020 U.S. population data to estimate exposure and losses caused by the sea level rise event. Assets (population, building stock, critical facilities, and land area) were totaled to estimate the frequency count and values for each asset that were exposed to the selected sea level rise event. To estimate potential losses, a Level 2 Hazus v6.1 coastal flood analysis was performed for the sea level rise event. The custom-built building stock inventory and the critical facility inventories were incorporated into the Hazus model. The Hazus model calculated the estimated potential losses to the population (shelter needs) using the 2020 U.S. Census population data, potential damages to the general building

stock as well as damages to critical facility inventories were based on the depth grids generated by the default Hazus damage functions in its flood model.

## 5.1.6 All Data Source Summary

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

**Table 5-5. Risk Assessment Data Documentation**

| Data | Source | Data | Format |
|---|---|---|---|
| **Population Data** | U.S. Census Bureau; American Community Survey 5-Year Estimates | 2020;2019-2023 | Comma-Separated Value (CSV) format |
| **Building Inventory** | U.S. Army Corps of Engineers; Orange County; RS Means | 2022; 2021; 2024 | Digital (GIS) format |
| **Land Cover** | National Land Cover Database, Multi-Resolution Land Characteristics | 2023 | Digital (GIS) format |
| **Critical Facilities and Lifelines** | California Department of Education; California Department of Transportation; Homeland Infrastructure Foundation-Level Data; Orange County; Orange County Sheriff's Department; U.S. Geological Survey; U.S. Army Corps of Engineers | 2024; 2024; 2022-2024;2022; 2024; 2024; 2024 | Digital (GIS) format |
| **Digitized Effective FIRM** | FEMA | 2019 | Digital (GIS) format |
| **1-Meter Digital Elevation Model** | Orange County Public Works (based on USGS and NOAA coastal LiDAR surveys) | 2011-2012 | TIFF |
| **Dam Failure Hazard Area** | State of California—Department of Water Resources, Division of Safety of Dams; U.S. Army Corps of Engineers | 2024; 2024 | Digital (GIS) format |
| **Sea Level Rise Hazard Area** | State of California, Natural Resources Agency and Ocean Protection Council; U.S. Geological Survey; Coastal Storm Modeling System | 2018; 2024 | Digital (GIS) format |
| **Tsunami Hazard Area** | California Geological Survey and California Governor's Office of Emergency Services | 2022 | Digital (GIS) format |

## 5.1.7 Limitations

Loss estimates, vulnerabilities analyses, and hazard-specific impact evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

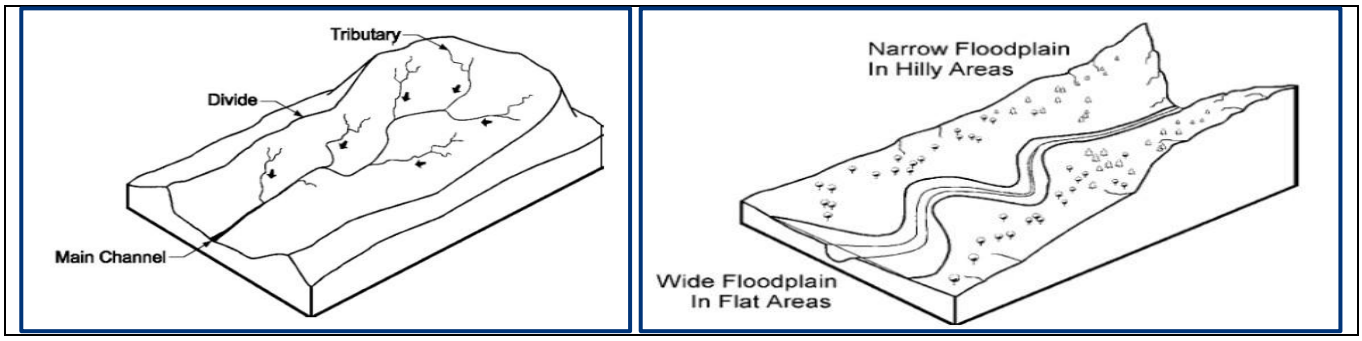
- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already enacted by the participating jurisdictions
- The amount of advance notice residents have to prepare for a specific hazard event
- Uncertainty of climate change projections

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. These results should be used only to understand relative risk. Over the long term, Orange County will collect additional data, updating and refining existing asset inventories to increase the accuracy of estimated potential losses.

## 5.2 RIVERINE FLOODING

Generally speaking, a riverine flood occurs when the main channel of a watercourse fills up with water, overflows (aka overtopping) its banks, and begins to spread into the adjacent floodplain. Channels are defined as natural surface features that carry water through and ultimately out of a given watershed. Figure 5-2 shows the two primary types of riverine floodplains and their associated watersheds.

**Figure 5-2. Riverine Floodplain and Watershed—Examples**




*Source: FEMA Floodplain Mngt.—Unit 1 Floods and Flood Management n.d.*

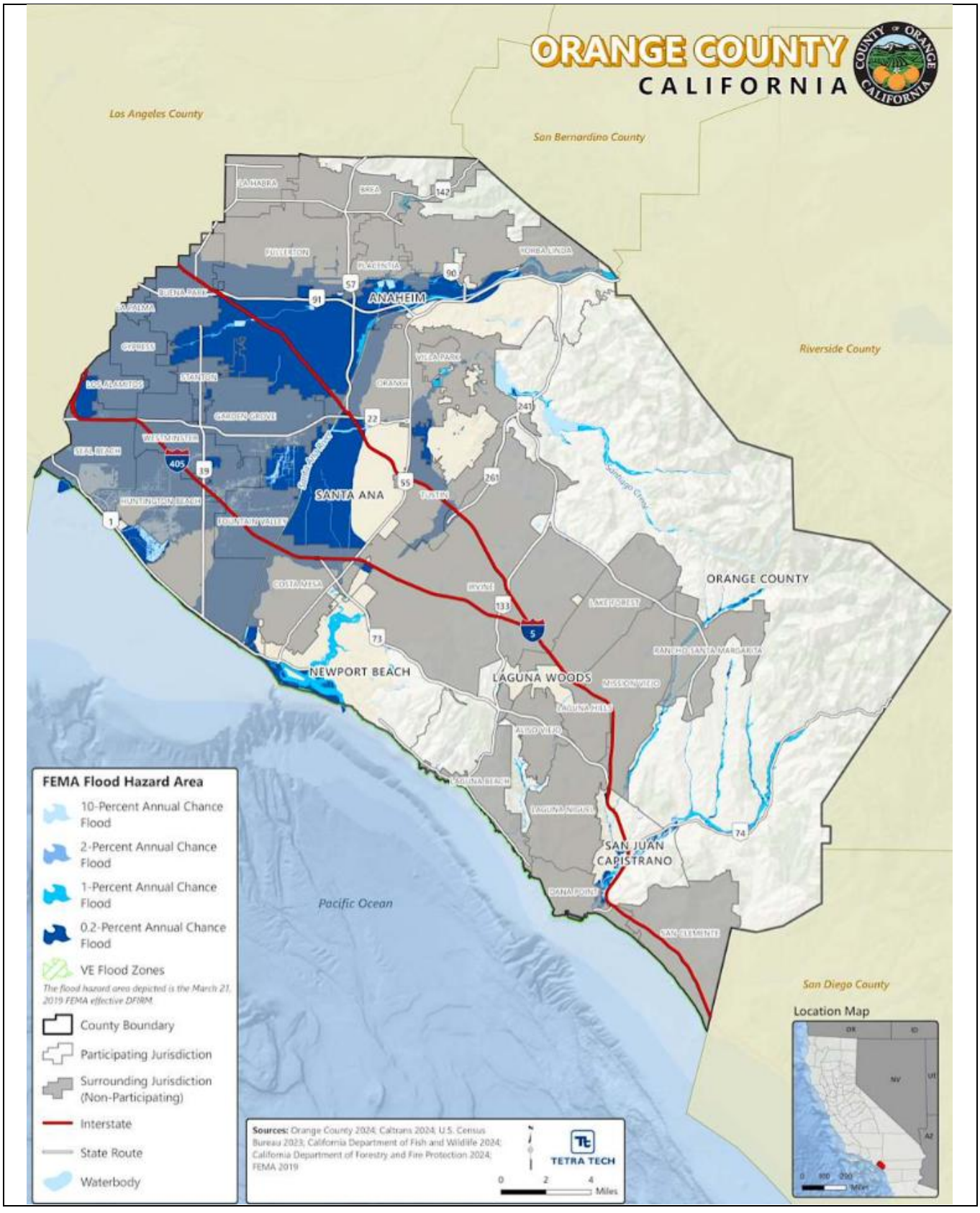
Riverine flooding is typically distinguished from flash flooding in that the channel gradually fills up with water, whereas a flash flood occurs much more quickly with the water rising out of the channel in dramatic fashion and in most cases, outside of a normal watercourse. This is especially true in areas with drier climates and rocky soil where excessive runoff from rain events transforms otherwise dry swales and drainage ditches into dangerous torrents of high-velocity water flows.

Channels go by a variety of names depending on where you are and the localized context you are in. The most common natural channel names are rivers, creeks, streams, and ditches. The frequency, intensity, and duration of riverine flooding is determined primarily by the extent of the watershed, how many tributaries feed the watershed, the degree of slope, surface type, and underlying soil conditions. A wide, gradually sloping watershed with sufficient vegetation and permeable soils will experience riverine flooding less often, and with less intensity than a watershed that is narrow, steep and consists of bare land and rocky soil. (FEMA 2006).

### 5.2.1 Location

Although flooding can occur anywhere in Orange County, certain locations are more vulnerable or more likely to experience flooding than others. The Santa Ana River is the most frequent source of flooding in Orange County. The AB/HH Watershed (see Section 4.2.2) is the most high-risk area of the County for flooding and is one of the largest remaining floodplains in the area. Figure 5-3 illustrates the FEMA Flood Hazard area in Orange County and outlines the AB/HH Watershed, along with the floodplains of the 10-percent, 1-percent, 2-percent, and 0.2-percent annual chance flood events. According to the County's Flood Insurance Study (FIS) report, multiple waterways have a history of flooding, with the earliest recorded events occurring within the Santa Ana River and Santiago Creek (1862 and 1884, respectively).

**Figure 5-3. FEMA Flood Hazard Area in Orange County**

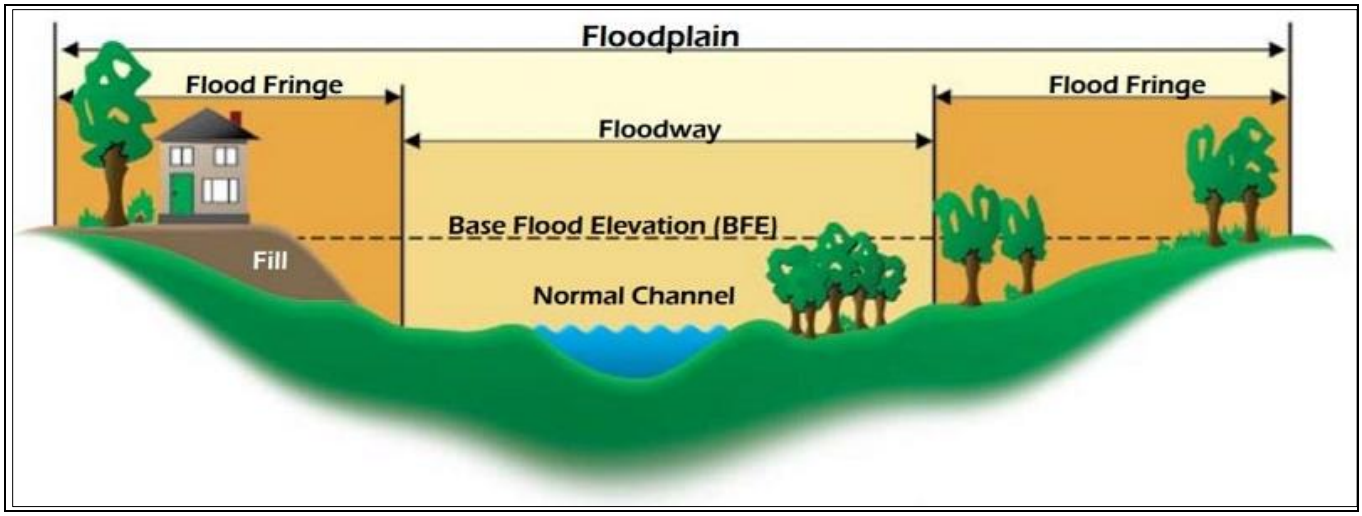


## Floodplains

A floodplain is defined as the land adjoining the channel of a river, stream, ocean, lake, or other body of water that becomes inundated with water during a flood (refer to Figure 5-4) (NWS n.d.). The floodplain describes the area inundated by the "100-year" flood, or a flood that has a 1-percent chance in any given year of being equaled or exceeded. A floodplain is designated when floodwater exceeds the capacity of the main channel, or water escapes the channel through bank erosion. A floodplain is made up of different sections (FEMA 2019, US DHS 2019):

- **Flood Fringe:** the area within the floodplain but outside the floodway; this area extends from the outer banks of a floodway to the river valley, where the elevation begins to rise.
- **Floodway:** the channel of a river or other waterway and the adjacent land areas that are under water or reserved to carry and discharge the overflow of water caused by flooding.

**Figure 5-4. Characteristics of a Floodplain**




*Source: FEMA 2022*

In Orange County, floodplains line the rivers, streams, lakes, and coastlines of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques (USGS 2016).

Floodplain mapping is based on riverine and coastal flooding conditions. Urban and stormwater flooding is not reflected in floodplain mapping. Future flooding conditions (from factors such as sea level rise and changes in rainfall) are not included in FEMA's development of floodplain mapping. As such, floodplain maps may underestimate flood risk in many areas in the region. As a result, the public may also underestimate risk (First Street Foundation 2019).

## Special Flood Hazard Area (SFHA)

FEMA defines a Special Flood Hazard Area (SFHA) is defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled to or exceeded in any given year. The 1-percent annual chance flood is also referred to as the base flood or 100-year flood. A 100-year floodplain is not a flood that will occur once every 100 years; the designation indicates a flood that has a 1-percent chance of being equaled or exceeded each year.

Thus, the 100-year flood could occur more than once in a relatively short period of time. Similarly, the moderate flood hazard area (500-year floodplain) will not occur every 500 years but is an event with a 0.2-percent chance of being equaled or exceeded each year (FEMA 2020). The 1-percent annual chance floodplain establishes the area that has flood insurance and floodplain management requirements.

The SFHA is depicted on Flood Insurance Rate Maps (FIRMs) and are designated by flood zones A, AO, AE, AH, V, VE, and more (FEMA 2020). Property owners in SFHAs are required to purchase flood insurance if they have federally regulated/insured mortgages (FEMA 2020). Figure 5-3 illustrates the FEMA Flood Hazard area in Orange County and outlines the VE flood zones in green.

It should be noted that areas located outside of the SFHA can be subject to flooding and may even act as an unofficial floodplain. Flooding outside of the SFHA area may include stormwater/urban flooding and flash flooding.

## Flood Gages

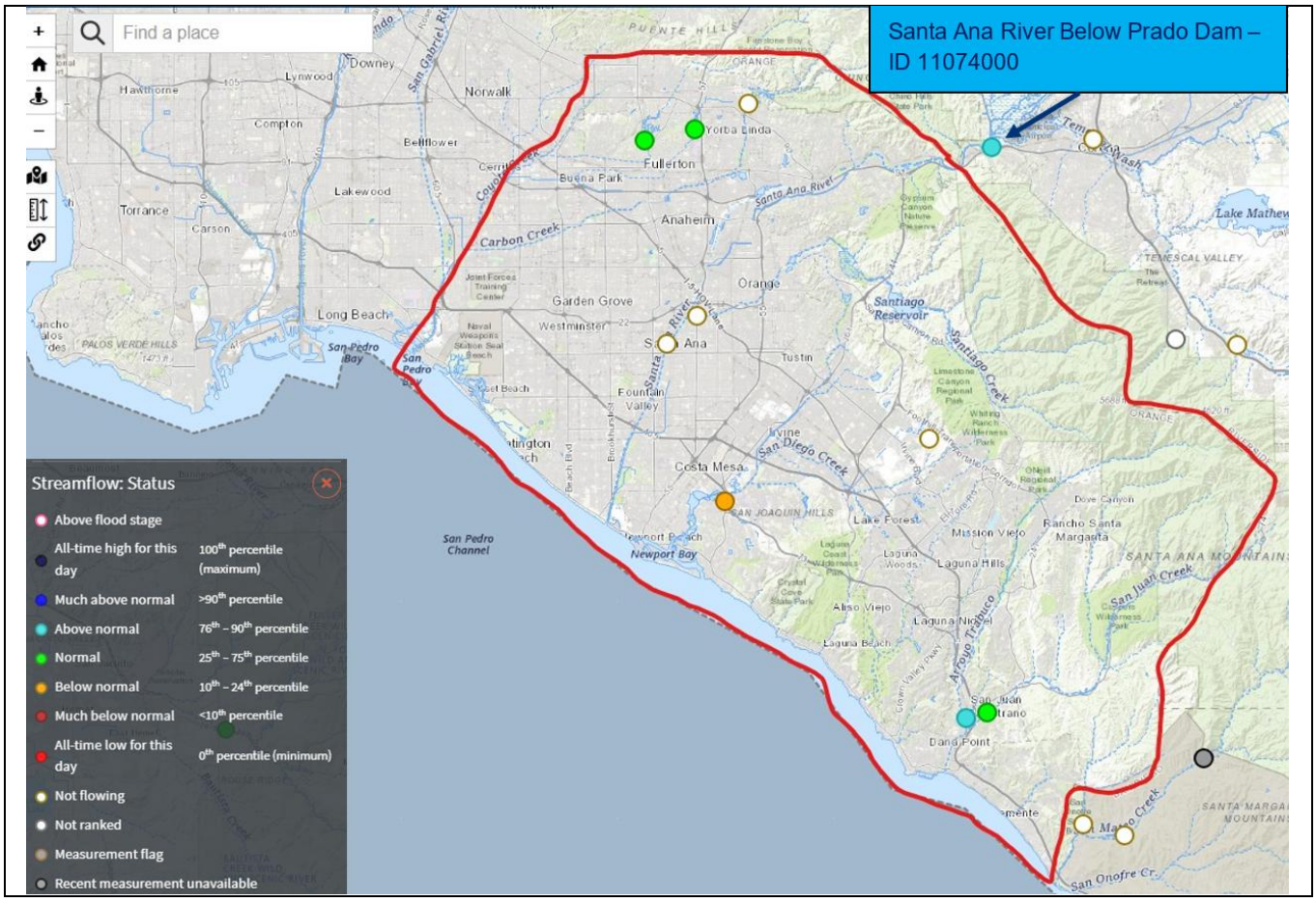
The USGS National Water Information System collects surface water data from more than 850,000 stations across the country. The time-series data describes stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data is collected by automatic recorders and manual field measurements at each gage location. The USGS uses stream gages to determine the severity of flood at different points along the body of water. There are 17 stream gages in the County. Table 5-6 shows the stream gages within Orange County and details about each gage. Locations are shown on Figure 5-5. The USGS website provides details about each of the gages and the gage heights of flooding events. The NWS Flood Tracking Charts provide current and historical flood stages for gages where established.

**Table 5-6. Stream Gages in Orange County**

| Gage Site Number | Site Name | Flood Stage Height in Feet | Record Flood Stage in feet (date occurred) |
|---|---|---|---|
| 11088500 | Brea Creek Below Brea Dam, near Fullerton | 1.19 | 7.63 (10/20/04) |
| 11089500 | Fullerton Creek Below Fullerton Dam, near Brea | 3.27 | 9.24 (02/06/10) |
| 11075720 | Carbon Creek Below Carbon Canyon Dam | 1.94 | 5.11 (03/01/83) |
| 11077500 | Santiago Creek at Santa Ana | 1.45 | 15.14 (10/20/04) |
| 11078000 | Santa Ana River at Santa Ana | 10.39 | 16.0 (01/30/81) |
| 11048600 | Bonita Creek at Irvine | 10.33 | 14.89 (10/27/04) |
| 11048175 | Agua Chinon Wash at Portola Springs Rd. near Irvine | 7.82 | 11.39 (12/06/18) |
| 11047300 | Arroyo Trabuco at San Juan Capistrano | 10.94 | 19.81 (02/23/98) |
| 11046530 | San Juna Creek at La Novia St. Bridge at San Juan Capistrano[a] | 11.56 | 22.50 (12/22/10) |
| 11074000 | Santa Ana River Below Prado Dam[b] | 3.24 | 8.83 (02/06/24) |

Source: USGS National Water Dashboard 2025; NWS n.d.
a. Not on USGS Water Dashboard Map—Sourced from USGS Water Watch Flood Tracking Chart—OCPW Gage
b. Site in Riverside Co.; included due to potentially high impact on Orange Co.

**Figure 5-5. Stream Gages in Orange County**




*Source: USGS National Water Dashboard 2025; NWS n.d.*

## 5.2.2 Severity

The nature of the built environment within Orange County dictates the degree and intensity of flooding, especially when one considers a large percentage of the watersheds are highly urbanized. While the initial trigger for many of the FIS recorded flood events are based on extreme rainfall within the parent watershed, ultimately, the full extent of the impacts is based on a combination of rainfall and stormwater infrastructure deficiencies. These deficiencies include river levee failures, limited storage and channel capacity, undersized culverts, excessive debris buildup within the channels, residential encroachment into channelization areas. (FEMA 2019). Based on the County FIS, approximately 50 percent of the flooding sources listed are within hardened, stormwater infrastructure such as channels and storm-drains, with 27 percent of the flooding sources from natural watercourses and the remaining 23 percent from dry canyons and washes (FEMA 2019). This underscores the scope of managing flooding in the County in that it comprises a significant amount of stormwater management at least as much as it is an exercise in managing a less urbanized, more naturalized riverine flooding environment.

The severity of riverine flooding is determined by a combination of several factors including stream and river basin topography and physiography; precipitation and weather patterns; recent soil moisture conditions; and degree of vegetative clearing and impervious surface. Generally, floods are long-term events that may last for several days. Severity depends not only on the amount of water that accumulates each time, but also on the land's ability to

manage this water. One element is the size of rivers and streams in an area; but an equally important factor is the land's absorbency. When it rains, the soil acts like a sponge. When the land is saturated or frozen, infiltration into the ground slows and any more water that accumulates must flow as runoff (Harris 2023). However, and as we see in a large percentage of flood sources tabulated by the County FIS, Orange County flood severity is significantly impacted by the limited ability for water to filter downward through the ground, and instead, tends to runoff, thereby increasing stormwater velocity.

In quantitative terms, the frequency and severity of riverine flooding can be measured in multiple ways. The method used by the Army Corps of Engineers and most technical studies is by using a discharge rate probability. That is, the probability that a certain river discharge rate (cubic feet per second) will be equaled or exceeded each year. For example, the County FIS lists flooding sources, locations, and importantly, the recurrence (percent annual chance) interval at three distinct discharge rates (FEMA 2019). Specifically, the discharge rates provided are at the 10 percent, 2 percent, 1 percent, and 0.2 percent annual change flood discharge rate. Notably from a flood insurance and management stance, the 1 percent and 0.2 percent discharge rates are equivalent to the 100 Year and 500 Year recurrence interval regulated under the NFIP and shown on the Flood Insurance Rate Maps (FIRMS). The 1 percent annual chance flood rate varies considerably depending on the flooding source, from a relatively low discharge rate of 25 cubic feet per second (Villa Park Storm Drain) up to 50,000 cubic feet per second along the Santa Ana River at Katella Avenue (City of Orange) and the Imperial Hwy (City of Anaheim).

From a public information and risk communication perspective, riverine flooding can be measured using a classification system of minor, moderate, or major. This method is utilized by the National Weather Service and is informed through coordination with the stream gauge reports generated by the United States Geologic Survey (USGS) and partnering federal and localized agencies. Minor river flooding indicates low-lying areas next to a watercourse in rural areas are subject to gradual inundation by rising flood waters. Moderate flooding signals that flood waters are elevated to the point where homes and businesses are at risk of being impacted. Moderate flooding is the classification used by the NWS to determine when targeted evacuation orders may need to be sent out, as collectors and arterial roadways could be impacted. Finally, when a flooding event is classified as Major, this indicates widespread flooding is imminent and will impact both rural and urban areas alike. During a Major flood classification, mandatory evacuations may be ordered as certain towns may be at risk of being isolated from first responders via flooding of access roads.

Each category has a definition based on property damage and public threat (NSSL n.d.).

- Minor flooding causes minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate flooding results in some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major flooding causes extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

Additionally, the severity of a flood depends not only on the amount of water that accumulates in a period of time, but also on the land's ability to manage this water. The infiltration rates of soil is a significant factor. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration rates decrease and any more water that accumulates must flow as runoff (Harris 2001). Orange County also has a moderate to high water table in certain areas which limits the rate of saturation (OCPW n.d.).

## 5.2.3 Frequency

Riverine flood frequency depends very much upon how the event is being measured. As we have seen in NFIP Flood Insurance Studies (FIS), using stream gauge station discharge rates is a precise measurement, but does not always guarantee an overtopping of a channels banks and/or flooding impact on area residents or associated infrastructure. An alternative means to assess the frequency of riverine flooding would be to examine how often the County, through the State of California, asks for Federal Disaster assistance. If granted, the Federal Government would then grant a formal Disaster Declaration, which opens federal funding assistance for public property and private property, as well as low interest loans for businesses recovery. While a less precise measure of riverine flooding frequency, it is not subject to the variability of hydrologic and hydraulic flows during flood events. To this end, Orange County has had nine Federal Disaster declarations for flood incidents between 1969 and 2021 (Orange County Sheriff's Department 2021). Additionally, there have been seven disaster declarations in Orange County where floods have been one of the secondary hazards. These associated events entail fire, severe storms, and coastal storms, which are categorized differently than flood in terms of the federal disaster declaration process.

Mentioned previously in regard location and extent, the frequency of riverine flooding is specific to its source along a natural watercourse. If one uses this categorization operationally to define the source of flooding, it becomes difficult to discern from historical records which flood event is sourced exclusively from a natural watercourse, which events were sourced from infrastructure limitations, and which events were a permutation of several sources. For practical purposes, floods can be multi-sourced, so capturing flood frequency statistics requires one to examine all sources together and define them collectively based on a set level of measure—i.e., disaster declaration, overtopping occurrence, etc.

For the reasons stated above, riverine flooding tends to be aggregated with various forms of channelized stormwater runoff from storm drains, canyons and washes.

### Recurrence Intervals

Some riverine flooding frequency is captured on the Flood Insurance Rate Maps (FIRMs). While not specific from location to location on the FIRMs, the areas depicted as having 1 percent recurrence interval are shown as Special Flood Hazard (SFHA), Zone A or AE, and those having a 0.2 percent recurrence interval are referred to as the 500-year flood. However, the FIRMs do not capture all areas along and adjacent to channelized stormwater infrastructure since these areas are assumed to be protected to or above the 1% and 0.2% flood events.

The 1 percent annual chance flood, which is the standard used by most federal and state agencies, is used by the NFIP for both floodplain management purposes and to determine flood insurance requirements. A structure located within the SFHA shown on a Flood Insurance Rate Map (FIRMs) typically has a 1% annual chance of flooding, also known as the 100-year floodplain. Over the course of a 30-year mortgage, the cumulative probability of experiencing at least one flood event is approximately 26%.

The extent of flooding associated with a 1-percent annual chance flood (the base flood or 100-year flood) is used as the regulatory boundary by many agencies. Also referred to as the SFHA, this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the water elevation resulting from a given discharge level, which is one of the most important factors used in estimating flood damage.

The term “500-year flood” is the flood that has a 0.2 percent chance of being equaled or exceeded each year. The 500-year flood could occur more than once in a relatively short period of time. Statistically, the 0.2 percent annual chance flood has a 6 percent chance of occurring during a 30-year period of time, the length of most federally backed mortgages. The 500-year floodplain is referred to as the “Shaded X Zone” on flood insurance rate maps (FIRMs). Base flood elevations (BFE) or depths are not shown within the Shaded X Zone and insurance purchase is not required for federally backed mortgages in this zone.

The 1-percent annual chance flood is not a flood that will occur once every 100 years. Rather, the 1-percent annual chance flood is statistically an event that has a 1-percent chance of being equaled or exceeded each year. Again, it is important to emphasize that the “100-year flood” can occur more than once in a one-hundred-year period. Further, the publication of FIRMs is to assist the National Flood Insurance Program (NFIP) in determining where to require federally backed mortgages to carry a flood insurance policy. Noteworthy to mention here is that the 1 percent annual chance flood areas shown on the FIRMs are an estimated aerial extent of where that flood would occur but is not an exact extent. Each flood event is unique in terms of its source, the amount, intensity, duration, and of course the characteristics of the drainage system or watershed the flood event falls into. Further, after every flooding event, incremental changes are made to the actual watercourse and associated floodplain.

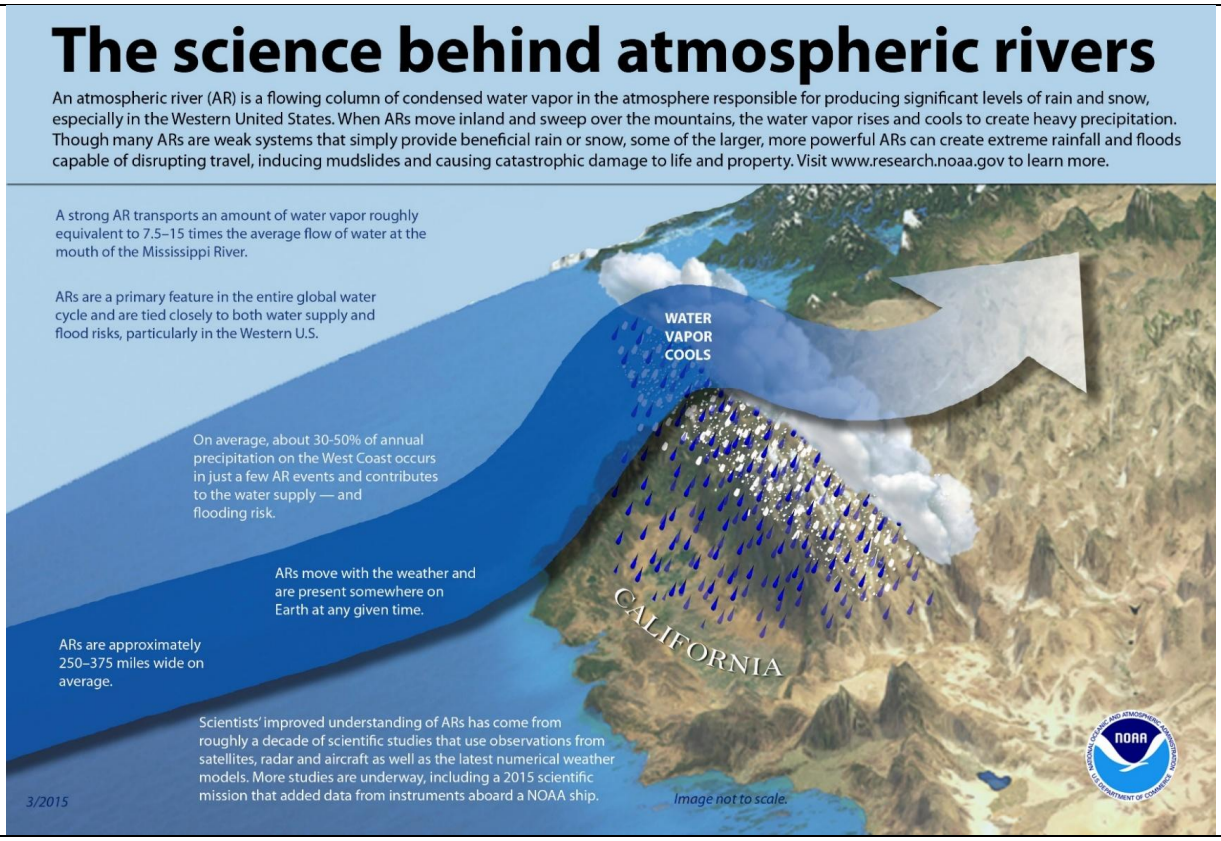
## Climate Change Projections

Assessing the frequency of flooding is challenging. As cited in this FMP, how frequency is measured dictates the measuring devices and how the measurement is calibrated. This poses to be an even greater challenge as the Earth’s climate continues to change. Under present warming scenarios, southern California’s seasonal precipitation patterns may not change all that much. However, in a warmer climate, precipitation models show a greater rainfall intensity (UCLA 2020). Moreover, in a warmer climate, atmospheric river (AR) events may become more commonplace. An atmospheric river is a steady stream of moisture laden air transported over a very large area in a consistent location and over a long time-period (see Figure 5-6. These rivers of air can be 250 to as much as 375 miles wide (NOAA n.d.). AR’s have gained much attention over the past couple of decades as research has been able to monitor their development and improve forecasts for them. Given that the primary source for California’s annual precipitation comes from the Pacific Ocean, the location and intensity of AR’s plays a large role in how large-scale flooding events may impact regions of the State.

From a global atmospheric circulation perspective, the location and intensity of AR’s has been heavily influenced by an even larger atmospheric phenomena known as the El Nino—Southern Oscillation (ENSO). ENSO is characterized by large-scale shifts in surface water along the equatorial Pacific Ocean. For reasons still not completely understood by scientists, ENSO is pronounced when northeast trade winds between the coasts of Ecuador and Peru and the western Pacific Ocean (Darwin, Australia) weaken to the point where warm surface waters in this vast stretch of ocean slide eastward. The result is unusually warmer waters off the coast of northwestern South America, which can extend northward toward the Gulf of California. Warmer than usual water of this magnitude has the effect of relocating the sub-tropical air patterns that, in turn, focus AR’s over the same region in California (see Figure 5-7). Moreover, the AR’s that are directed because of El Nino tend to be longer duration and greater in intensity.

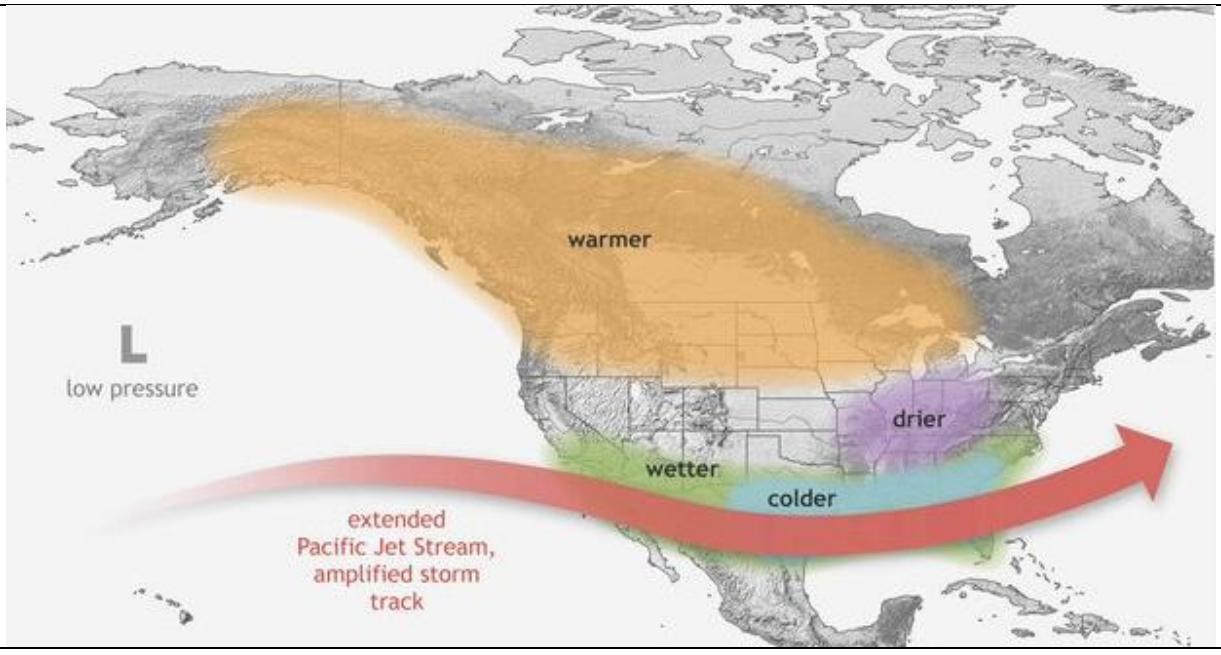
For floodplain management planning purposes, a warmer climate can impact flood risks. This will mean that the qualitative and quantitative measures of riverine flood frequency will likely increase as well. Floodplain managers will need to pay close attention to changes in the large-scale precipitation patterners, as understanding the correlation between climate and localized precipitation intensity plays a role in which floodplain management actions to take or how to adjust them as a result.

**Figure 5-6. Atmospheric River Summary**




*Source: (NOAA n.d.)*

**Figure 5-7. Typical El Nino Winter Jet Stream Pattern**




*Source: (NOAA Climate ENSO n.d.)*

## 5.2.4 Warning Time

Emergency preparedness plans, particularly those focused on flood related emergencies, examine the characteristics of the flooding sources carefully to forecast the time the hazard takes to impact a defined population and/or location. Fortunately, advances in water levels and volume monitoring have led to more accurate riverine flood models and associated forecasts. The speed of [hazard] onset is the measurement of how long it takes between the event itself (rainfall commencement) and the actual flooding downstream to impact population centers or related infrastructure. Water volume, intensity, watershed size, surface type, soil type, slope all factors in to modeling the speed of onset over areas of interest. This said, the National Weather Service (NWS) Water Prediction Service (WPS) in coordination with the United States Geologic Survey (USGS) have created an online mapping interface aimed at allowing users to select which variables they want to analyze for their area of interest (NWS Water Prediction Service n.d.). Users can select current observations and forecasts, or long-range flood outlook products. While experimental in nature, there is value in allowing end-users to analyze data for defined scenarios and variables. The data is standardized, in a controlled setting to retain data quality while also preserving the robust data content, and access for all users no matter their location.

## 5.2.5 Secondary Hazards

The arid nature of southern California's climate, its rocky soil, and extreme seasonal precipitation patterns make the region susceptible to secondary hazards such as wildfires and landslides. Areas that have experienced significant wildfires often leave behind large swaths of barren land, with no vegetation left to hold the soil into place. During flooding events, the barren soil becomes unstable and causes large quantities of surface material to slide off to form land and/or mud slides. The dichotomy here is that wildfires are triggered through ignition—most often dry lightning strokes—while the landslides are triggered by heavy rainfall over unprotected land.

Flooding can increase the likelihood of a landslide occurring if the water destabilizes slopes. More intense flood events may also amplify potential debris flows or associated damage from landslides. Floods of any type have the potential to result in water and power utilities failures. Such failures may impact public and private use, as well as cause disruption to critical infrastructure. Oversaturated soils from periods of heavy rain and flooding may cause utility poles to tip over or fall completely, interrupting the power grid for a potentially large area, especially if the transformer is impacted.

Depending on a flood's severity and the substances in its path, floodwaters can be contaminated by pollutants such as sewage, human and animal feces, pesticides, fertilizers, oil, asbestos, and rusting building materials. After flood events, excess moisture and standing water contribute to the growth of mold in buildings. Mold may present a health risk to building occupants, especially those with already compromised immune systems such as infants, children, the elderly and pregnant women. Common public health risks associated with flood events also include unsafe food, contaminated drinking or washing water, more disease-carrying organisms (i.e., mosquitos), carbon monoxide poisoning, and even mental stress and fatigue (CDC 2024).

## 5.2.6 Vulnerability Assessment

Four levels of flood were evaluated for the riverine flood hazard: 10-percent, 2-percent, 1-percent, and 0.2-percent annual chance. The calculation of these levels is cumulative in nature, such that all areas and assets within the hazard area for one of the flood levels are also within the hazard area for all larger flood levels. For example, if residential households are located within the 1-percent annual chance flood hazard area, then they are also within the 0.2-percent annual chance flood hazard area.

## Land Exposure

Based upon the array of projected riverine flood inundation areas, land area exposure to these flooding scenarios is summarized in Table 5-7.

**Table 5-7. Land Area Potentially Exposed to Riverine Flooding Events**

| Jurisdiction | Total Land Area (Acres) | Inundated Land Area [a] | |
|---|---|---|---|
| | | Total Area (Acres) | % of Jurisdiction |
| **10% Annual Chance Flood** | | | |
| Anaheim | 32,170 | 28.3 | 0.1% |
| Laguna Woods | 2,116 | 7.7 | 0.4% |
| Newport Beach | 16,450 | 29.3 | 0.2% |
| San Juan Capistrano | 9,220 | 158.9 | 1.7% |
| Santa Ana | 17,531 | 183.1 | 1.0% |
| Unincorporated County | 174,768 | 509.6 | 0.3% |
| **Total** | **252,255** | **916.9** | **0.4%** |
| **2% Annual Chance Flood** | | | |
| Anaheim | 32,170 | 70.0 | 0.2% |
| Laguna Woods | 2,116 | 15.0 | 0.7% |
| Newport Beach | 16,450 | 40.8 | 0.2% |
| San Juan Capistrano | 9,220 | 318.5 | 3.5% |
| Santa Ana | 17,531 | 309.8 | 1.8% |
| Unincorporated County | 174,768 | 730.6 | 0.4% |
| **Total** | **252,255** | **1,484.7** | **0.6%** |
| **1% Annual Chance Flood** | | | |
| Anaheim | 32,170 | 741.8 | 2.3% |
| Laguna Woods | 2,116 | 24.5 | 1.2% |
| Newport Beach | 16,450 | 1,822.3 | 11.1% |
| San Juan Capistrano | 9,220 | 503.0 | 5.5% |
| Santa Ana | 17,531 | 494.8 | 2.8% |
| Unincorporated County | 174,768 | 4,234.8 | 2.4% |
| **Total** | **252,255** | **7,821.2** | **3.1%** |
| **0.2% Annual Chance Flood** | | | |
| Anaheim | 32,170 | 22,044.8 | 68.5% |
| Laguna Woods | 2,116 | 27.4 | 1.3% |
| Newport Beach | 16,450 | 2,772.1 | 16.9% |
| San Juan Capistrano | 9,220 | 1,075.0 | 11.7% |
| Santa Ana | 17,531 | 10,863.7 | 62.0% |
| Unincorporated County | 174,768 | 9,026.6 | 5.2% |
| **Total** | **252,255** | **45,809.6** | **18.2%** |

a. Land area excludes areas designated as water

## Population

### Exposure

Using this approach, it is estimated that 8,039 people in the participating jurisdictions are in the 1-percent annual chance event and 549,659 people are exposed to the 0.2-percent annual chance flood event. This means that approximately 0.9-percent of the population of jurisdiction participating are exposed to the 1-percent annual chance flood hazard area, and 59.2-percent are exposed to the 0.2-percent annual chance flood hazard area. Refer to Table 5-8 for the results.

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact on their family. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention, which may not be available due to isolation during a flood event and they may have more difficulty evacuating. Special consideration should be taken when planning for disaster preparation, response, and recovery for these vulnerable groups. Table 5-9 summarizes vulnerable populations in the riverine flood hazard areas.

### Impacts

The impact of flooding on life, health, and safety depends on the severity of the event and the warning time provided. Exposure represents the population living in or near the hazard areas that could be impacted should an event occur. Table 5-10 shows the results of the Hazus analysis on population in the riverine flood hazard areas.

Cascading impacts may also include exposure to pathogens such as mold. As a result of repetitive flooding, mold has the potential to develop endangering the health of residents, especially those with already compromised immune systems (e.g., people with HIV infection, cancer patients receiving chemotherapy, and individuals who have received an organ transplant) along with other vulnerable populations, including infants, children, the elderly, and pregnant women. The degree of that impact will vary and is not strictly measurable. Buildings should be properly cleaned and dried out to safely prevent mold growth (CDC 2024).

Floodwater can be contaminated by pollutants such as sewage, pesticides, fertilizers, oil, asbestos, and rusting building materials. Common public health risks associated with flood events also include:

- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitoes and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as Hazus are not equipped to measure public health impacts. The best level of mitigation for these impacts is to be aware that they can occur, educate the public on prevention, and be prepared to deal with these vulnerabilities in responding to flood events.

Casualties due to flooding are generally limited based on advance weather forecasting, blockades and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions are in place. Ongoing mitigation should help to avoid the most likely cause of injury—people trying to cross flooded roadways.

**Table 5-8. Estimated Population in the Riverine Flood Hazard Areas**

| Jurisdiction | Total Population (2020 Decennial) | Population in the 10-Percent Annual Chance Flood Hazard Area | | Population in the 2-Percent Annual Chance Flood Hazard Area | | Population in the 1-Percent Annual Chance Flood Hazard Area | | Population in the 0.2-Percent Annual Chance Flood Hazard Area | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Persons | % of Jurisdiction Total | Number of Persons | % of Jurisdiction Total | Number of Persons | % of Jurisdiction Total | Number of Persons | % of Jurisdiction Total |
| **Anaheim** | 346,824 | 0 | 0.0% | 114 | <0.1% | 517 | 0.1% | 269,794 | 77.8% |
| **Laguna Woods** | 17,644 | 0 | 0.0% | 10 | 0.1% | 0 | 0.0% | 0 | 0.0% |
| **Newport Beach** | 85,239 | 0 | 0.0% | 0 | 0.0% | 1,149 | 1.3% | 19,907 | 23.4% |
| **San Juan Capistrano** | 35,196 | 3 | <0.1% | 83 | 0.2% | 1,289 | 3.7% | 4,858 | 13.8% |
| **Santa Ana** | 310,227 | 1,494 | 0.5% | 2,873 | 0.9% | 4,496 | 1.4% | 217,862 | 70.2% |
| **Unincorporated County** | 132,877 | 16 | <0.1% | 128 | 0.1% | 588 | 0.4% | 37,238 | 28.0% |
| **Total** | **928,007** | **1,513** | **0.2%** | **3,208** | **0.3%** | **8,039** | **0.9%** | **549,659** | **59.2%** |

Source: U.S. Census Bureau 2020; FEMA 2019; Orange County Public Works 2016, 2019; USACE 2018

### Table 5-9. Vulnerable Population Located in the Riverine Flood Hazard Areas

| Jurisdiction | Estimated Number of Vulnerable Persons Located in the Riverine Flood Hazard Areas | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Persons Over 65 | % of Total | Persons Under 5 | % of Total | Non-English Speaking Persons | % of Total | Persons with a Disability | % of Total | Persons in Poverty | % of Total |
| **10% Annual Chance Flood** | | | | | | | | | | |
| Anaheim | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Laguna Woods | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Newport Beach | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| San Juan Capistrano | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Santa Ana | 166 | 0.5% | 82 | 0.5% | 139 | 0.5% | 127 | 0.5% | 164 | 0.5% |
| Unincorporated County | 2 | <0.1% | 0 | 0.0% | 0 | 0.0% | 1 | <0.1% | 0 | 0.0% |
| **Total** | 168 | 0.1% | 82 | 0.2% | 139 | 0.2% | 128 | 0.1% | 164 | 0.2% |
| **2% Annual Chance Flood** | | | | | | | | | | |
| Anaheim | 14 | <0.1% | 6 | <0.1% | 10 | <0.1% | 11 | <0.1% | 14 | <0.1% |
| Laguna Woods | 8 | 0.1% | 0 | 0.0% | 2 | 0.1% | 3 | 0.1% | 1 | 0.1% |
| Newport Beach | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| San Juan Capistrano | 16 | 0.2% | 3 | 0.2% | 1 | 0.2% | 8 | 0.2% | 5 | 0.2% |
| Santa Ana | 320 | 0.9% | 158 | 0.9% | 268 | 0.9% | 244 | 0.9% | 316 | 0.9% |
| Unincorporated County | 19 | 0.1% | 7 | 0.1% | 6 | 0.1% | 10 | 0.1% | 7 | 0.1% |
| **Total** | 377 | 0.3% | 174 | 0.4% | 287 | 0.4% | 276 | 0.3% | 343 | 0.4% |
| **1% Annual Chance Flood** | | | | | | | | | | |
| Anaheim | 65 | 0.1% | 30 | 0.1% | 47 | 0.1% | 50 | 0.1% | 63 | 0.1% |
| Laguna Woods | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Newport Beach | 265 | 1.3% | 40 | 1.3% | 28 | 1.3% | 93 | 1.3% | 82 | 1.3% |
| San Juan Capistrano | 260 | 3.6% | 58 | 3.6% | 20 | 3.6% | 130 | 3.6% | 92 | 3.6% |
| Santa Ana | 501 | 1.4% | 248 | 1.4% | 420 | 1.4% | 383 | 1.4% | 495 | 1.4% |
| Unincorporated County | 89 | 0.4% | 32 | 0.4% | 30 | 0.4% | 46 | 0.4% | 35 | 0.4% |
| **Total** | 1,180 | 0.8% | 408 | 0.8% | 545 | 0.7% | 702 | 0.8% | 767 | 0.8% |

| Jurisdiction | Estimated Number of Vulnerable Persons Located in the Riverine Flood Hazard Areas | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Persons Over 65 | % of Total | Persons Under 5 | % of Total | Non-English Speaking Persons | % of Total | Persons with a Disability | % of Total | Persons in Poverty | % of Total |
| **0.2% Annual Chance Flood** | | | | | | | | | | |
| Anaheim | 33,902 | 77.8% | 15,661 | 77.8% | 24,494 | 77.8% | 26,441 | 77.8% | 33,042 | 77.8% |
| Laguna Woods | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| Newport Beach | 4,603 | 23.4% | 697 | 23.3% | 497 | 23.3% | 1,625 | 23.3% | 1,432 | 23.3% |
| San Juan Capistrano | 983 | 13.8% | 219 | 13.8% | 76 | 13.7% | 493 | 13.8% | 349 | 13.8% |
| Santa Ana | 24,306 | 70.2% | 12,018 | 70.2% | 20,392 | 70.2% | 18,563 | 70.2% | 23,985 | 70.2% |
| Unincorporated County | 5,666 | 28.0% | 2,035 | 28.0% | 1,926 | 28.0% | 2,920 | 28.0% | 2,234 | 28.0% |
| **Total** | 69,460 | 49.7% | 30,630 | 62.4% | 47,385 | 64.0% | 50,042 | 57.8% | 61,042 | 64.1% |

Source: U.S. Census Bureau, American Community Survey 2023; State of California, Natural Resources Agency and Ocean Protection Council 2018; United States Geological Survey.

**Table 5-10. Impacts on People Living in the Riverine Flood Hazard Areas**

| Jurisdiction | Total Population (2020 Decennial) | Population in the 10-Percent Annual Chance Flood Hazard Area | | Population in the 2-Percent Annual Chance Flood Hazard Area | | Population in the 1-Percent Annual Chance Flood Hazard Area | | Population in the 0.2-Percent Annual Chance Flood Hazard Area | |
|---|---|---|---|---|---|---|---|---|---|
| | | Displaced Population | Persons Seeking Short-Term Shelter | Displaced Population | Persons Seeking Short-Term Shelter | Displaced Population | Persons Seeking Short-Term Shelter | Displaced Population | Persons Seeking Short-Term Shelter |
| **Anaheim** | 346,824 | 242 | 188 | 580 | 340 | 1,915 | 819 | 295,727 | 15,008 |
| **Laguna Woods** | 17,644 | 13 | 13 | 83 | 63 | 60 | 49 | 73 | 55 |
| **Newport Beach** | 85,239 | 0 | 0 | 0 | 0 | 1,743 | 92 | 13,955 | 231 |
| **San Juan Capistrano** | 35,196 | 26 | 15 | 223 | 61 | 1,458 | 299 | 4,676 | 442 |
| **Santa Ana** | 310,227 | 3,185 | 1,384 | 5,306 | 1,693 | 6,450 | 1,870 | 203,577 | 8,071 |
| **Unincorporated County** | 132,877 | 45 | 25 | 213 | 69 | 720 | 188 | 39,462 | 1,926 |
| **Total** | **928,007** | **3,511** | **1,625** | **6,405** | **2,226** | **12,346** | **3,317** | **557,470** | **25,733** |

Source: Hazus v6.1; U.S. Census Bureau 2020; State of California, Natural Resources Agency and Ocean Protection Council 2018; United States Geological Survey

## Buildings and Property

### Exposure

Table 5-11 summarizes the estimated number, and associated Replacement Cost Value (RCV) of buildings that may be exposed to riverine flooding. Table 5-12 shows the distribution of these exposed buildings by their occupancy class—residential, commercial, and industrial occupants.

### Impacts

Table 5-13 provides a loss estimate for buildings impacted by a riverine flooding for each FMP participating jurisdiction, and for each building occupancy class.

Table 5-14 provides a summary of estimated debris tonnage from riverine flooding. Debris generated by riverine flooding event poses a massive risk to life and property. It is also extremely costly to recover, remove from public roadways, and dispose of safely. Debris quantities are based on flood depths entered into the Hazus software.

### NFIP Policy, Claim, and Repetitive Loss Statistics

Participation in the National Flood Insurance Program (NFIP) is voluntary. To join the NFIP, a community must complete an application, adopt a resolution of intent to participate and cooperate with FEMA, and adopt a floodplain management ordinance that meets or exceeds the minimum NFIP criteria. Note that the adopted floodplain management ordinance must also adopt any FIRM or Flood Hazard Boundary Map for the community. Through NFIP participation, communities agree to adopt and implement local floodplain management regulations that protect lives and reduce risk from future flooding. In return, the federal government makes flood insurance available to property owners throughout the community (FEMA 2020) (FEMA 2022).

Table 5-15 summarizes the Repetitive Loss (RL) and Severe Repetitive Loss (SRL) properties by jurisdiction and occupancy class. Table 5-16 summarizes NFIP claims, payments, and repetitive loss statistics for Orange County. Locations of the properties with policies, claims, and repetitive and severe repetitive flooding were geocoded by FEMA with the understanding that differences (and variations in those differences) were possible between listed longitude and latitude coordinates of properties and actual locations of property addresses—namely, that indications of some locations were more accurate than others.

### Table 5-11. Building Exposure to the Riverine Flood Hazard

| Jurisdiction | Buildings Potentially Exposed to Riverine Flood Hazard Area | | | |
|---|---|---|---|---|
| | Number of Buildings | | Replacement Cost Value | |
| | Count | % of Jurisdiction Total | Value | % of Jurisdiction Total |
| **10% Annual Chance Flood** | | | | |
| Anaheim | 0 | 0.0% | $0 | 0.0% |
| Laguna Woods | 0 | 0.0% | $0 | 0.0% |
| Newport Beach | 0 | 0.0% | $0 | 0.0% |
| San Juan Capistrano | 1 | <0.1% | $95,541 | <0.1% |
| Santa Ana | 224 | 0.4% | $118,849,465 | 0.1% |
| Unincorporated County | 4 | <0.1% | $3,482,008 | <0.1% |
| **Total** | **229** | **0.1%** | **$122,427,014** | **<0.1%** |
| **2% Annual Chance Flood** | | | | |
| Anaheim | 25 | <0.1% | $40,573,961 | <0.1% |
| Laguna Woods | 2 | 0.1% | $1,091,842 | <0.1% |
| Newport Beach | 0 | 0.0% | $0 | 0.0% |
| San Juan Capistrano | 54 | 0.5% | $162,421,455 | 0.8% |
| Santa Ana | 437 | 0.8% | $348,229,101 | 0.3% |
| Unincorporated County | 32 | 0.1% | $25,615,829 | 0.1% |
| **Total** | **550** | **0.3%** | **$577,932,188** | **0.1%** |
| **1% Annual Chance Flood** | | | | |
| Anaheim | 93 | 0.1% | $144,599,912 | 0.1% |
| Laguna Woods | 0 | 0.0% | $0 | 0.0% |
| Newport Beach | 419 | 1.3% | $422,759,370 | 0.5% |
| San Juan Capistrano | 411 | 3.9% | $671,868,687 | 3.4% |
| Santa Ana | 673 | 1.3% | $504,039,635 | 0.4% |
| Unincorporated County | 159 | 0.5% | $111,077,099 | 0.3% |
| **Total** | **1,755** | **0.9%** | **$1,854,344,703** | **0.4%** |
| **0.2% Annual Chance Flood** | | | | |
| Anaheim | 52,945 | 79.6% | $154,275,848,386 | 86.5% |
| Laguna Woods | 0 | 0.0% | $0 | 0.0% |
| Newport Beach | 7,165 | 23.0% | $8,107,657,626 | 9.5% |
| San Juan Capistrano | 1,554 | 14.8% | $3,809,724,325 | 19.4% |
| Santa Ana | 34,273 | 66.6% | $64,617,812,202 | 50.1% |
| Unincorporated County | 9,827 | 28.1% | $9,239,211,765 | 21.0% |
| **Total** | **105,764** | **53.4%** | **$240,050,254,305** | **51.5%** |

**Table 5-12. Buildings Exposed to Riverine Flooding, by Occupancy Classification**

| Jurisdiction | Total Exposed Buildings | Residential Occupancy | Commercial Occupancy | Industrial Occupancy | Other[a] |
|---|---|---|---|---|---|
| **10% Annual Chance Flood** | | | | | |
| Anaheim | 0 | 0 | 0 | 0 | 0 |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 |
| Newport Beach | 0 | 0 | 0 | 0 | 0 |
| San Juan Capistrano | 1 | 1 | 0 | 0 | 0 |
| Santa Ana | 224 | 209 | 12 | 3 | 0 |
| Unincorporated County | 4 | 4 | 0 | 0 | 0 |
| **Total** | **229** | **214** | **12** | **3** | **0** |
| **2% Annual Chance Flood** | | | | | |
| Anaheim | 25 | 19 | 6 | 0 | 0 |
| Laguna Woods | 2 | 2 | 0 | 0 | 0 |
| Newport Beach | 0 | 0 | 0 | 0 | 0 |
| San Juan Capistrano | 54 | 22 | 25 | 2 | 5 |
| Santa Ana | 437 | 402 | 30 | 4 | 1 |
| Unincorporated County | 32 | 32 | 0 | 0 | 0 |
| **Total** | **550** | **477** | **61** | **6** | **6** |
| **1% Annual Chance Flood** | | | | | |
| Anaheim | 93 | 86 | 3 | 3 | 1 |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 |
| Newport Beach | 419 | 372 | 42 | 4 | 1 |
| San Juan Capistrano | 411 | 341 | 52 | 8 | 10 |
| Santa Ana | 673 | 629 | 38 | 5 | 1 |
| Unincorporated County | 159 | 147 | 8 | 1 | 3 |
| **Total** | **1,755** | **1,575** | **143** | **21** | **16** |
| **0.2% Annual Chance Flood** | | | | | |
| Anaheim | 52,945 | 44,804 | 5,590 | 2,046 | 505 |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 |
| Newport Beach | 7,165 | 6,442 | 632 | 71 | 20 |
| San Juan Capistrano | 1,554 | 1,285 | 200 | 44 | 25 |
| Santa Ana | 34,273 | 30,477 | 2,914 | 629 | 253 |
| Unincorporated County | 9,827 | 9,296 | 384 | 108 | 39 |
| **Total** | **105,764** | **92,304** | **9,720** | **2,898** | **842** |

a. Other = Government, Religious, Agricultural, and Educational Occupancy

### Table 5-13. Riverine Flood Impacts on Buildings—Estimated Losses by Occupancy Class

| Jurisdiction | Total Building Count | Total Flood Impacted Buildings | Riverine Flood Impacts on Buildings—Estimated Loss[a] | | | |
|---|---|---|---|---|---|---|
| | | | All Occupancies | Residential Properties | Commercial Properties | All Other Occupancies |
| **10% Annual Chance Flood** | | | | | | |
| Anaheim | 66,553 | 0 | $0 | $0 | $0 | $0 |
| Laguna Woods | 3,519 | 0 | $0 | $0 | $0 | $0 |
| Newport Beach | 31,118 | 0 | $0 | $0 | $0 | $0 |
| San Juan Capistrano | 10,465 | 1 | $0 | $0 | $0 | $0 |
| Santa Ana | 51,451 | 224 | $2,526,607 | $2,219,508 | $307,099 | $0 |
| Unincorporated County | 34,945 | 4 | $233,856 | $233,856 | $0 | $0 |
| **Total** | **198,051** | **229** | **$2,760,463** | **$2,453,364** | **$307,099** | **$0** |
| **2% Annual Chance Flood** | | | | | | |
| Anaheim | 66,553 | 25 | $16,703,935 | $3,751,375 | $12,952,560 | $0 |
| Laguna Woods | 3,519 | 2 | $86,619 | $86,619 | $0 | $0 |
| Newport Beach | 31,118 | 0 | $0 | $0 | $0 | $0 |
| San Juan Capistrano | 10,465 | 54 | $23,297,072 | $1,064,298 | $8,805,603 | $13,427,172 |
| Santa Ana | 51,451 | 437 | $5,808,395 | $5,242,001 | $566,394 | $0 |
| Unincorporated County | 34,945 | 32 | $3,299,270 | $3,299,270 | $0 | $0 |
| **Total** | **198,051** | **550** | **$49,195,291** | **$13,443,563** | **$22,324,557** | **$13,427,172** |
| **1% Annual Chance Flood** | | | | | | |
| Anaheim | 66,553 | 93 | $5,652,343 | $2,210,979 | $950,558 | $2,490,806 |
| Laguna Woods | 3,519 | 0 | $0 | $0 | $0 | $0 |
| Newport Beach | 31,118 | 419 | $18,985,865 | $14,699,376 | $3,860,223 | $426,266 |
| San Juan Capistrano | 10,465 | 411 | $46,397,645 | $8,626,940 | $22,506,409 | $15,264,296 |
| Santa Ana | 51,451 | 673 | $13,258,087 | $12,549,357 | $708,729 | $1 |
| Unincorporated County | 34,945 | 159 | $19,067,347 | $15,379,674 | $2,380,628 | $1,307,045 |
| **Total** | **198,051** | **1,755** | **$103,361,287** | **$53,466,326** | **$30,406,547** | **$19,488,414** |
| **0.2% Annual Chance Flood** | | | | | | |
| Anaheim | 66,553 | 52,945 | $21,485,103,656 | $7,320,612,174 | $9,460,153,482 | $4,704,338,000 |
| Laguna Woods | 3,519 | 0 | $0 | $0 | $0 | $0 |
| Newport Beach | 31,118 | 7,165 | $674,297,169 | $452,326,019 | $206,400,622 | $15,570,528 |
| San Juan Capistrano | 10,465 | 1,554 | $549,986,893 | $172,649,839 | $306,042,932 | $71,294,122 |
| Santa Ana | 51,451 | 34,273 | $6,453,551,152 | $2,720,181,773 | $2,705,529,725 | $1,027,839,654 |
| Unincorporated County | 34,945 | 9,827 | $1,307,509,477 | $959,989,433 | $259,397,256 | $88,122,789 |
| **Total** | **198,051** | **105,764** | **$30,470,448,347** | **$11,625,759,238** | **$12,937,524,017** | **$5,907,165,093** |

**Table 5-14. Estimated Debris Created from Riverine Flooding in Orange County**

| Jurisdiction | Estimated Debris Created (Tons) | | | |
|---|---|---|---|---|
| | Total | Finish | Structure | Foundation |
| **10% Annual Chance Flood** | | | | |
| Anaheim | 191 | 180 | 6 | 5 |
| Laguna Woods | 41 | 41 | 0 | 0 |
| Newport Beach | 0 | 0 | 0 | 0 |
| San Juan Capistrano | 31 | 21 | 5 | 5 |
| Santa Ana | 731 | 442 | 145 | 144 |
| Unincorporated County | 13 | 13 | 0 | 0 |
| **Total** | 1,006 | 697 | 155 | 154 |
| **2% Annual Chance Flood** | | | | |
| Anaheim | 456 | 427 | 16 | 13 |
| Laguna Woods | 262 | 261 | 0 | 0 |
| Newport Beach | 0 | 0 | 0 | 0 |
| San Juan Capistrano | 477 | 249 | 120 | 108 |
| Santa Ana | 1,488 | 806 | 359 | 323 |
| Unincorporated County | 79 | 79 | 0 | 0 |
| **Total** | 2,761 | 1,821 | 496 | 444 |
| **1% Annual Chance Flood** | | | | |
| Anaheim | 1,761 | 811 | 514 | 437 |
| Laguna Woods | 586 | 583 | 1 | 1 |
| Newport Beach | 11,799 | 7,102 | 2,764 | 1,934 |
| San Juan Capistrano | 1,603 | 690 | 335 | 578 |
| Santa Ana | 3,900 | 1,908 | 968 | 1,024 |
| Unincorporated County | 1,419 | 939 | 256 | 225 |
| **Total** | 21,068 | 12,033 | 4,838 | 4,199 |
| **0.2% Annual Chance Flood** | | | | |
| Anaheim | 184,790 | 171,859 | 3,924 | 9,008 |
| Laguna Woods | 745 | 743 | 1 | 1 |
| Newport Beach | 38,498 | 31,021 | 3,531 | 3,947 |
| San Juan Capistrano | 7,132 | 3,314 | 1,621 | 2,197 |
| Santa Ana | 123,293 | 107,783 | 4,837 | 10,672 |
| Unincorporated County | 41,327 | 40,178 | 447 | 702 |
| **Total** | 395,786 | 354,898 | 14,361 | 26,527 |

### Table 5-15. Summary of Repetitive Loss Properties by Jurisdiction

| Jurisdiction | Repetitive Loss Properties | | | | | Severe Repetitive Loss Properties | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Single Family | 2-4 Family | Business | Other Residential | Other Non-Residential | Single Family | 2-4 Family | Business | Other Residential | Other Non-Residential |
| Anaheim | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Newport Beach | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| San Juan Capistrano | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Santa Ana | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unincorporated County | 9 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |
| **Total** | **22** | **4** | **0** | **1** | **1** | **0** | **0** | **0** | **0** | **0** |

Source: FEMA, 2024

### Table 5-16. NFIP Claims, Payments, and Repetitive Loss Statistics for Orange County

| Jurisdiction | Total Claims | Total Payments | Number of NFIP Repetitive Loss (RL) Properties | Number of NFIP Severe Repetitive Loss Properties |
|---|---|---|---|---|
| Anaheim | 0 | $0.00 | 0 | 0 |
| Laguna Woods | 0 | $0.00 | 0 | 0 |
| Newport Beach | 16 | $164,667.78 | 8 | 0 |
| San Juan Capistrano | 2 | $25,268.96 | 1 | 0 |
| Santa Ana | 16 | $102,852.70 | 7 | 0 |
| Unincorporated County | 17 | $913,276.20 | 12 | 0 |
| **Total** | **51** | **$1,206,065.64** | **28** | **0** |

Source: FEMA, 2024

### Repetitive Loss Areas

In conjunction with the FMP planning process, the County is also developing a Repetitive Loss Area Analysis (RLAA). An RLAA is an in-depth study aimed at identifying and addressing areas that experience frequent flood damage. This comprehensive analysis involves identifying those properties that have suffered repeated flood losses, assessing the underlying causes of these losses, and developing targeted mitigation strategies to prevent future losses. The RLAA is particularly crucial for Orange County as a participating community in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS), as it enables the County to increase their CRS credit potential, which in turn assists with securing funding for future floodplain management efforts.

The key components of a Repetitive Loss Area Analysis (RLAA) include:

- **Identification of Repetitive Loss Properties:** This involves pinpointing properties that have experienced multiple flood losses over time. By identifying these properties, the analysis can focus on the area's most in need of intervention.
- **Data Collection and Analysis:** Gathering and analyzing data on past flood events, the extent of damages, and the causes of these events is essential. This data provides a foundation for understanding the patterns and factors contributing to repetitive losses.
- **Risk Assessment:** Evaluating the specific risk factors that contribute to repetitive losses is a critical step. This assessment helps in identifying vulnerabilities and prioritizing areas for mitigation.
- **Mitigation Strategies:** Developing targeted measures to reduce future flood damage is a core component of the RLAA. These strategies may include structural improvements, changes in land use, and the implementation of flood-proofing measures.
- **Community Engagement:** Involving local stakeholders, including property owners, residents, and municipal officials, in the planning and implementation process is vital. Effective communication and collaboration with the community ensure that the mitigation efforts are inclusive and consider the needs and perspectives of those directly impacted by flooding.
- **Documentation and Reporting:** Keeping detailed records of the findings and actions taken during the RLAA is essential for transparency and accountability. This documentation serves as a valuable resource for monitoring and evaluating the effectiveness of the implemented strategies.
- **Monitoring and Evaluation:** Continuously assessing the effectiveness of the implemented strategies is crucial for ensuring that the mitigation measures remain effective over time. This ongoing evaluation allows for adjustments and improvements to be made as needed.

These components help Orange County and its FMP participating jurisdictions to better understand and address the specific challenges posed by repetitive flooding, ultimately contributing to a safer and more resilient community. Orange County prepared its RLAA as a separate document, in concert with the FMP development.

## Critical Facilities

### Exposure

An exposure analysis of was performed on all critical facilities collected throughout the County and the FMP participating jurisdictions. This was accomplished by importing all critical facility points into a GIS and then overlaying the SFHA flood layer, generating a frequency count of all critical facilities. Table 5-17 summarizes the results of that critical facilities exposure analysis for riverine based flooding hazards.

### Table 5-17. Critical Facilities Exposed to the Riverine Flood Hazard Area

| Jurisdiction | Critical Facilities Exposed to Riverine Flood Hazards by Community Lifeline | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Communication | Energy | Food, Hydration, Shelter | Hazardous Materials | Health & Medical | Safety & Security | Transportation | Water Systems | Other Critical Facilities | Count | % of Jurisdiction Total |
| **10% Annual Chance Flood** | | | | | | | | | | | |
| Anaheim | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Newport Beach | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| San Juan Capistrano | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 2.0% |
| Santa Ana | 0 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 | 5 | 1.5% |
| Unincorporated County | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0.5% |
| **Total** | **0** | **0** | **0** | **2** | **0** | **0** | **5** | **0** | **0** | **7** | **0.6%** |
| **2% Annual Chance Flood** | | | | | | | | | | | |
| Anaheim | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0.2% |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Newport Beach | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0.9% |
| San Juan Capistrano | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 0 | 0 | 3 | 5.9% |
| Santa Ana | 0 | 0 | 0 | 2 | 0 | 1 | 8 | 0 | 0 | 11 | 3.4% |
| Unincorporated County | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 4 | 2.0% |
| **Total** | **0** | **0** | **0** | **3** | **0** | **5** | **12** | **0** | **0** | **20** | **1.8%** |
| **1% Annual Chance Flood** | | | | | | | | | | | |
| Anaheim | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 13 | 3.0% |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Newport Beach | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 4 | 3.5% |
| San Juan Capistrano | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 5 | 9.8% |
| Santa Ana | 0 | 0 | 0 | 2 | 0 | 1 | 8 | 0 | 0 | 11 | 3.4% |
| Unincorporated County | 0 | 0 | 0 | 0 | 0 | 5 | 20 | 0 | 1 | 26 | 12.9% |
| **Total** | **0** | **0** | **0** | **2** | **0** | **11** | **45** | **0** | **1** | **59** | **5.2%** |

| Jurisdiction | Critical Facilities Exposed to Riverine Flood Hazards by Community Lifeline | | | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Communication | Energy | Food, Hydration, Shelter | Hazardous Materials | Health & Medical | Safety & Security | Transportation | Water Systems | Other Critical Facilities | Count | % of Jurisdiction Total |
| **0.2% Annual Chance Flood** | | | | | | | | | | | |
| Anaheim | 1 | 5 | 0 | 95 | 34 | 119 | 121 | 0 | 5 | 380 | 89.0% |
| Laguna Woods | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| Newport Beach | 0 | 0 | 0 | 0 | 0 | 5 | 11 | 0 | 1 | 17 | 14.9% |
| San Juan Capistrano | 0 | 0 | 0 | 0 | 0 | 7 | 5 | 0 | 0 | 12 | 23.5% |
| Santa Ana | 0 | 5 | 0 | 46 | 11 | 83 | 47 | 0 | 0 | 192 | 59.3% |
| Unincorporated County | 0 | 0 | 0 | 0 | 2 | 16 | 38 | 0 | 1 | 57 | 28.4% |
| **Total** | **1** | **10** | **0** | **141** | **47** | **230** | **222** | **0** | **7** | **658** | **58.5%** |

Source: California Department of Education 2024; Caltrans 2024; Homeland Infrastructure Foundation-Level Data 2022, 2023, 2024; Orange County 2022, Orange County Sheriff's Department 2024; U.S. Geological Survey 2024; USACE 2024; USACE 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

Flooding can cause extensive damage to public utilities and disruptions to the delivery of services. Loss of power and communications may occur; and drinking water and wastewater treatment facilities may be temporarily out of operation. As indicated in Table 5-17, seven facilities are located in the 10-percent annual chance flood hazard area, 20 in the 2-percent annual chance flood hazard area, 59 in the 1-percent annual chance flood hazard area, and 658 in the 0.2-percent annual chance flood hazard area. All of the inundation areas are cumulative in nature.

## Impact

Impacts to critical facilities was analyzed throughout the County and the FMP participating jurisdictions. This was accomplished by importing all critical facility points into a GIS and then using existing depth grids through the Hazus software to estimate percent damage to each facility. The estimated average percent of damage for each class of critical facilities is shown for the four evaluated flood hazard areas in Table 5-18 through Table 5-21.

**Table 5-18. Estimated Damage to Critical Facilities Impacted by 10% Annual Chance Flood Event**

| Lifeline | <5% Damage | 5 – 19% Damage | 20 – 39% Damage | 40 – 49% Damage | 50% or Greater Damage |
|---|---|---|---|---|---|
| **Communications** | 0 | 0 | 0 | 0 | 0 |
| **Energy** | 0 | 0 | 0 | 0 | 0 |
| **Food, Hydration, Shelter** | 0 | 0 | 0 | 0 | 0 |
| **Hazardous Materials** | 0 | 1 | 0 | 0 | 1 |
| **Health and Medical** | 0 | 0 | 0 | 0 | 0 |
| **Safety and Security** | 0 | 0 | 0 | 0 | 0 |
| **Transportation** | 0 | 0 | 0 | 0 | 0 |
| **Water Systems** | 0 | 0 | 0 | 0 | 0 |

Note: Hazus does not perform damage assessments for bridges and critical facilities classified under the "Other" lifeline category. As a result, facility exposure counts may not align on a one-to-one basis with the reported damage assessment percentages, as these assets are not included in the damage modeling methodology.

**Table 5-19. Estimated Damage to Critical Facilities Impacted by 2% Annual Chance Flood Event**

| Lifeline | <5% Damage | 5 – 19% Damage | 20 – 39% Damage | 40 – 49% Damage | 50% or Greater Damage |
|---|---|---|---|---|---|
| **Communications** | 0 | 0 | 0 | 0 | 0 |
| **Energy** | 0 | 0 | 0 | 0 | 0 |
| **Food, Hydration, Shelter** | 0 | 0 | 0 | 0 | 0 |
| **Hazardous Materials** | 2 | 0 | 0 | 1 | 0 |
| **Health and Medical** | 0 | 0 | 0 | 0 | 0 |
| **Safety and Security** | 3 | 1 | 1 | 0 | 0 |
| **Transportation** | 0 | 0 | 0 | 0 | 0 |
| **Water Systems** | 0 | 0 | 0 | 0 | 0 |

Note: Hazus does not perform damage assessments for bridges and critical facilities classified under the "Other" lifeline category. As a result, facility exposure counts may not align on a one-to-one basis with the reported damage assessment percentages, as these assets are not included in the damage modeling methodology.

**Table 5-20. Estimated Damage to Critical Facilities Impacted by 1% Annual Chance Flood Event**

| Lifeline | <5% Damage | 5 – 19% Damage | 20 – 39% Damage | 40 – 49% Damage | 50% or Greater Damage |
|---|---|---|---|---|---|
| **Communications** | 0 | 0 | 0 | 0 | 0 |
| **Energy** | 0 | 0 | 0 | 0 | 0 |
| **Food, Hydration, Shelter** | 0 | 0 | 0 | 0 | 0 |
| **Hazardous Materials** | 2 | 0 | 0 | 0 | 0 |
| **Health and Medical** | 0 | 0 | 0 | 0 | 0 |
| **Safety and Security** | 7 | 1 | 1 | 0 | 2 |
| **Transportation** | 0 | 0 | 0 | 0 | 0 |
| **Water Systems** | 0 | 0 | 0 | 0 | 0 |

Note: Hazus does not perform damage assessments for bridges and critical facilities classified under the "Other" lifeline category. As a result, facility exposure counts may not align on a one-to-one basis with the reported damage assessment percentages, as these assets are not included in the damage modeling methodology.

**Table 5-21. Estimated Damage to Critical Facilities Impacted by 0.2% Annual Chance Flood Event**

| Lifeline | <5% Damage | 5 – 19% Damage | 20 – 39% Damage | 40 – 49% Damage | 50% or Greater Damage |
|---|---|---|---|---|---|
| **Communications** | 0 | 1 | 0 | 0 | 0 |
| **Energy** | 0 | 10 | 0 | 0 | 0 |
| **Food, Hydration, Shelter** | 0 | 0 | 0 | 0 | 0 |
| **Hazardous Materials** | 0 | 141 | 0 | 0 | 0 |
| **Health and Medical** | 40 | 7 | 0 | 0 | 0 |
| **Safety and Security** | 204 | 23 | 1 | 0 | 2 |
| **Transportation** | 0 | 3 | 0 | 0 | 0 |
| **Water Systems** | 0 | 0 | 0 | 0 | 0 |

Note: Hazus does not perform damage assessments for bridges and critical facilities classified under the "Other" lifeline category. As a result, facility exposure counts may not align on a one-to-one basis with the reported damage assessment percentages, as these assets are not included in the damage modeling methodology.

## 5.3 COASTAL FLOODING

Coastal flooding occurs along the coasts of oceans, bays, estuaries, coastal rivers, and large lakes. Coastal floods are the submersion of land areas along the ocean coast and other inland waters caused by seawater over and above normal tide action. Coastal flooding is a result of the storm surge where local sea levels rise often resulting in weakened or destroyed coastal structures. The main causes of coastal flooding in California include daily tides, King tides, storm surges from coastal storms which include tropical storms and mid-latitude cyclones, and the effects El Niño on local sea levels (NOAA NOS n.d.).

### 5.3.1 Location

California's coastal waters include the Pacific Ocean and all connecting water bodies, bays, harbors, shallows, and wetlands. There are approximately 43 miles of Orange County shoreline, with a number of communities along this stretch of coast being susceptible. Specifically, the communities of Seal Beach, Sunset Beach, Huntington Beach, Newport Beach, and Laguna Beach tend to be particularly vulnerable due to their close proximity to the Pacific Ocean. This close proximity increases their risk to coastal flooding from major coastal storms, with risks further enhanced by high tides, storm surges, and gradual increased risks from sea level rise induced by climate change factors. For more information on sea level rise, refer to Section 5.6.

#### Tide

Tides are long period waves that move though the ocean in response to the gravitational forces exerted by the moon and sun (NOAA NOS 2024; CSIRO n.d.). Tides originate in the ocean and progress toward the coastline where they appear as the regular rise and fall of the sea surface (NOAA NOS 2024a). Most coastal locations have two high tides and two low tides a day (NOAA NOS 2024b). However, large continents block the passage of the tidal bulges and this can cause certain coastal lines to experience only one high tide and low tide a day or 2 unequal high tides and 2 unequal low tides a day (NOAA NOS n.d.-a) The magnitude of tides at the smaller scale can be influenced by the shape of the shoreline (NOAA NOS n.d.-b). The height of tides can be magnified when the tidal bulges hit the submarine edge of the continental crust and the magnitude of the tides can be altered by funnel shape bays (NOAA NOS n.d.-a).

Spring Tides, also know as King Tides, occurs when the sun and moon are nearly in alignment and this combined gravitational pull causes the high tides to be a little higher and the low tides lower than average (NOAA NOS 2024c). Spring Tides typically occur during full or new moons which occur twice each month (NOAA NOS 2024c). High tide flood describes the increase common flooding conditions along the coast due to rising sea levels, sinking land, and the loss of natural barriers (NOAA NOS 2024). High tide flooding occurs when local factors that influence water levels and sea level rise push water level higher than the normal high tide and can occur on sunny days (NOAA NOS 2024). The local factors that can lead to an increase in water levels include changes in prevail winds, changes in ocean current, and strong tidal force (including Spring Tides) (NOAA NOS 2024).

#### Storm Surge

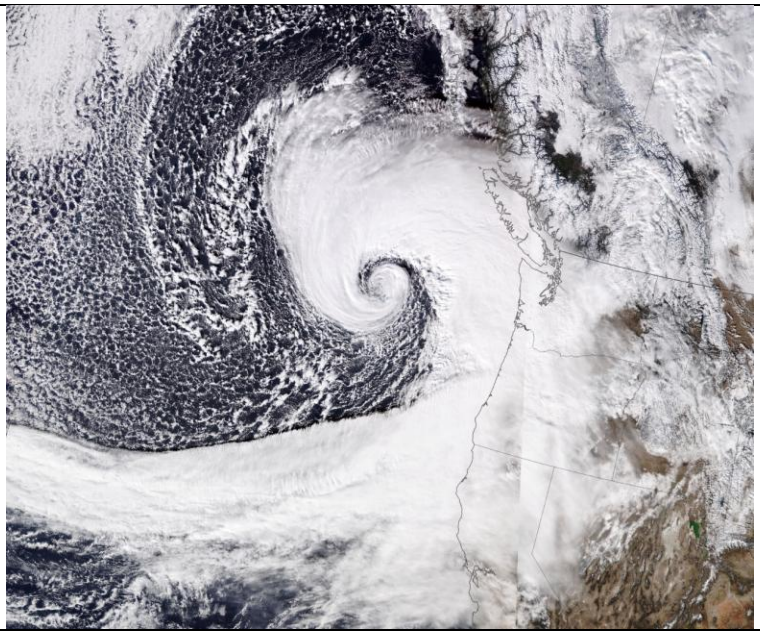
Storm surge contributes to coastal flooding. Storm surges inundate coastal floodplains by dune over wash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. Strong winds can increase in tide levels and water-surface elevations. Storm systems generate large waves that run up and flood coastal beaches. The combined effects create storm surges that affect the beach, dunes, and adjacent low-lying floodplains. Shallow, offshore depths can cause storm-driven waves and tides to pile up against the shoreline and

inside bays. Based on an area's topography, a storm surge may inundate only a small area or storm surge may inundate coastal lands for a mile or more inland from the shoreline.

## Mid-Latitude Cyclones

Mid-latitude cyclones, also called extratropical cyclones (see Figure 5-8), occur along a boundary between cold and warm air masses and develop when an area of low pressure in the upper atmosphere interacts with the surface air mass boundary causing the cold and warm air masses to move leading to cold fronts and warm fronts (Association of Certified Meteorologists 2024; NOAA 2023). Mid-latitude cyclones occur midlatitudes which is more than 30° latitude away from the equator (NASA n.d.). The weather associated with these storms include strong wind and heavy precipitation (NOAA NESDIS n.d., CIRA n.d., NASA n.d., NASA n.d.). The typical track of these storms in the Pacific Ocean is move east from Japan toward the eastern Pacific Ocean and then move northeastward (Lamont Doherty Earth Observatory n.d.)

**Figure 5-8. Extratropical Cyclone near the Pacific Northwest**



*Source: NASA n.d.*

## Hurricanes, Tropical Storm, and Tropical Cyclones

A tropical cyclone is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. These storms rotate counterclockwise in the northern hemisphere around the center and are accompanied by heavy rain and strong winds (National Weather Service [NWS] 2013). Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development (NOAA 2013).

Tropical cyclones are fueled by a different heat mechanism than other cyclonic windstorms such as polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the

atmosphere, the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called “warm core” storm systems (NOAA 2013).

The National Weather Service (NWS) issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- Hurricane/Typhoon Warning is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm force winds (24 hours in the western north Pacific). The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- Hurricane Watch is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm force winds.
- Tropical Storm Warning is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours (24 hours for the western north Pacific) in association with a tropical, subtropical, or post-tropical storm.
- Tropical Storm Watch is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm (NWS 2013).

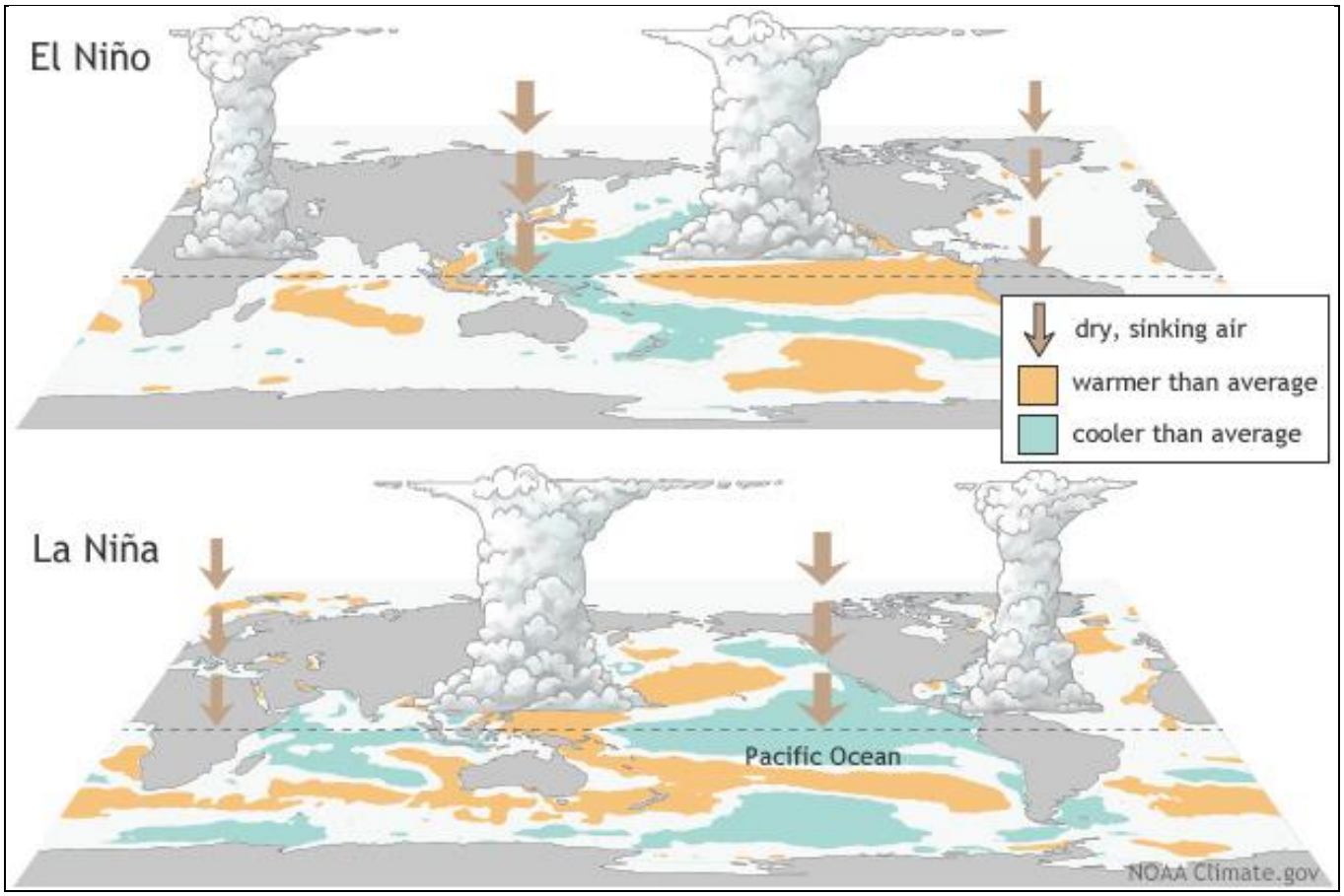
## El Niño

El Niño is a climate pattern that develops in the Pacific Ocean that can affect the weather patterns worldwide (NOAA NOS 2024d). Durning the normal conditions in the Pacific, the trade winds blow west along the equator which pushes warm water from South America to Asia and leads to the upwelling of cold water along the South American coasts (NOAA NOS 2024d). During El Niño, the trade winds weaken and the warm water shifts back toward South America ( (NOAA NOS 2024d). This warmer waters along the South American coast causes a southward shift in the Pacific Jetstream which can affect the weather significantly (NOAA NOS 2024d).

El Niño has an opposite in the form of La Niña and both are part of the El Niño—Southern Oscillation (ENSO) cycle (see Figure 5-9) (NOAA NOS 2024d). Durning La Niña, the trade winds strengthened causing more warm water to cross the Pacific Ocean and cause more upwelling of cold water along the South American coast (NOAA NOS 2024d). These colder waters cause the Pacific Jetstream to migrate northward which can also affect the weather significantly (NOAA NOS 2024d). Episodes of El Niño and La Niña typically last 9 to 12 months and typically occurs every 2 to 7 years (NOAA NOS 2024d).

El Niño can also cause an increase in sea level along the west coast of the United States due to the warm water that is typically push westward being push back east toward the South American coast which is then split to flow north and south along the coast (NOAA 2023). There is an increase in regional sea level rise can lead to increase instances of high tide flooding (NOAA 2023). In addition to the increase in regional sea level, El Niño also bring intense rainfall and wave action to coastal California due to the southernly shift in Pacific winter storms (Scripps Institution of Oceanography 2023). This increase in wave action and intense rainfall leads to increase erosion of beaches and coastal bluffs and cause coastal flooding (Scripps Institution of Oceanography 2023). California has experience strong El Niño events in 1982/1983 and in 1997/1998 which caused large amounts destruction including deaths of several people (California Coastal Commission n.d.).

Figure 5-9. El Niño and La Niña Phases




*Source: NOAA Climate ENSO n.d.*

## 5.3.2 Severity

Generally, the severity of coastal flooding can be measured by the stillwater elevations for a water source. Stillwater elevations are the projected elevation of floodwaters in the absence of waves resulting from wind or seismic effects. In coastal areas, stillwater elevations are determined when modeling coastal storm surge; the results of overland wave modeling are used in conjunction with the stillwater elevations to develop base flood elevations. For more information on the coastal flood. Table 5-22 shows the stillwater elevations identified in the effective FIS for the County.

Table 5-22. Summary of Stillwater Elevations for Non-Coastal Orange County

| Source/Location | Elevation (feet NAVD) | | | |
|---|---|---|---|---|
| | 10-Year | 50-Year | 100-Year | 500-Year |
| **Huntington Beach Channel (D01)—West Bank: Between Brookhurst Street and Magnolia** | N/A | N/A | 8.0 | N/A |
| **Huntington Beach Channel (D01)—Near Banning Avenue** | N/A | N/A | 7.9 | N/A |

Source: FEMA 2019
Note: NAVD = North American Vertical Datum

FEMA evaluates the potential impact of coastal floods through coastal hydraulic analysis, which consists of a combination of transect layout, field reconnaissance, erosion analysis, and overland wave modeling. Transects show the elevation of the ground onshore and offshore, and they are the locations where overland wave height modeling occurs. The transects selected for the analysis recorded in the FIS are the sites of primary flooding in Orange County. For more information on riverine flooding severity, see Section 5.2. Table 5-23 provides the transect data from the County's most recent FEMA FIS and Appendix H provides the FIS maps for this data. The highest elevation for the 10-year flood event (10 percent annual chance) is 31.8 feet NAVD (North American Vertical Datum), and for the 100-year flood event (1 percent annual chance) it is 43.8 feet NAVD. The highest feet in NAVD for the 500-year flood event (0.2 percent annual chance) is 55.7 feet in flood elevation.

**Table 5-23. Coastal Transect Data Parameters in Orange County**

| Transect* | Elevation (feet NAVD) | | |
|---|---|---|---|
| | 10-Year | 100-Year | 500-Year |
| **1** | 10.1 | 11.7 | 13.5 |
| **2** | 15.8 | 17.6 | 20.3 |
| **3** | 19.0 | 21.4 | 24.8 |
| **4** | 17.0 | 19.0 | 22.2 |
| **5** | 19.6 | 22.3 | 26.9 |
| **6** | 16.9 | 18.9 | 21.8 |
| **7** | 19.4 | 21.9 | 25.6 |
| **8** | 14.7 | 16.7 | 18.1 |
| **9** | 13.4 | 15.8 | 18.0 |
| **10** | 11.2 | 12.7 | 14.0 |
| **11** | 14.8 | 18.9 | 22.3 |
| **12** | 12.1 | 13.5 | 14.5 |
| **13** | 12.8 | 13.6 | 13.9 |
| **14** | 11.7 | 12.4 | 12.8 |
| **15** | 13.8 | 15.5 | 16.6 |
| **16** | 13.7 | 13.6 | 14.9 |
| **17** | 15.0 | 14.8 | 17.5 |
| **18** | 12.5 | 13.0 | 14.1 |
| **19** | 11.5 | 12.2 | 12.5 |
| **20** | 19.1 | 17.8 | 20.6 |
| **21** | 19.8 | 20.9 | 21.3 |
| **22** | 16.1 | 18.4 | 17.4 |
| **23** | 18.5 | 18.3 | 19.9 |
| **24** | 19.1 | 18.3 | 20.3 |
| **25** | 11.3 | 11.6 | 11.7 |
| **26** | 13.2 | 14.3 | 14.9 |
| **27** | 12.3 | 13.1 | 13.5 |
| **28** | 12.1 | 16.9 | 20.9 |
| **29** | 12.5 | 16.6 | 21.3 |
| **30** | 11.5 | 13.4 | 15.0 |

| Transect* | Elevation (feet NAVD) | | |
|---|---|---|---|
| | 10-Year | 100-Year | 500-Year |
| 31 | 12.2 | 13.0 | 13.3 |
| 32 | 12.5 | 13.1 | 13.3 |
| 33 | 11.9 | 12.8 | 13.4 |
| 34 | 12.4 | 14.8 | 16.9 |
| 35 | 12.7 | 13.9 | 14.6 |
| 36 | 13.3 | 14.6 | 15.4 |
| 37 | 21.7 | 26.7 | 30.4 |
| 38 | 12.2 | 13.4 | 14.2 |
| 39 | 13.3 | 14.2 | 14.7 |
| 40 | 19.1 | 22.7 | 25.2 |
| 41 | 13.3 | 14.6 | 15.4 |
| 42 | 13.6 | 15.0 | 16.0 |
| 43 | 14.2 | 16.1 | 17.9 |
| 44 | 19.2 | 22.4 | 25.0 |
| 45 | 13.6 | 16.4 | 18.3 |
| 46 | 12.6 | 13.0 | 13.2 |
| 47 | 13.3 | 14.2 | 14.6 |
| 48 | 12.7 | 15.7 | 18.5 |
| 49 | 12.3 | 13.7 | 14.6 |
| 50 | 12.0 | 15.0 | 19.0 |
| 51 | 23.1 | 28.1 | 32.0 |
| 52 | 16.8 | 21.5 | 25.9 |
| 53 | 17.9 | 20.5 | 22.2 |
| 54 | 13.9 | 15.3 | 16.2 |
| 55 | 18.3 | 21.2 | 23.5 |
| 56 | 13.7 | 16.0 | 17.7 |
| 57 | 22.8 | 26.7 | 29.6 |
| 58 | 21.3 | 24.8 | 27.2 |
| 59 | 22.3 | 28.9 | 33.9 |
| 60 | 20.0 | 22.6 | 24.3 |
| 61 | 20.3 | 25.5 | 30.9 |
| 62 | 17.1 | 19.7 | 21.7 |
| 63 | 18.3 | 23.1 | 27.6 |
| 64 | 13.4 | 15.8 | 18.0 |
| 65 | 16.5 | 23.6 | 31.6 |
| 66 | 12.5 | 14.5 | 15.9 |
| 67 | 12.8 | 17.7 | 25.4 |
| 68 | 12.5 | 18.6 | 27.6 |
| 69 | 19.2 | 25.4 | 31.5 |
| 70 | 24.6 | 28.7 | 31.5 |

| Transect* | Elevation (feet NAVD) | | |
|---|---|---|---|
| | 10-Year | 100-Year | 500-Year |
| **71** | 14.1 | 17.9 | 21.5 |
| **72** | 31.8 | 39.3 | 44.2 |
| **73** | 31.2 | 43.8 | 55.7 |
| **74** | 21.3 | 22.9 | 23.8 |
| **75** | 18.3 | 19.6 | 20.1 |
| **76** | 14.7 | 18.5 | 18.6 |
| **77** | 14.7 | 18.9 | 15.5 |
| **78** | 19.3 | 19.0 | 21.2 |
| **79** | 15.5 | 16.2 | 16.4 |
| **80** | 12.4 | 16.1 | 19.9 |
| **81** | 17.3 | 22.0 | 27.0 |
| **82** | 13.8 | 14.5 | 14.7 |
| **83** | 12.1 | 13.1 | 13.8 |
| **84** | 12.5 | 13.4 | 13.9 |
| **85** | 12.6 | 15.2 | 17.7 |
| **86** | 19.4 | 20.6 | 21.1 |
| **87** | 18.6 | 20.8 | 22.3 |
| **88** | 24.3 | 29.6 | 34.3 |

Source: FEMA 2019
Note: 1-Percent Annual Chance Wave Crest Not calculated for this Flood Risk Project. *Refer to Appendix H for transect maps.

The U.S. Geological Survey (USGS) provides other resources for tracking the severity and potential incidents for a coastal flooding event. There are two tide gauges in the County which track elevations. Tide gage 9410660 is located in Los Angeles and tide gage 9410580 is located in Newport Bay (FEMA 2019).

Coastal flooding has many of the same problems identified for riverine flooding (see section 5.1.3 Riverine Flooding) but also has additional problems such as beach erosion; loss or submergence of wetlands and other coastal ecosystems; saltwater intrusion; high water tables; loss of coastal recreation areas, beaches, protective sand dunes, parks, and open space; and loss of coastal structures. Coastal structures can include sea walls, piers, bulkheads, bridges, or buildings (FEMA 2021).

There are several forces that occur with coastal flooding:

- Hydrostatic forces against a structure are created by standing or slowly moving water. Flooding can cause vertical hydrostatic forces, or flotation. These types of forces are one of the main causes of flood damage.
- Hydrodynamic forces on buildings are created when coastal floodwaters move at high velocities. These high-velocity flows are capable of destroying solid walls and dislodging buildings with inadequate foundations. High-velocity flows can also move large quantities of sediment and debris that can cause additional damage. In coastal areas, high-velocity flows are typically associated with one or more of the following:
- Storm surge and wave run-up flowing landward through breaks in sand dunes or across low-lying areas

- Tsunamis
- Outflow of floodwaters driven into bay or upland areas
- Strong currents parallel to the shoreline, driven by waves produced from a storm
- High-velocity flows

High-velocity flows can be created or exacerbated by the presence of man-made or natural obstructions along the shoreline and by weak points formed by roads and access paths that cross dunes, bridges or canals, channels, or drainage features.

- Waves can affect coastal buildings from breaking waves, wave run-up, wave reflection and deflection, and wave uplift. The most severe damage is caused by breaking waves. The force created by these types of waves breaking against a vertical surface is often at least 10 times higher than the force created by high winds during a coastal storm.
- Flood-borne debris produced by coastal flooding events and storms typically includes decks, steps, ramps, breakaway wall panels, portions of or entire houses, heating oil and propane tanks, cars, boats, decks and pilings from piers, fences, erosion control structures, and many other types of smaller objects. Debris from floods are capable of destroying unreinforced masonry walls, light wood-frame construction, and small-diameter posts and piles (FEMA 2021).

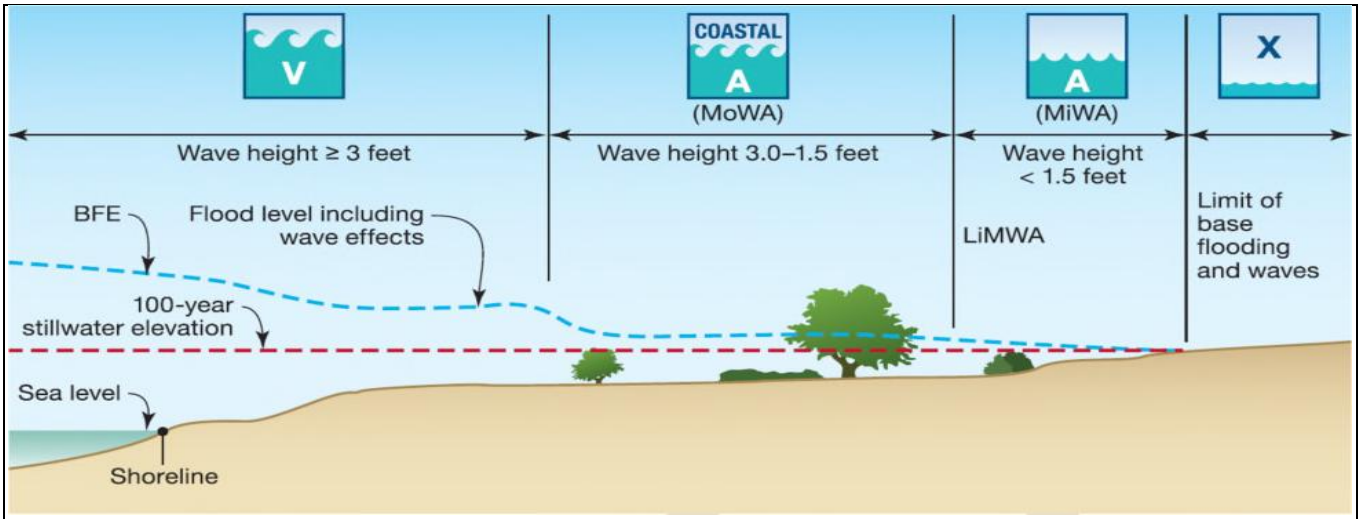
Zone V (including Zones VE, V1-30, and V) is the portion of the special flood hazard area (SFHA) that extends from offshore to the inland limit of a primary frontal dune or is subject to high-velocity wave action from storms or seismic sources. The boundary of Zone V is generally based on wave heights 3 feet or greater or wave run-up depths 3 feet or greater. Zone V can also be mapped based on the wave overtopping rate (when waves run up and over a dune or barrier). Zones A and AE are not within the Coastal High Hazard Area but designate both coastal and non-coastal SFHAs. Regulatory requirements of the NFIP for buildings in Zone A are the same for both coastal and riverine flooding hazards. Zone AE in coastal areas is divided by the limit of moderate wave action (LiMWA). The LiMWA represents the landward limit of the 1.5-foot wave (FEMA 2011).

The area between the LiMWA and the Zone V limit is known as the Coastal A-Zone (CAZ) (for building codes and standard purposes) and as the Moderate Wave Action area (by FEMA flood mappers). This area is subject to wave heights between 1.5 and 3 feet during the base flood. The area between the LiMWA and the landward limit of Zone A is known as the Minimal Wave Action area and is subject to wave heights less than 1.5 feet during the base flood (FEMA 2011). Figure 5-10 shows a typical transect through Zone V, the Coastal A-Zone and Zone A, and the effects of energy dissipation and regeneration of a wave as it moves inland. Wave elevations are decreased by obstructions such as vegetation or rising ground (FEMA 2011). Since the LiMWA is indicated on the County's Effective FIRM (dated March 19, 2019), the 2016 Uniform Construction Code requires new buildings and substantially improved buildings to comply with the requirements for Zone V (San Bruno n.d.). However, federal flood insurance in CAZs is rated using Zone A rates (lower than Zone V rates) (FEMA 2021).

## 5.3.3 Frequency

Coastal flooding frequency is closely linked to the occurrence of coastal storm events. These storms, which include hurricanes, mid-latitude cyclones, and other severe weather systems, bring heavy rainfall, strong winds, and storm surges that can lead to significant flooding in coastal areas. The intensity and frequency of these storms directly correlate to the frequency of coastal flooding events (California Ocean Protection Council 2024).

**Figure 5-10. Transect Schematic of Zone V, Coastal A-Zone, Zone A, and Zone X**




Note: LiMWA = limit of moderate wave action; MiWA = Minimal Wave Action area; BFE = Base Flood Elevation; MoWA = Moderate Wave Action area

*Source: FEMA 2011*

In California, coastal flooding is influenced by factors such as atmospheric river storms and sea level rise. Atmospheric rivers can bring intense rainfall and cause significant flooding along the coast (DWR n.d.-i). Additionally, as sea levels rise due to climate change, even minor storms can result in more extensive flooding (NOAA Office for Coastal Management n.d.). Urban development in coastal areas can exacerbate the problem by reducing natural buffers like wetlands and dunes that help absorb storm impacts. Understanding these dynamics is crucial for effective coastal flood management and mitigation strategies in California.

## Climate Change Projections

Climate change projections indicate that California will face significant challenges related to coastal flooding in the coming decades. Rising sea levels, driven by global warming, are expected to exacerbate the frequency and severity of coastal flooding events. According to the California Climate Change Assessment, sea levels along the California coast could rise by up to 7 feet by 2100, significantly increasing the risk of flooding in coastal communities (California Climate Change Assessment 2019). This rise in sea levels will not only inundate low-lying areas but also amplify the impact of storm surges and high tides, leading to more frequent and severe flooding events (California Climate Change Assessment 2019).

In addition to sea level rise, the frequency and intensity of atmospheric river storms are projected to increase, further contributing to coastal flooding risks. These storms, which bring heavy rainfall and strong winds, can cause significant flooding and erosion along the coast (NOAA n.d.). The combination of higher sea levels and more intense storms will likely result in more frequent and severe coastal flooding, posing a threat to infrastructure, ecosystems, and communities (NOAA n.d.).

The impacts of these changes are already being observed, with increased coastal erosion and more frequent flooding events in recent years. The California Ocean Protection Council highlights the need for adaptive strategies to mitigate these risks, including the development of resilient infrastructure and the restoration of natural barriers such as wetlands and dunes (California Climate Adaptation Strategy 2025). By understanding and preparing for these projected changes, California can better protect its coastal communities and ecosystems from the growing threat of climate change

## 5.3.4 Warning Time

Due to the sequential pattern of meteorological conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for floods can be between 24 and 48 hours. Flash flooding can be less predictable, but potential hazard areas can be warned in advanced of potential flash flooding danger.

Each watershed has unique qualities that affect its response to rainfall or coastal flooding. A hydrograph, which is a graph or chart illustrating stream flow or tidal height in relation to time is a useful tool for examining a stream's response to rainfall or tidal water's response to storm surge.

The potential warning time a community has to respond to a flooding threat is a function of the time between the first measurable rainfall or start of storm surge and the first occurrence of flooding. The time it takes to recognize a flooding threat reduces the potential warning time for a community that has to take actions to protect lives and property. Another element that characterizes a community's flood threat is the length of time floodwaters remain above flood stage.

The NWS issues watches and warnings when forecasts indicate rivers or coastlines may approach bank-full levels. The flood extent or severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat:

- Minor Flooding—minimal or no property damage, but possibly some public threat or inconvenience.
- Moderate Flooding—some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations are necessary.
- Major Flooding—extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations (NWS 2005).

Orange County's flood warning capabilities are supported by a network of hydrologic monitoring stations that include approximately 10 active USGS stream gauges and one primary NOAA tidal monitoring station at Newport Beach (Station 9410580). Stream gauges provide continuous measurements of water surface elevation and streamflow, while the Newport Beach tide gauge monitors coastal water levels, tides, and storm surge conditions. Together, these monitoring systems support flood forecasting, situational awareness, and emergency response operations throughout the County.

Orange County utilizes the Automated Local Evaluation in Real Time (ALERT) flood warning system. Local tide gauges, rain gauges, and computer base stations are also utilized in the ALERT flood warning system. The System provides coastal flooding forecasts and the County employs AlertOC for mass notifications to keep residents informed during emergencies and flood events (OCPW n.d.).

## 5.3.5 Secondary Hazards

Coastal erosion associated with coastal flooding can be more damaging than the flooding itself. The relentless action of waves and storm surges can strip away beaches, dunes, and coastal infrastructure, leading to significant long-term impacts on the environment and property. Another secondary hazard is the potential for hazardous materials spills from any storage tanks compromised during a flood.

## 5.3.6 Vulnerability Assessment

### Land Exposure

Table 5-24 summarizes land areas exposed to the coastal flooding hazard.

**Table 5-24. Land Area Exposed to the Coastal Flooding Hazard**

| Jurisdiction | Total Land Area (Acres) Excludes Water Bodies | Land Area in Coastal Flooding Hazard Area | |
|---|---|---|---|
| | | Total Area (acres) | % of Jurisdiction Total |
| **Anaheim** | 32,170 | 0.0 | 0.0% |
| **Laguna Woods** | 2,116 | 0.0 | 0.0% |
| **Newport Beach** | 16,450 | 121.6 | 0.7% |
| **San Juan Capistrano** | 9,220 | 0.0 | 0.0% |
| **Santa Ana** | 17,531 | 0.0 | 0.0% |
| **Unincorporated County** | 174,768 | 28.9 | <0.1% |
| **Total** | **252,255** | **150.5** | **0.1%** |

Source: Orange County 2024; State of California Department of Water Resources, Division of Safety of Dams 2024; USACE 2024
Note: Excludes areas designated as water

### Population

#### Exposure

Table 5-25 summarizes the total population that would be exposed to the coastal flooding hazard area (1 percent annual chance coastal V/VE zone) for the planning area.

**Table 5-25. Population in the Coastal Flooding Hazard Area**

| Jurisdiction | Total Population (2020 Decennial) | Population in the Coastal Flooding Hazard Area | |
|---|---|---|---|
| | | Number of Persons | % of Jurisdiction Total |
| **Anaheim** | 346,824 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 6 | <0.1% |
| **San Juan Capistrano** | 35,196 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 0 | 0.0% |
| **Total** | **928,007** | **6** | **<0.1%** |

Source: U.S. Census Bureau 2020; USACE 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

Table 5-26 summarizes the degree of exposure certain population groups could experience during a coastal flooding event. The vulnerable population groups are described in further detail in Section 5.1. In short, the selected socio-demographic groups were considered more vulnerable because they, on average, have more difficulty responding to and recovering from a flood hazard event relative to other socio-demographic groups.

**Table 5-26. Vulnerable Population Located in the Coastal Flooding Hazard Area**

| Jurisdiction | Estimated Number of Vulnerable Persons Located in the Coastal Flooding Hazard Area | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Persons Over 65 | % of Total | Persons Under 5 | % of Total | Non-English Speaking Persons | % of Total | Persons with a Disability | % of Total | Persons in Poverty | % of Total |
| **Anaheim** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Laguna Woods** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Newport Beach** | 1 | <0.1% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **San Juan Capistrano** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Santa Ana** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Unincorporated County** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Total** | **1** | **<0.1%** | **0** | **0.0%** | **0** | **0.0%** | **0** | **0.0%** | **0** | **0.0%** |

Source: U.S. Census Bureau, American Community Survey 2023; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024).

### Impacts

Table 5-27 shows the results of the Hazus analysis on population. Review of mapping of the 1-percent annual chance flood event and sea level rise mapping shows that even in the most minor of the flooding conditions, the majority of the participating jurisdictions, which include the AB/HH Watershed, are flooded. This means all evacuation routes which service these areas are also vulnerable to flood hazards. As Orange County has the Anaheim Bay/Huntington Harbor watershed, other major watersheds, and the Pacific Ocean as sources of flooding, some communities are uniquely prone to dangerous over wash and wave damage during large coastal storms. Evacuations of the entire coastal and riverine communities are likely to be ordered under each flooding scenario, resulting in the need for short-term shelter outside of municipal boundaries.

**Table 5-27. Coastal Flooding Impacts on People**

| Jurisdiction | Total Population (2020 Decennial) | Coastal Flooding Impacts on People | |
|---|---|---|---|
| | | Displaced Population | Persons Seeking Short-Term Shelter |
| **Anaheim** | 346,824 | 0 | 0 |
| **Laguna Woods** | 17,644 | 0 | 0 |
| **Newport Beach** | 85,239 | 105 | 7 |
| **San Juan Capistrano** | 35,196 | 0 | 0 |
| **Santa Ana** | 310,227 | 0 | 0 |
| **Unincorporated County** | 132,877 | 7 | 0 |
| **Total** | **928,007** | **112** | **7** |

Source: Hazus v6.1; U.S. Census Bureau 2020; State of California, Natural Resources Agency and Ocean Protection Council 2018; USGS 2024

## Buildings and Property

### Exposure

Table 5-28 shows the results of the vulnerability analysis on the buildings in the planning area. Table 5-29 shows the breakdown of buildings located in coastal flooding hazard area by occupancy class.

### Impacts

Table 5-30 show the Hazus analysis results on those buildings in the FMP Planning Area.

## Critical Facilities Exposure and Impacts

An exposure analysis of was performed on all critical facilities collected throughout the County and the FMP participating jurisdictions. This was accomplished by importing all critical facility points into a GIS and then overlaying the SFHA coastal V/VE zones, generating a frequency count of all critical facilities exposed to the coastal high-hazard flood type. The analysis found no critical facilities exposed to the Coastal High Hazard Flood Zones—Zone V/VE. Given that there are no critical facilities exposed to the Coast Zone V/VE, there is also no impact to be identified through a Hazus analysis.

### Table 5-28. Buildings in Coastal Flood Hazard Area (V/VE)

| Jurisdiction | Total Buildings | | Buildings in the Coastal Flood Hazard Area | | | |
|---|---|---|---|---|---|---|
| | | | Number of Buildings | | Replacement Cost Value | |
| | Count | Replacement Cost Value | Count | % of Jurisdiction Total | Value | % of Jurisdiction Total |
| **Anaheim** | 66,553 | $178,343,603,814 | 0 | 0.0% | $0 | 0.0% |
| **Laguna Woods** | 3,519 | $10,117,235,987 | 0 | 0.0% | $0 | 0.0% |
| **Newport Beach** | 31,118 | $84,976,395,506 | 3 | <0.1% | $1,766,945 | <0.1% |
| **San Juan Capistrano** | 10,465 | $19,621,067,650 | 0 | 0.0% | $0 | 0.0% |
| **Santa Ana** | 51,451 | $128,949,333,589 | 0 | 0.0% | $0 | 0.0% |
| **Unincorporated County** | 34,945 | $43,975,080,160 | 0 | 0.0% | $0 | 0.0% |
| **Total** | **198,051** | **$465,982,716,705** | **3** | **<0.1%** | **$1,766,945** | **<0.1%** |

Source: USACE 2022; Orange County 2021; RS Means 2024; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

### Table 5-29. Buildings in the Coastal Flood Hazard Area by General Occupancy Class

| Jurisdiction | Buildings in the Coastal Flood Hazard Area | | | |
|---|---|---|---|---|
| | Residential | Commercial | Industrial | Other[a] |
| **Anaheim** | 0 | 0 | 0 | 0 |
| **Laguna Woods** | 0 | 0 | 0 | 0 |
| **Newport Beach** | 2 | 1 | 0 | 0 |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 |
| **Santa Ana** | 0 | 0 | 0 | 0 |
| **Unincorporated County** | 0 | 0 | 0 | 0 |
| **Total** | **2** | **1** | **0** | **0** |

Source: USACE 2022; Orange County 2021; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

a. Other = Government, Religion, Agricultural, and Education

### Table 5-30. Coastal Flooding Impacts on Buildings

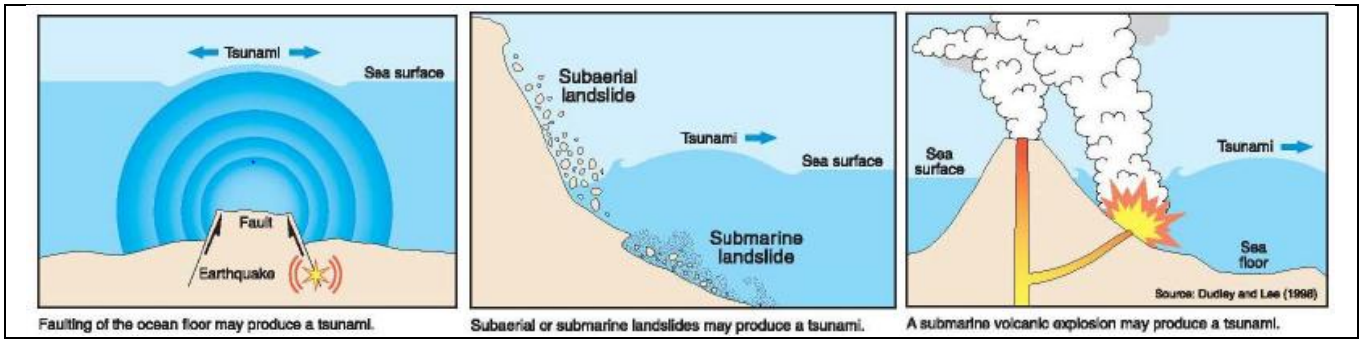
| Jurisdiction | Total Replacement Cost Value | Estimated Building Loss Due to Coastal Flooding | | | | |
|---|---|---|---|---|---|---|
| | | All Occupancies | | Occupancy Type | | |
| | | Loss | % of Total | Residential | Commercial | Other |
| **Anaheim** | $178,343,603,814 | $0 | 0.0% | $0 | $0 | $0 |
| **Laguna Woods** | $10,117,235,987 | $0 | 0.0% | $0 | $0 | $0 |
| **Newport Beach** | $84,976,395,506 | $154,496 | <0.1% | $145,261 | $9,235 | $0 |
| **San Juan Capistrano** | $19,621,067,650 | $0 | 0.0% | $0 | $0 | $0 |
| **Santa Ana** | $128,949,333,589 | $0 | 0.0% | $0 | $0 | $0 |
| **Unincorporated County** | $43,975,080,160 | $0 | 0.0% | $0 | $0 | $0 |
| **Total** | **$465,982,716,705** | **$154,496** | **<0.1%** | **$145,261** | **$9,235** | **$0** |

Source: Hazus v6.1; USACE 2022; Orange County 2021; RS Means 2024; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

## 5.4 TSUNAMI

A tsunami is a large wave (or series of waves) of water typically triggered by seismic or geologic events, as shown in Figure 5-11. While tsunamis can be caused by landslides or volcanic eruption, the most common cause is by earthquake. Tsunamis triggered by an earthquake are referred to as “tsunamigenic earthquakes.” Earthquakes generate tsunamis when the sea floor abruptly deforms and displaces the overlying water from its equilibrium position. Waves are formed as the displaced water mass, which acts under the influence of gravity, attempts to regain its equilibrium. In general, scientists believe it requires an earthquake of at least a magnitude 7.0 to produce a tsunami. This is especially the case during large, submarine earthquakes (magnitude 8 or higher) that create an upward movement of the sea floor, pushing the seawater above the seafloor upward. This motion radiates waves of seawater out and away from source region in all directions. These radiating waves of water are what are known as a tsunami.

**Figure 5-11. Triggers for Tsunamis**



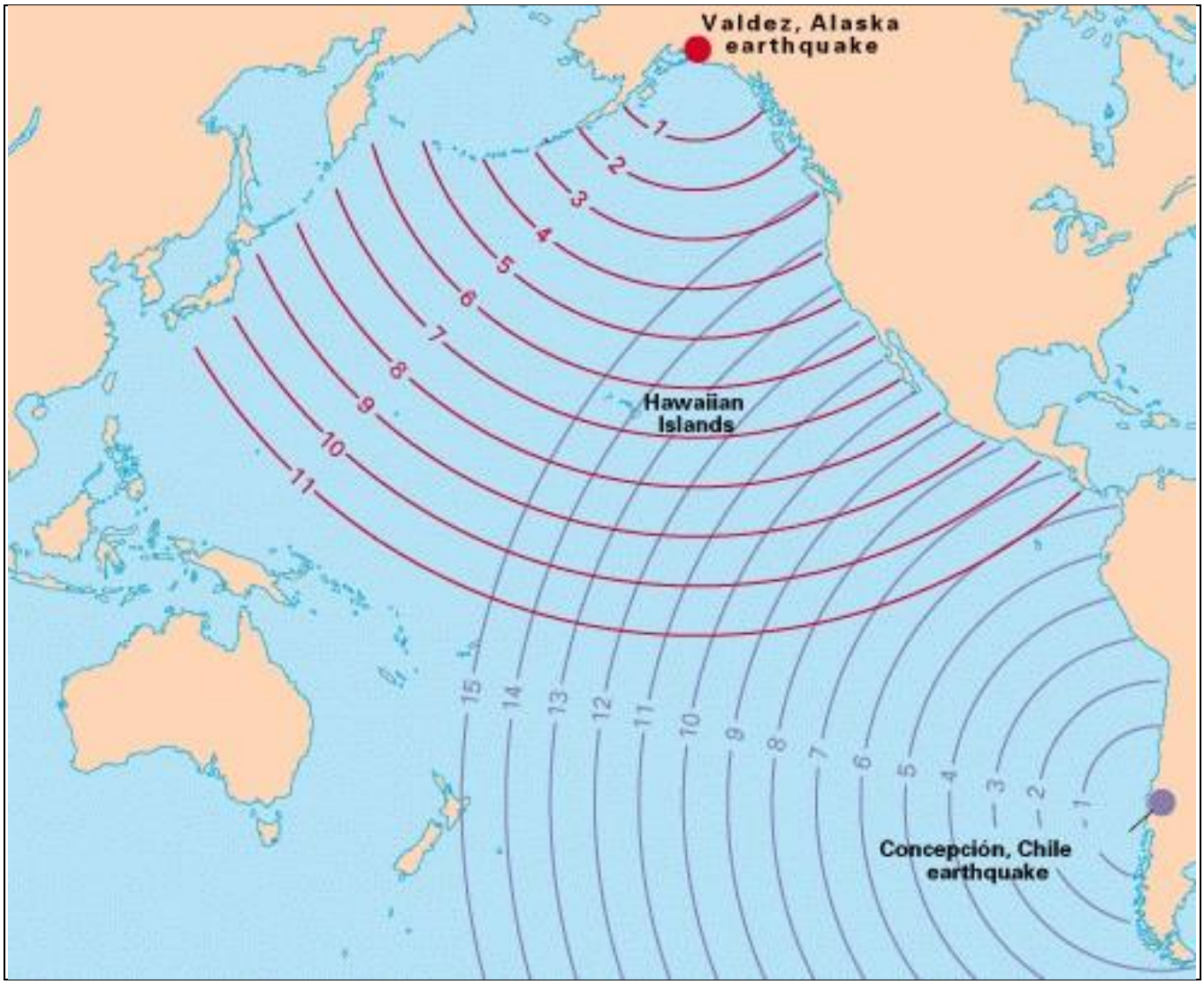

*Source: (USGS-California Water Science Center n.d.)*

Tsunamis are capable of traveling at speeds up to 500 miles per hour in the open ocean. The stronger the seismic event, the faster the tsunami moves. Figure 5-12 shows the time it takes for tsunamis to travel from two different source locations (USGS 1999).

### 5.4.1 Location

Once a tsunami wave approaches the shoreline, the underwater depths begin to decrease. As this happens, the tsunami slows down and wave energy is transferred from horizontal to vertical and the wave begins to increase in height (California Geologic Survey n.d.). During a tsunami event, the first wave in the series is smaller in size, with the second waves forming much larger and being more impactful. As tsunamis reach the coastline, they may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). Tsunami impacts are a function of the waves overall size and speed as it reaches a given stretch of shoreline. Size and speed of the wave are determined not only by the triggering event, but the shape of the coastline and variations un the underwater topography (i.e., bathymetry).

**Figure 5-12. Tsunami Travel Time (Hours)**




*Source: (USGS 1999)*

Changes to the underwater topography can be affected by the presence of canyons and trenches. Off-shore islands can focus, re-direct, or disperse a tsunami's wave energy. Further, the orientation of a particular stretch of coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on the coast and much larger at other points. It is also important to note that the presence of bays, harbors, inlets, rivers, streams, and flood control channels can have an impact on the level of tsunami related damage. There have been studies where findings show tsunami waves entering a flood control channel can be focused and extend in excess of one mile from the coastline. This can be exacerbated if a tsunami wave strikes a channel at the same time as high-tide (American Meteorological Society (AMS) 2007).

## 5.4.2 Severity

The severity of damage from a tsunami is directly associated with wave height, which in turn determines how far inland from the coastline inundation may occur. According to NOAA, tsunami events with run-ups of more than 1 meter (about 3 feet) are the most likely to be dangerous to people and property (NOAA 2023). In their scientific research on tsunami risk in California, the USGS examines predicted tsunami run-up heights along with their primary triggering locations (sources). Figure 5-13 shows these predicted values for Orange County and several communities along its coastline (USGS 2013). Note that these tsunami run-up heights are the maximum predicted height for both distant and local sources.

**Figure 5-13. Predicted Maximum Run-up Heights and Primary Sources in Orange County.**

| Location | County | Maximum onshore runup elevation (feet) | Distant source | | Local source | |
|---|---|---|---|---|---|---|
| | | | High incoming wave elevation (feet) | Source for maximum run-up | High incoming wave elevation (feet) | Source for maximum run-up |
| Huntington Beach | Orange | 16.40 | 8.20 | Aleutians 3 | 15.74 | Palos Verdes slide no.2 |
| Newport Beach | Orange | 15.74 | 4.59 | Aleutians 3 | 13.45 | Catalina Fault |
| Dana Point | Orange | 20.01 | 6.89 | Aleutians 3 | 13.12 | San Mateo thrust fault |
| San Clemente | Orange | 17.06 | 6.23 | Aleutians 3 | 16.07 | San Mateo thrust fault |

*Source: Appendix 1, from (USGS 2013)*

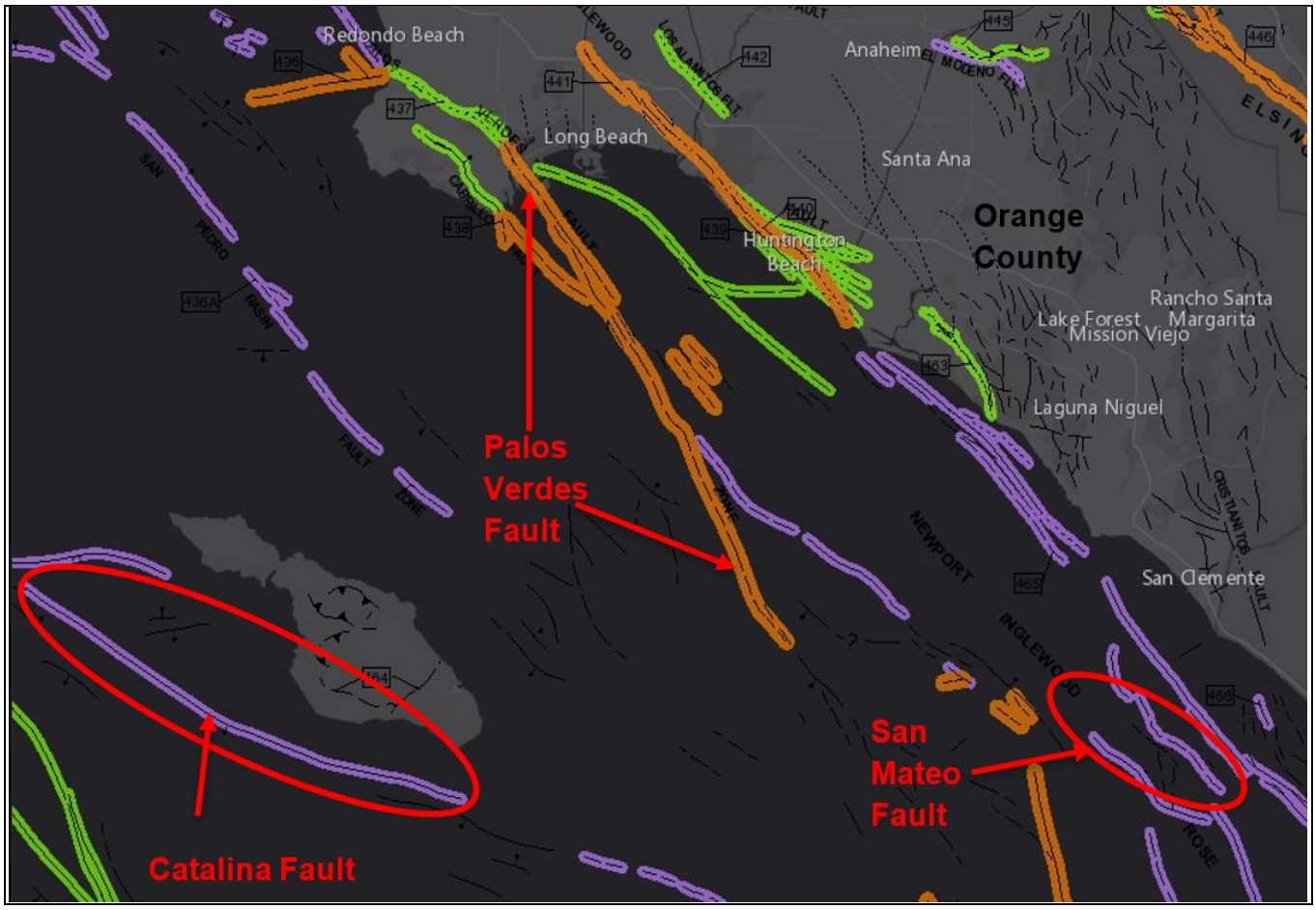
The Palos Verdes, Catalina, and San Mateo faults trigger the greatest maximum wave run-up heights for Orange County. These three faults, of course, are not the only local tsunami triggers affecting Orange County and its coastline. However, identifying these faults increases the ability to identify the source regions for tsunami events of particular concern to the County and its communities. Figure 5-14 shows these faults in relation to Orange County (California Geologic Survey n.d.). Furthermore, understanding the source regions for local tsunamis assists scientists and emergency preparedness officials in targeting their monitoring and response efforts.

The USGS report also provides some insight regarding tsunami exposure through the use of indexing multiple risk factors into a singular metric. This metric, entitled *Composite Indices of Risk Exposure*, normalizes a series of vulnerability factors (population density, business exposure, demographics, etc.), and combines them to a single tsunami inundation risk index (USGS 2013). Figure 5-15 shows these index values for Orange County and selected cities within it.

## 5.4.3 Frequency

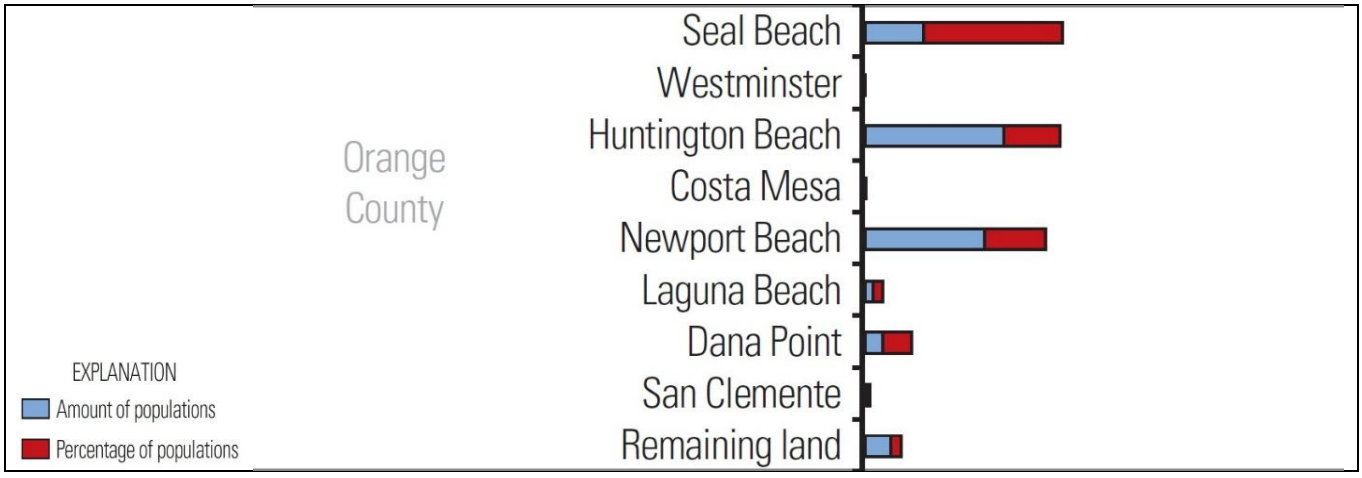
According to the State of California Geologic Survey, there have been more than 80 tsunamis (recorded or observed) that have impacted the California coastline and their communities. Of those, only 10 tsunami events have been significant enough to cause appreciable damage to property and risk to life. Table 5-31 is a list of noteworthy tsunami events impacting the State of California. (California Geologic Survey n.d.)

**Figure 5-14. Southern California/Orange County Fault Activity**




*Source. (California Geologic Survey n.d.)*

**Figure 5-15. Orange County Tsunami Risk—Sum of Normalized Composite Values**




*Source: (USGS 2013)*

**Table 5-31. Historic California Tsunami Events**

| Year | Description of Event |
|---|---|
| **1700** | Cascadia subduction zone (CSZ) earthquake and tsunami impacted northern California and is a source for oral histories of the first peoples. |
| **1812** | An earthquake near Santa Barbara caused a tsunami which caused the first peoples (Chumash) to move their habitation sites from Santa Rosa Island to the La Purisma Mission near Santa Barbara. |
| **1946** | A magnitude M8.6 Alaska/Aleutian earthquake triggered tsunami flooded portions of Half Moon Bay, CA and other locations, caused damages in excess of $150,000 (2022 dollars), and led to 1 fatality in CA. |
| **1960** | Crescent City, CA, was inundated by tsunami from the magnitude M9.5 earthquake in Chile that led to 1 death in the state and nearly $1,000,000 (2022 dollars) in damages. |
| **1964** | Crescent City, CA, was inundated by tsunami generated by the magnitude M9.2 Good Friday earthquake in Alaska that led to 13 deaths in the state. Damage in CA exceeded $160 million (2022 dollars). |
| **1992** | The most recent locally sourced tsunami generated by the magnitude M7.2 Cape Mendocino earthquake caused waves to be recorded on NOAA tide gages statewide. |
| **2006** | Tsunami sourced from the magnitude M8.3 Kuril Islands earthquake in the NW Pacific Ocean generated strong currents and caused $20 million in damage in Crescent City, CA. |
| **2010** | A magnitude M8.8 earthquake in Chile generated tsunami waves that caused millions in damage in CA. Left: Photo taken during the tsunami as it caused damage to docks at Shelter Island, San Diego, CA. |
| **2011** | The Great East Japan earthquake and tsunami caused hazardous currents and surges in CA resulting in over $100 million in damage to marinas and harbors. |
| **2022** | Collapse of a volcano in the Kingdom of Tonga produced tsunami flooding along the coast of CA, generated strong currents, and caused $8-10 million in damage. |

Source: (California Geologic Survey n.d.)

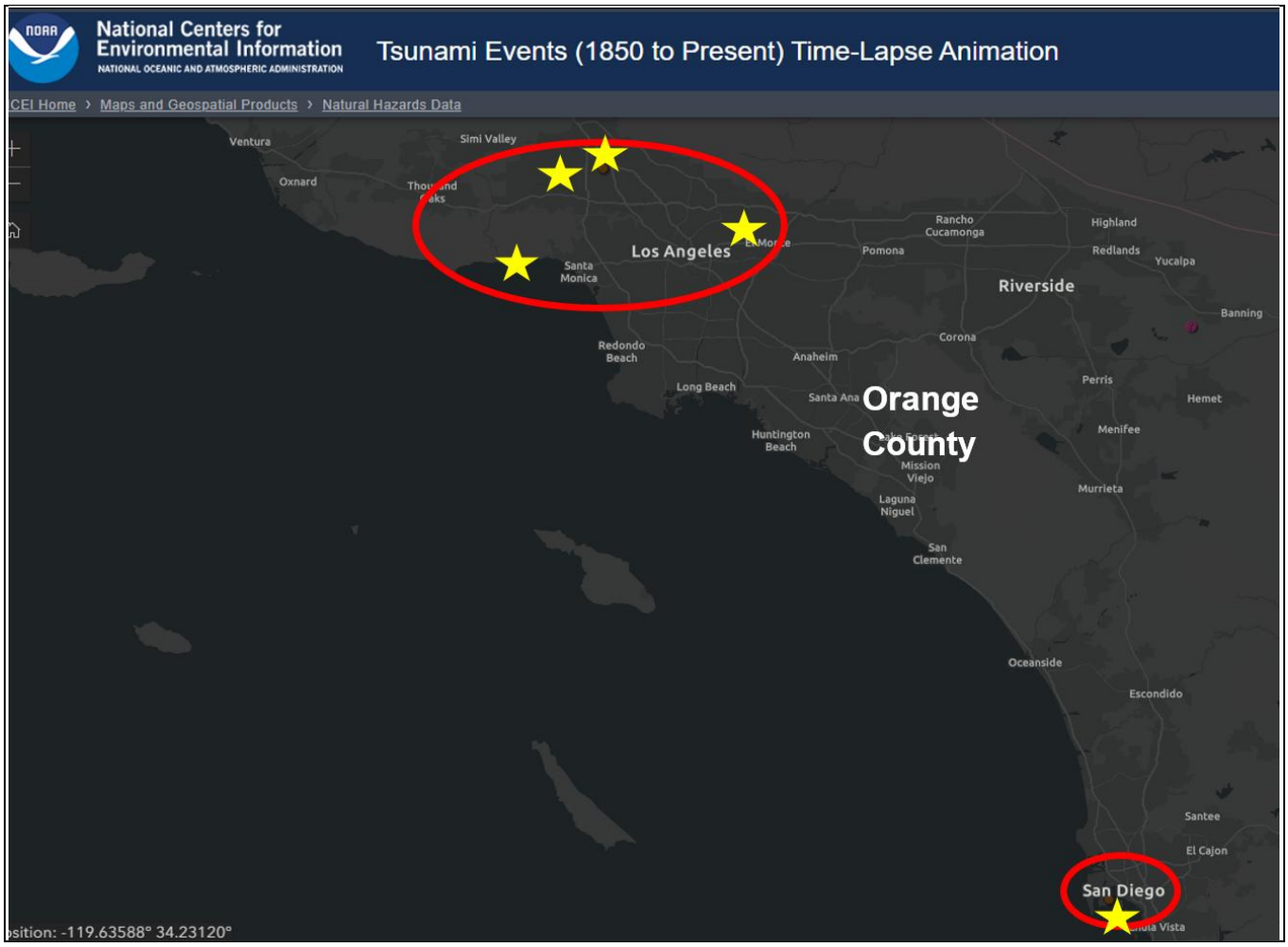
In terms of frequency of occurrence to Southern California and the Orange County coastline, there has been very little recorded tsunami activity (see Figure 5-16). Examining historical data from the NOAA National Center for Environmental Information (NCEI) from 1850 to the present, reveals that there was only one recorded tsunami event occurring in southern California (NOAA NCEI n.d.). This lone event was recorded off the immediate coast of San Diego, with a total wave-run up recorded at approximately 3.9 feet (1.2 meters). Even with the very limited frequency of occurrence, tsunami events can be very dangerous and cause tremendous damage. NOAA cites that since the early 1900's, thirty-four (34) tsunamic events have killed over 500 people and cost the U.S. over 1.7 billion dollars in damage to its coastal states and territories (NOAA n.d.).

## 5.4.4 Warning Time

### Initial Signs of Tsunami

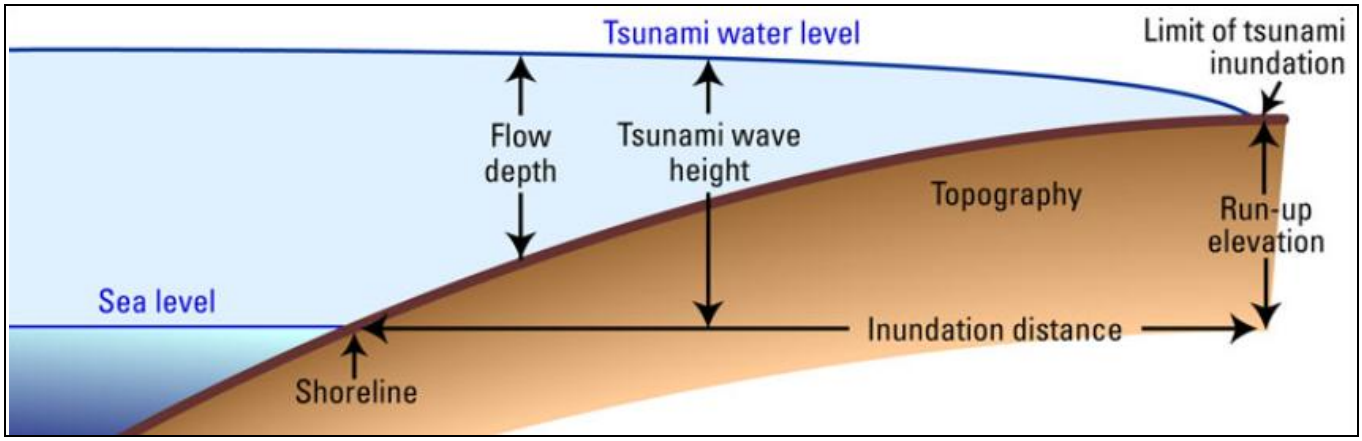
Tsunami hazard recognition is critical in that it plays a major role in how quickly a community can response to the hazard event. However, recognizing the onset of a tsunami event is challenging given the low frequency of occurrence, and compounded in that only a small percentage of people have experienced one directly. Further complicating the ability to recognize the onset of a tsunami is that the first signs can be very different depending on the nature of the triggering event. For instance, the first visible signs of a tsunami may be a rise in water level. This may at first appear to look like a rising tide. In the case of a tsunami, the rate of tidal rise is much faster, and the resulting wave action does not break in the same way as a typical wave. Additionally, this surge of water does not stop at the shoreline and pushes above normal sea level tidal reach. This phenomenon is called "run-up" (see Figure 5-17).

**Figure 5-16. Historical Southern California Tsunami Events—1850 to Present**




*Source: (NOAA NCEI n.d.)*

**Figure 5-17. Run-up Distance and Height in Relation to the Datum and Shoreline**




*Source: USGS, 2010.*

In cases where the surge in water is seen as small (3 to 6 feet), this height in water level is enough to move vehicles, small structures, boats, and large debris, causing mass amounts of damage withing the run-up zone. Conversely, the first indication of an approaching tsunami may be a mass recession of water (draw down) ahead of the large wave crest. If the drawdown is rapid enough, harbor inlets and channels, roads, buildings, bulkheads, and other structures can be severely damaged as the erosive power of tidal exodus scours and erodes the shore, scours piers and pilings, pulls docked boats from their moorings. For boating vessels that are out in the open water, the recession of water and the currents they produce are enough to capsize or sink them.

## Warning Systems

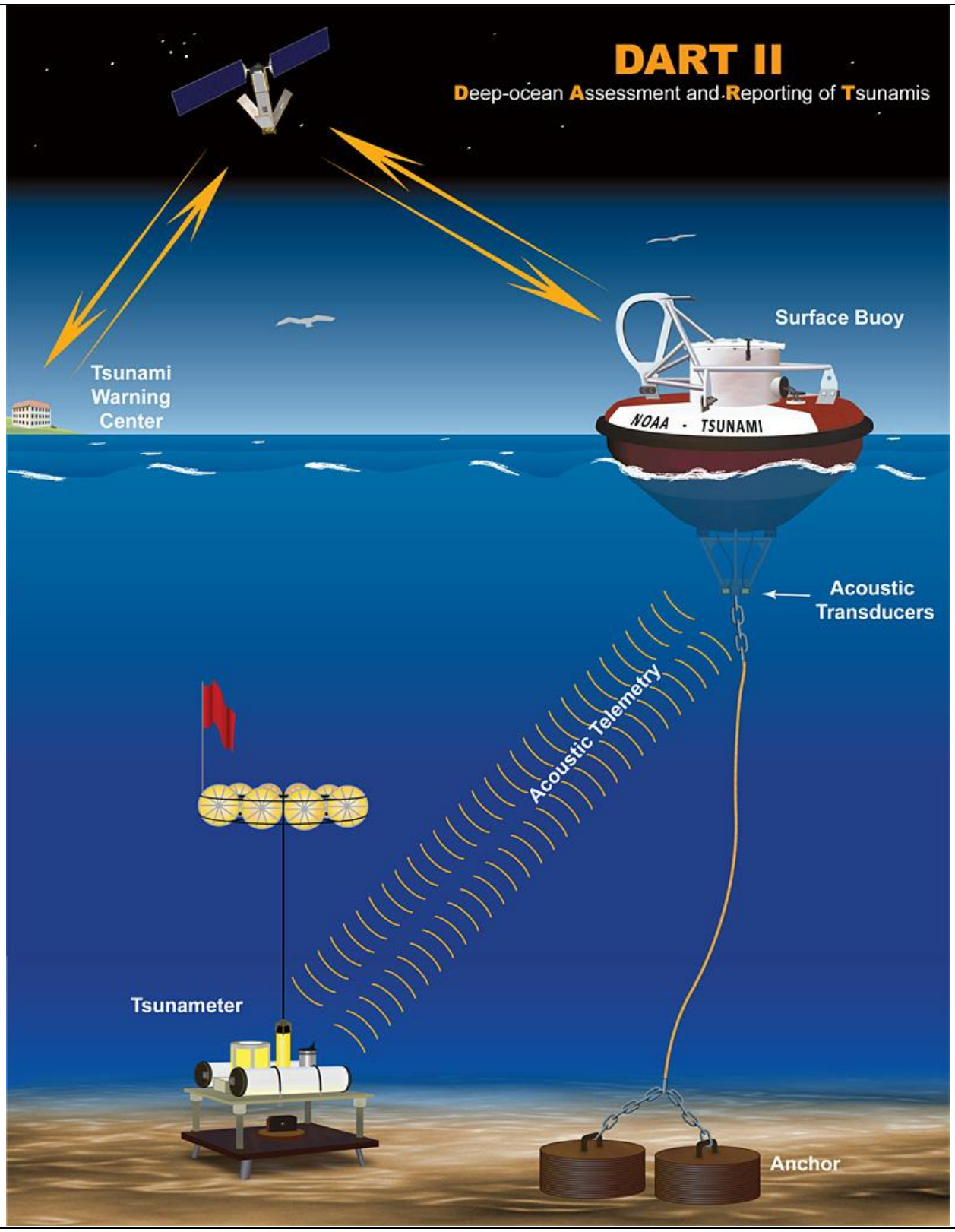
The amount of warning time for a tsunami's impacts is, in large part, determined by how far away the triggering event occurs. To this end, a local tsunami is one where the origin event (i.e. earthquakes) occurs relatively close to the coastline, versus a distant tsunami, where the triggering event occurs much farther away, such as around the Pacific rim or Ring of Fire (USGS Pacific Coastal and Marine Science Center n.d.). Given their relatively close proximity to affected shorelines, local tsunamis provide far less warning and response times. Distant tsunamis, however, can travel for hours before striking a coastline, providing more time to a potentially impacted community to provide warning to their residents and respond accordingly. Typical signs of a tsunami hazard are earthquakes and/or sudden and unexpected rise or fall in coastal water, where the resulting large waves are often preceded by coastal flooding and followed by a quick recession of the water. In the open ocean, tsunamis are difficult to detect due to their relatively low wave height—often less than 3 feet.

Administered by the National Weather Service (NWS), the National Tsunami Warning Center (NTWC) located in Palmer, Alaska, is a cooperative effort which serves the continental United States, Alaska and Canada. The NTWC is the primary warning system for the U.S. west coast, and includes numerous seismic stations, water level stations and information distribution centers (NOAA-NWS 2024).

The U.S. National Tsunami Hazard Mitigation Program implemented the Deep-Ocean Assessment and Reporting of Tsunami (DART) project to ensure detection of tsunamis and to acquire data critical to real-time forecasts. DART systems consist of an anchored seafloor bottom pressure recorder and a moored surface buoy for real-time communications. An acoustic link transmits data from the recorder on the seafloor to the surface buoy. The surface buoy transmits data to the NWS Telecommunications Gateway, which then distributes it in real-time to the NTWC. Figure 5-18 depicts the operation of the DART System (NOAA Center for Tsunami Research n.d.).

In the event earthquakes meet specified criteria, the NTWC issues U.S. message alerts through a variety of methods to emergency management teams, dedicated public officials, news and/or media outlets, and the public in general. Additionally, the NTWC issues messages to the Pacific Tsunami Warning Center (PTWC) based in Hawaii, as well as international agencies that may be impacted by an incoming tsunami event. The NTWC issues four levels of alert messages—Information, Watch, Advisory, and Warning. The most urgent of these messages is Warning level, at which time, these messages are sent to all forms of communication outlets including phone, wireless carriers, local news and radio stations, emergency alert systems, the NOAA Weather Radio network and NOAA websites. Messages may also be sent through outdoor alert siren networks and directly from the local first responder offices (NOAA n.d.). Once warning messages have been issues, scientists across multiple agencies begin to use real-time data to model and size and speed of the incoming tsunami wave, estimate its time of arrival and impact, and model its potential impacts.

**Figure 5-18. Operations of the DART II System**




*Source: (NOAA-NWS 2024).*

## 5.4.5 Secondary Hazards

Port facilities, naval facilities, fishing fleets and public utilities are often the backbone of the economy of the affected areas, and these are the resources that generally receive the most severe damage. Until debris can be cleared, wharves and piers rebuilt, utilities restored, and fishing fleets reconstituted, communities may find themselves without fuel, food and employment. Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

## 5.4.6 Vulnerability Assessment

Vulnerability analysis was performed to understand the impacts a tsunami event may have on population and structures in Orange County. The California Dept. of Conservation California Geologic Survey (CGS) in partnership with the California Governor's Office of Emergency Services provided projected tsunami inundation data. The projected inundation zone, shown in Figure 5-19, uses a probabilistic approach and a recurrence interval of 975 years. The vulnerability analysis examines tsunami impacts to physical land surface, overall population, vulnerable population groups, displaced population, physical buildings (count), building valuations and replacement costs, as well as debris generation.

### Land Exposure

Projected tsunami inundation areas result in potential exposure of land areas. These results are summarized in Table 5-32.

**Table 5-32. Land Area Potentially Exposed to Tsunami**

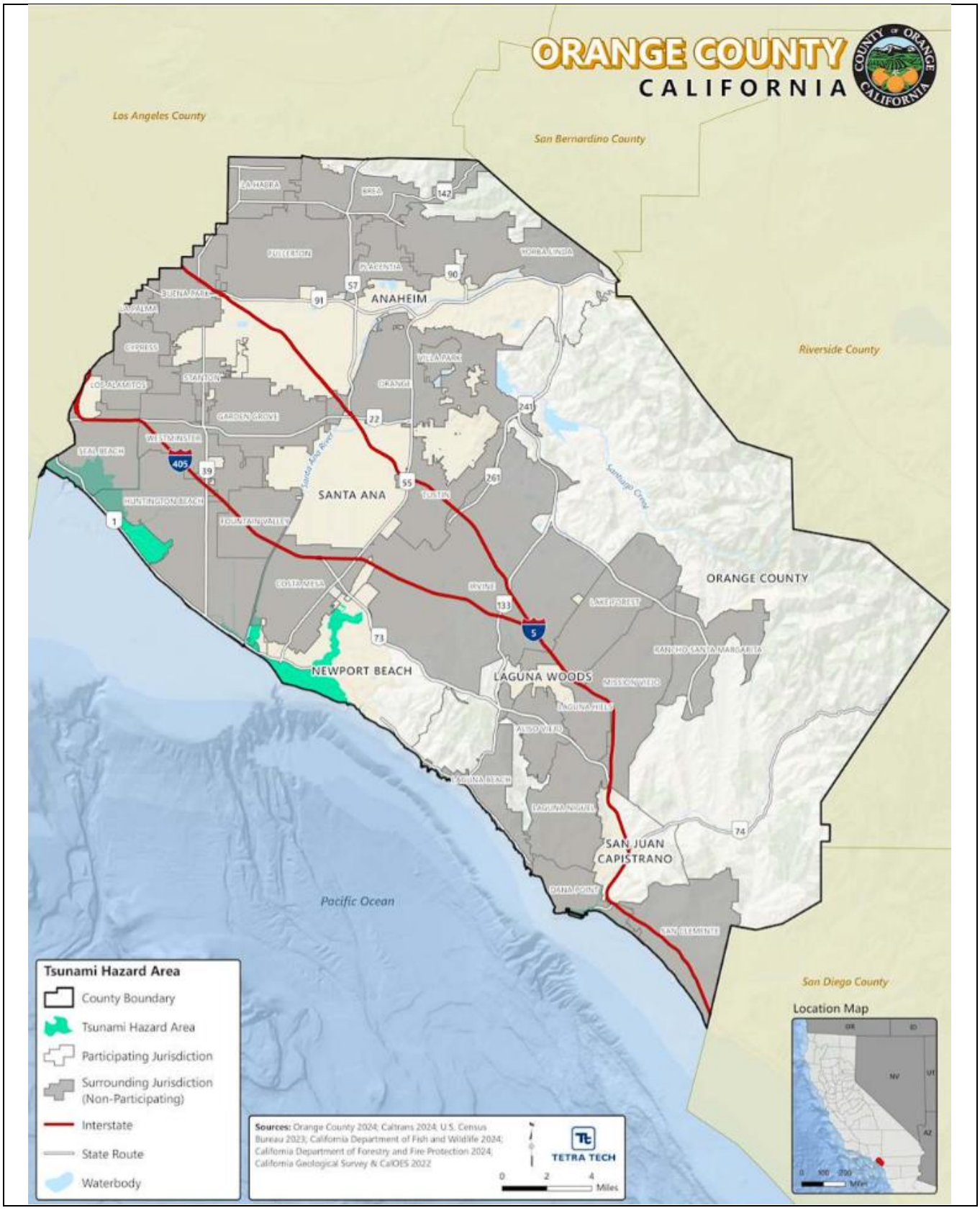
| Jurisdiction | Total Land Area (Acres) | Inundated Land Area [a] | |
|---|---|---|---|
| | | Total Area (Acres) | % of Jurisdiction |
| **Anaheim** | 32,170 | 0 | 0% |
| **Laguna Woods** | 2,116 | 0 | 0% |
| **Newport Beach** | 16,450 | 43,932 | 20% |
| **San Juan Capistrano** | 9,220 | 0 | 0% |
| **Santa Ana** | 17,531 | 0 | 0% |
| **Unincorporated County** | 174,768 | 357 | 1.1% |
| **Total** | **252,255** | **44,289** | **2.0%** |

a. Land area excludes areas designated as water

### Population Exposure and Impact

Table 5-33 summarizes population exposed and impacted by the projected tsunami inundation areas. Projected tsunami inundation areas result in potential exposure of socio-demographic groups identified as most vulnerable. These results are summarized in Table 5-34 through Table 5-38.

**Figure 5-19. Tsunami Hazard Area in Orange County**



### Table 5-33. Tsunami Exposure and Impacts on People

| Jurisdiction | Total Population (2020 Decennial) | Tsunami Population Exposure | | Tsunami Impacts on People [a] | |
|---|---|---|---|---|---|
| | | Tsunami Impacted Population | % of Total | Displaced Population | Persons Seeking Short-Term Shelter |
| **Anaheim** | 346,824 | 0 | 0% | 0 | 0 |
| **Laguna Woods** | 17,644 | 0 | 0% | 0 | 0 |
| **Newport Beach** | 85,239 | 24,091 | 28.3% | 16,709 | 237 |
| **San Juan Capistrano** | 35,196 | 0 | 0% | 0 | 0 |
| **Santa Ana** | 310,227 | 0 | 0% | 0 | 0 |
| **Unincorporated County** | 132,877 | 180 | 0.1% | 68 | 0 |
| **Total** | **928,007** | **24,271** | **2.6%** | **16,777** | **237** |

a. Output generated by Hazus v6.1 software

### Table 5-34. Tsunami Exposure of Persons Under Age 5

| Jurisdiction | Total Population (2020 Decennial) | Total Persons Under 5 Years | Tsunami Exposure of Persons Under 5 Years | % of Total Population Under 5 Years |
|---|---|---|---|---|
| **Anaheim** | 346,824 | 20,133 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 0 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 2,986 | 843 | 28.3% |
| **San Juan Capistrano** | 35,196 | 1,592 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 17,114 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 7,265 | 9 | 0.1% |
| **Total** | **928,007** | **49,090** | **852** | **1.7%** |

Source: USCB 2020

### Table 5-35. Tsunami Exposure of Persons Over Age 65

| Jurisdiction | Total Population (2020 Decennial) | Total Persons Over 65 Years | Tsunami Exposure of Persons Over 65 Years | % of Total Population Over 65 Years |
|---|---|---|---|---|
| **Anaheim** | 346,824 | 43,582 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 14,393 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 19,711 | 5,571 | 28.3% |
| **San Juan Capistrano** | 35,196 | 7,124 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 34,612 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 20,221 | 27 | 0.1% |
| **Total** | **928,007** | **139,643** | **5,598** | **4.0%** |

Source: USCB 2020

### Table 5-36. Tsunami Exposure of Non-English-Speaking Persons

| Jurisdiction | Total Population (2020 Decennial) | Total Non-English Speaking Persons | Tsunami Exposure of Non-English Speaking Persons | % of Total Non-English Speaking Persons |
|---|---|---|---|---|
| **Anaheim** | 346,824 | 31,488 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 3,938 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 2,129 | 601 | 28.3% |
| **San Juan Capistrano** | 35,196 | 554 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 29,038 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 6,873 | 9 | 0.1% |
| **Total** | **928,007** | **74,020** | **610** | **2.3%** |

Source: USCB 2020

### Table 5-37. Tsunami Exposure of Persons with Disability

| Jurisdiction | Total Population (2020 Decennial) | Total Persons with Disability | Tsunami Exposure of Persons with Disability | % of Total Persons with Disability |
|---|---|---|---|---|
| **Anaheim** | 346,824 | 33,991 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 5,125 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 6,962 | 1,967 | 28.3% |
| **San Juan Capistrano** | 35,196 | 3,572 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 26,434 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 10,421 | 14 | 0.1% |
| **Total** | **928,007** | **86,505** | **1,981** | **2.3%** |

Source: USCB 2020

### Table 5-38. Tsunami Exposure of Persons in Poverty

| Jurisdiction | Total Population (2020 Decennial) | Total Persons in Poverty | Tsunami Exposure of Persons in Poverty | % of Total Persons in Poverty |
|---|---|---|---|---|
| **Anaheim** | 346,824 | 42,477 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 1,954 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 6,134 | 1,733 | 28.3% |
| **San Juan Capistrano** | 35,196 | 2,530 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 34,155 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 7,972 | 10 | 0.1% |
| **Total** | **928,007** | **95,222** | **1,743** | **1.8%** |

Source: USCB 2020

## Buildings and Property

Table 5-39 lists the total number of buildings and replacement cost value by FMP participating jurisdiction.

**Table 5-39. Total Buildings and Replacement Cost Value (RCV)**

| Jurisdiction | Total Buildings | |
|---|---|---|
| | Count | Replacement Cost Value |
| **Anaheim** | 66,553 | $178,343,603,814 |
| **Laguna Woods** | 3,519 | $10,117,235,987 |
| **Newport Beach** | 31,118 | $84,976,395,506 |
| **San Juan Capistrano** | 10,465 | $19,621,067,650 |
| **Santa Ana** | 51,451 | $128,949,333,589 |
| **Unincorporated County** | 34,945 | $43,975,080,160 |
| **Total** | **198,051** | **$465,982,716,705** |

## Exposure

Table 5-40 summarizes the estimated number and RCV of buildings that could be exposed to a tsunami. Table 5-41 shows the distribution of these buildings by occupancy class.

**Table 5-40. Building Exposure to Tsunami Hazard**

| Jurisdiction | Buildings Potentially Exposed to Tsunami Hazard Area | | | |
|---|---|---|---|---|
| | Number of Buildings | | Replacement Cost Value | |
| | Count | % of Jurisdiction Total | Value | % of Jurisdiction Total |
| **Anaheim** | 0 | 0.0% | $0 | 0.0% |
| **Laguna Woods** | 0 | 0.0% | $0 | 0.0% |
| **Newport Beach** | 8,605 | 27.7% | $10,792,073,755 | 12.7% |
| **San Juan Capistrano** | 0 | 0.0% | $0 | 0.0% |
| **Santa Ana** | 0 | 0.0% | $0 | 0.0% |
| **Unincorporated County** | 45 | 0.1% | $65,975,905 | 0.2% |
| **Total** | **8,650** | **4.4%** | **$10,858,049,660** | **2.3%** |

**Table 5-41. Buildings Potentially Exposed to a Tsunami, by Occupancy Classification**

| Jurisdiction | Total Exposed Buildings | Residential | Commercial | Industrial | Other[a] |
|---|---|---|---|---|---|
| **Anaheim** | 0 | 0 | 0 | 0 | 0 |
| **Laguna Woods** | 0 | 0 | 0 | 0 | 0 |
| **Newport Beach** | 8,605 | 7,796 | 701 | 79 | 29 |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 | 0 |
| **Santa Ana** | 0 | 0 | 0 | 0 | 0 |
| **Unincorporated County** | 45 | 45 | 0 | 0 | 0 |
| **Total** | **8,650** | **7,841** | **701** | **79** | **29** |

a. Other = Government, Religious, Agricultural, and Educational Occupancy

## Impacts

Table 5-42 provides a loss estimate for buildings impacted by a projected tsunami for each FMP participating jurisdiction, and for each building occupancy class.

**Table 5-42. Tsunami Impacts on Buildings—Estimated Losses by Occupancy Class**

| Jurisdiction | Total Building Count | Total Tsunami Impacted Buildings | Tsunami Impacts on Buildings—Estimated Loss[a] | | | |
|---|---|---|---|---|---|---|
| | | | All Occupancies | Residential Properties | Commercial Properties | All Other Occupancies |
| **Anaheim** | 66,553 | 0 | 0 | 0 | 0 | 0 |
| **Laguna Woods** | 3,519 | 0 | 0 | 0 | 0 | 0 |
| **Newport Beach** | 31,118 | 8,605 | $944,327,698 | $698,415,133 | $224,390,229 | $21,522,336 |
| **San Juan Capistrano** | 10,465 | 0 | 0 | 0 | 0 | 0 |
| **Santa Ana** | 51,451 | 0 | 0 | 0 | 0 | 0 |
| **Unincorporated County** | 34,945 | 45 | $4,168,611 | $4,168,611 | 0 | 0 |
| **Total** | **198,051** | **8,650** | **$948,496,309** | **$702,583,744** | **$224,390,229** | **$21,522,336** |

a. Output generated by Hazus v6.1 software

Table 5-43 provides a summary of estimated debris tonnage from a tsunami. Debris generated by a tsunami event poses a massive risk to life and property. It is also extremely costly to recover, remove from public roadways, and dispose of. Debris quantities are based on flood depths entered into the Hazus software. Hazus estimates 44,289 tons of debris generated for the tsunami hazard event for participating jurisdictions. Additionally, 39,878 of this total is finish debris, 1,260 is structure debris, and 3,151 is foundation debris tons.

**Table 5-43. Estimated Debris Created from a Tsunami Event in Orange County**

| Jurisdiction | Estimated Debris Created (Tons) | | | |
|---|---|---|---|---|
| | Total | Finish | Structure | Foundation |
| **Anaheim** | 0 | 0 | 0 | 0 |
| **Laguna Woods** | 0 | 0 | 0 | 0 |
| **Newport Beach** | 43,932 | 39,521 | 1,260 | 3,151 |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 |
| **Santa Ana** | 0 | 0 | 0 | 0 |
| **Unincorporated County** | 357 | 357 | 0 | 0 |
| **Total** | **44,289** | **39,878** | **1,260** | **3,151** |

Output generated by Hazus v6.1 software

## Critical Facilities

### Exposure

An exposure analysis of was performed on all critical facilities collected throughout the County and the FMP participating jurisdictions. This was accomplished by importing all critical facility points into a GIS and then overlaying the modeled tsunami hazard area, generating a frequency count of critical facilities that could be exposed to a tsunami hazard event (see Table 5-44).

### Impact

Impact analysis on all critical facilities by community lifeline designation were conducted for the entire planning area. All critical facility points into a GIS and then overlay the modeled tsunami hazard area and then using the Hazus software to generate a frequency count of critical facilities and percent damage to those facilities that could result from the modeled tsunami inundation area (see Table 5-45). As is shown in the table, while there are several critical facilities that may be exposed to a projected tsunami, there is only modest structural damage based on the Hazus output. Specifically, out of the twenty-one facilities exposed, only one sustained any percentage of damage (Upper Newport Bay Nature Preserve; 5.0 percent damage).

**Table 5-44. Critical Facilities Exposed to Tsunami Inundation Hazard Area**

| Jurisdiction | Critical Facilities Exposed to Tsunami Inundation by Community Lifeline | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | Communications | Energy | Hazardous Materials | Health & Medical | Safety & Security | Transportation | Water Systems | Total Count | % of Jurisdiction Total |
| **Anaheim** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Laguna Woods** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Newport Beach** | 0 | 0 | 0 | 0 | 0 | 7 | 13 | 20 | 17.5% |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Santa Ana** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Unincorporated County** | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0.5% |
| **Total** | **0** | **0** | **0** | **0** | **0** | **7** | **14** | **21** | **1.9%** |

Source: California Department of Education 2024; Caltrans 2024; Homeland Infrastructure Foundation-Level Data 2022, 2023, 2024; Orange County 2022, Orange County Sheriff's Department 2024; U.S. Geological Survey 2024; USACE 2024; USACE 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

**Table 5-45. Critical Facilities Damage Due to Tsunami**

| Jurisdiction | Critical Facility Type | FEMA Lifeline Category | Critical Facility/Lifeline Located in the Tsunami Hazard Area (% Damage) |
|---|---|---|---|
| **Newport Beach** | County Park | Safety and Security | 5.0% |
| **Newport Beach** | Alternative Education | Safety and Security | 0.0% |
| **Newport Beach** | Law Enforcement | Safety and Security | 0.0% |
| **Newport Beach** | Fire Station | Safety and Security | 0.0% |
| **Newport Beach** | Primary Education | Safety and Security | 0.0% |
| **Newport Beach** | Fire Station | Safety and Security | 0.0% |
| **Newport Beach** | Fire Station | Safety and Security | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Newport Beach** | Bridge | Transportation | 0.0% |
| **Unincorporated County** | Bridge | Transportation | 0.0% |

## 5.5 DAM FAILURE

A dam is an artificial barrier built to contain, control or divert water, wastewater, or any liquid-borne material. The purpose of a dam is to store water, wastewater, or liquid borne materials for several reasons, including flood control, human water supply, energy generation, recreation, or pollution control (ASDSO 2024). Many dams fulfill a combination of these functions. Dams require regular maintenance to retain their level of protection. The materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (such as plastic or rubber) and any combination of these materials.

A failure is any malfunction or abnormality outside of the design that adversely affects the primary function of impoundment (FEMA 2018). When dams fail or overtop, they can lead to major flooding and cause catastrophic impacts especially in downstream areas (ASDSO 2024). Overtopping occurs by water spilling over the top of the dam and is usually a precursor of a failure (ASDSO 2024). A breach is an opening through a dam that allows the uncontrolled draining of a reservoir and is generally associated with partial or total failure of a dam (ASDSO n.d.). Dam failures are somewhat rare however aging infrastructure and changing weather patterns due to climate change has increased the risk that older dams will experience a failure (Texas A & M University 2025).

Dam failures occur when the dam is damaged or destroyed, releasing water or other liquid stored behind the dam. Throughout history, hundreds of dams failed in the United States, causing property and environmental damage, injuries, and fatalities. Dam failures can occur suddenly, without warning, and may occur during normal operating conditions. This is referred to as a “sunny day” failure. Dam failures may also occur during a large storm event. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows, and a failure may occur. Dam failures are most likely for one or a combination of the following events (ASDSO 2024):

- Overtopping caused by water spilling over the top of a dam.
- Foundation defects, including settlement and slope instability.
- Cracking caused by movement.
- Inadequate maintenance and upkeep.
- Improper seepage filtration enables the formation of sinkholes in the dam.

### *5.5.1* Regulatory Oversight of Dams

The potential for catastrophic flooding caused by dam failures led to enactment of the National Dam Safety Act (Public Law 92-367), which for 30 years has protected Americans from dam failures. The National Dam Safety Program is a partnership among states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under the Federal Emergency Management Agency’s (FEMA) leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most dams in the United States (FEMA 2024).

#### California State Dam Safety Section

The division charged with dam safety oversight in California is the Division of Safety of Dam (DSOD) housed within the California Department of Water Resources (DWR n.d.-e) The dam safety program in California was

created in response to the St Francis dam failure on March 12, 1928 (DWR n.d.-e) The California legislature created the dam safety program on August 14, 1929 and the responsibilities of this new program was to examine and approve of dams constructed prior to 1929, approval of plans and specifications of new and existing dams, supervise the construction and maintenance for all jurisdictional dams (DWR n.d.-e). The program has continued to evolve based on dam failures that required changes in regulations (DWR n.d.-e). Figure 5-20 shows the dam inundation area for the dams regulated by the DSOD that impact Orange County. The participating jurisdictions that are impacted include the cities of Anaheim, Laguna Woods, Newport Beach, San Juan Capistrano, Santa Ana, and Unincorporated Orange County. The map shows that a large portion of the City of Santa Ana is located in the dam inundation area for the dams regulated by the DSOD.

The regulations that govern the dam safety program is The California Water Code (California Legisture n.d.). Under The California Water Code Division 3 Dams and Reservoirs, the DSOD is tasked with:

- Reviewing and approving dam enlargements, repairs, alterations, and removals to ensure that the dam appurtenant structures are designed to meet minimum requirements (DWR n.d.-e).
- Performing independent analysis to understand dam and appurtenant structures performance (DWR n.d.-e).
- Overseeing construction to ensure work is being done in accordance with the approved plans and specifications (DWR n.d.-e).
- Inspecting each dam on an annual basis to ensure that it is safe, performing as intended, and is not developing issues (DWR n.d.-e).
- Periodically reviewing the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California (DWR n.d.-e).

## U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 2014). The USACE dams are exempted from the DSOD jurisdiction, but they do provide inundation maps to show the extent of the flooding from a dam failure (DWR n.d.-h). Figure 5-21 shows dam inundation for USACE dams that impact Orange County. The participating jurisdictions impacted by the inundation area include the cities of Anaheim, Newport Beach, Santa Ana, and Unincorporated Orange County. The map shows that the cities of Anaheim and Santa Ana have a large portion of their areas located in the USACE dam inundation area.

## Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with several federal and state agencies to ensure and promote dam safety and, more recently, homeland security. A total of 3,036 dams are part of regulated hydroelectric projects and are included in the FERC program; two-thirds of these dams are more than 50 years old (FERC 2020). Concern about their safety and integrity grows as dams age, rendering oversight and regular inspection especially important.

**Figure 5-20. Division of Safety of Dams Inundation Hazard Area**

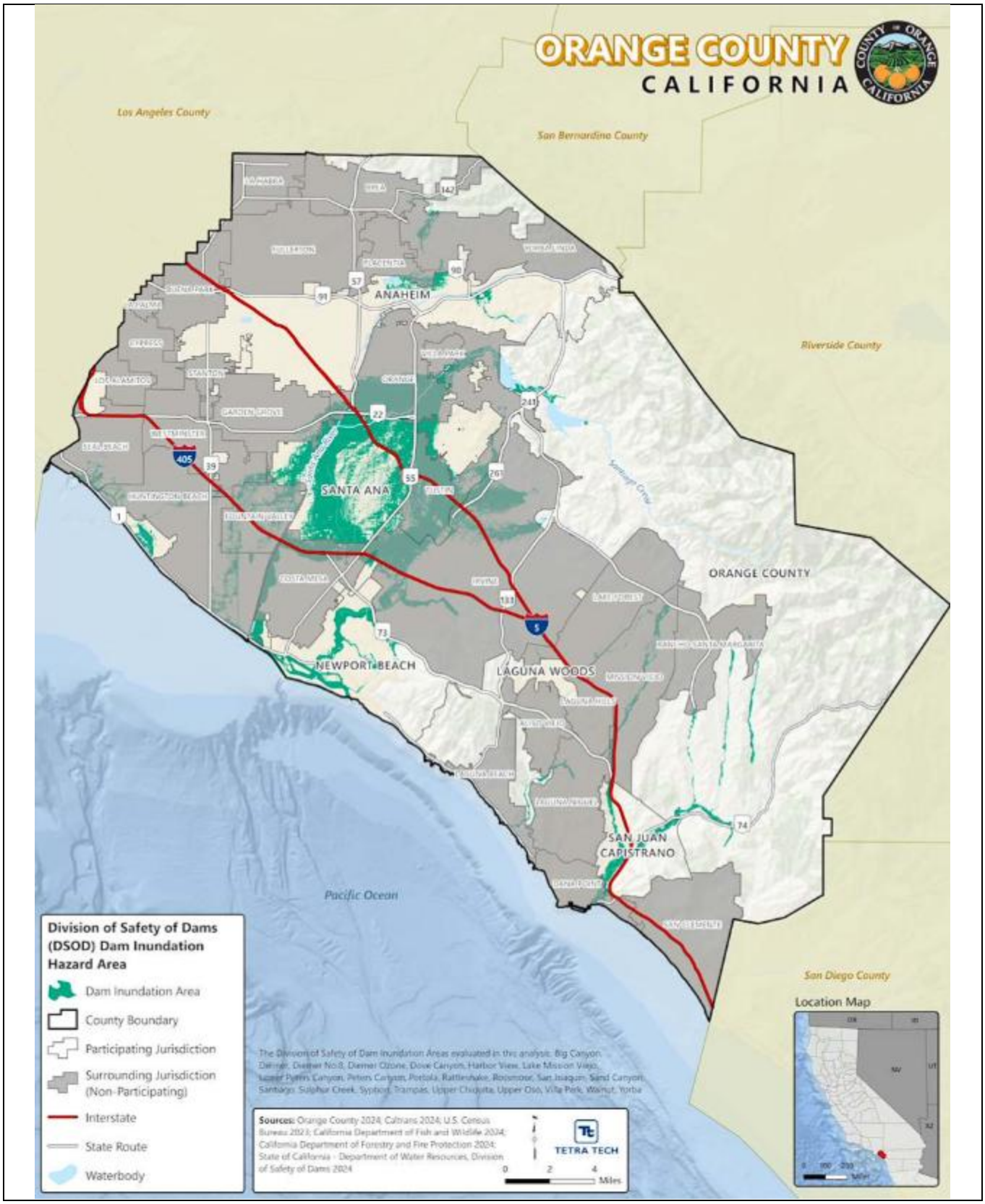
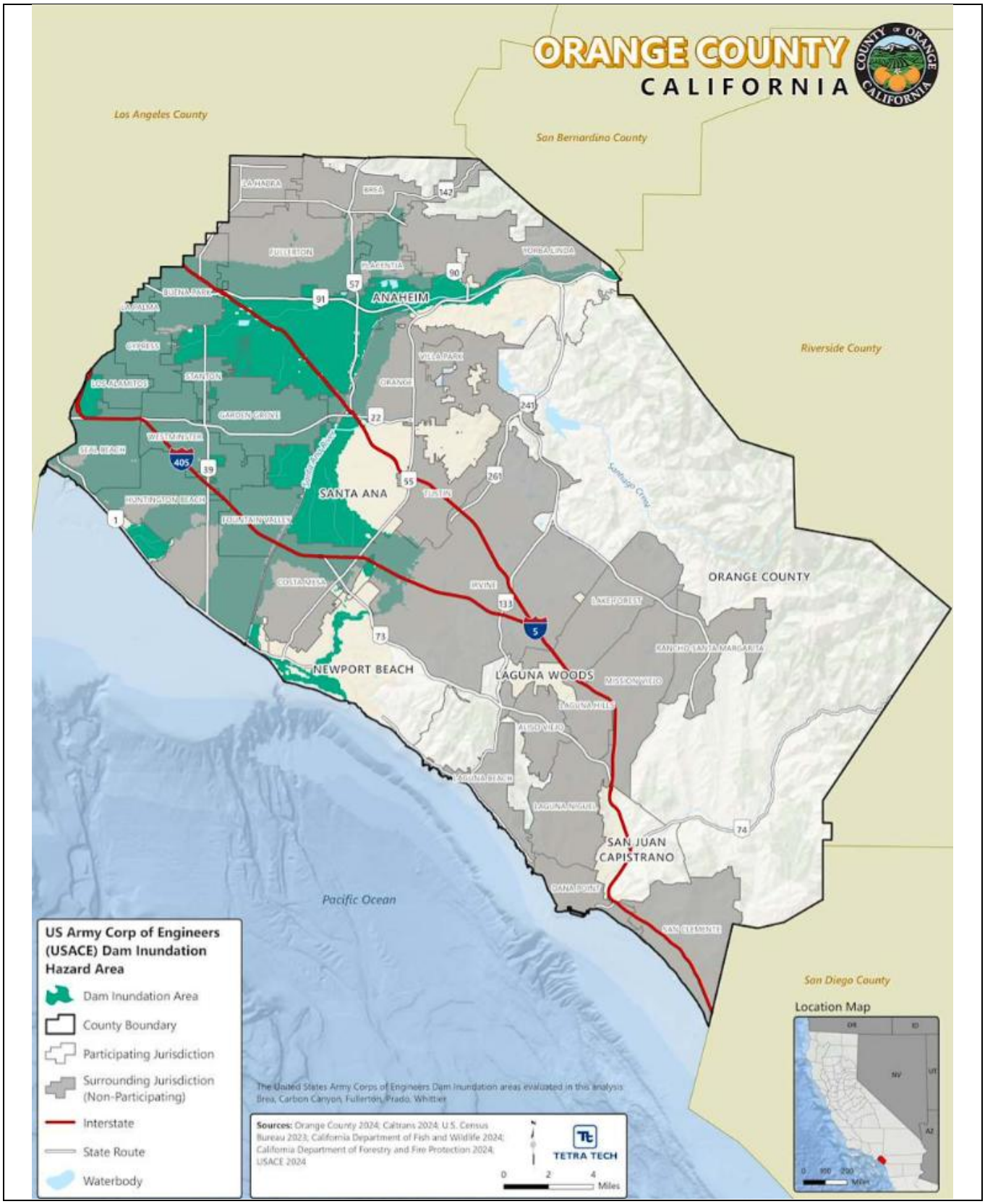


Figure 5-21. USACE Inundation Hazard Area



FERC staff inspect hydroelectric projects on an unscheduled basis to investigate the following issues (FERC 2020):

- Potential dam safety problems.
- Complaints about constructing and operating a project.
- Safety concerns related to natural disasters.
- Issues concerning compliance with terms and conditions of a license.

Every five years, an independent consulting engineer, approved by FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with total storage capacity of more than 2,000 acre-feet (FERC 2020).

FERC evaluates seismic research in areas where seismic activity is a concern. This information is applied to analyze hydroelectric projects within these areas. FERC staff also evaluates the effects of potential and actual large floods on dam safety. FERC staff visit dams and licensed projects during and after floods, assess extents of damage, and direct any studies or remedial measures the licensee must undertake. FERC's *Engineering Guidelines for the Evaluation of Hydropower Projects* guides FERC engineering staff and licensees in evaluations of dam safety. The publication is frequently revised to reflect current information and methodologies (FERC 2020).

FERC requires licensees to prepare EAPs and conducts training sessions on developing and testing these plans. The plans outline an early warning system in the event of an actual or potential sudden release of water from a dam failure. The plans include operational procedures that may be implemented during regulatory measures, such as reducing reservoir levels and downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that all applicable parties are informed of the proper procedures in emergencies (FERC 2020).

## 5.5.2 Location

Dam failures cause serious downstream flooding either because of partial or complete dam collapse. Failures are usually associated with intense rainfall and prolonged flood conditions; however, dam breaks may occur during dry periods as a result of progressive erosion of an embankment. The greatest threat from a dam break is to areas immediately downstream. Dam failures may or may not leave enough time for evacuation of people and property, depending on their abruptness. Seepages in earth dams usually develop gradually, and if the embankment damage is detected early, downhill residents have at least a few hours or days to evacuate. Failures of concrete or masonry dams tend to occur suddenly, sending a wall of water and debris down the valley at more than 100 miles per hour (mph). Survival would be a matter of having the good fortune not to be in the flood path at the time of the break. Dam failures due to the overtopping of a dam normally give sufficient lead time for evacuation.

The 2023 California Hazard Mitigation Plan lists a total of 1,250 jurisdictional dams located within the state and the 2021 Hazard Mitigation Plan for Orange County noted that there are 44 dams and reservoirs located within Orange County or within the immediately adjacent area. (CalOES 2023; Orange County Sheriff's Department 2021). The California Water Code defines a jurisdictional dam as an artificial barrier, together with appurtenant works, that may impound or divert water which is either 25 feet higher or more and that has a storage capacity of 15 acre-feet or more or is 6 feet high or more and has storage capacity of 50 acre-feet or more (California Legislature n.d.; California Department of Water Resources n.d.). Dams meeting these requirements fall under the regulatory powers of the State of California (California Legislature n.d.; California Department of Water Resources n.d.).

DSOD released a report of the number of jurisdictional dams by county (DWR 2024). The report lists 40 jurisdictional dams located in Orange County (DWR 2024). Table 5-46 shows the jurisdictional dams located in Orange County along with the dam characteristics. Dam locations and hazard categories are shown in Figure 5-22. It should be noted that several mitigation and restoration plans are in place for dams with high hazard potential within the County. For example, Irvine Ranch Water District is planning improvements for the Santiago Creek Dam (refer to Table 5-46). Construction on the Santiago Creek Dam spillway and outlet tower are expected to occur over a four-year period beginning around fall of 2027. The plans aim to upgrade the dam's spillway and outlet tower to meet current safety and seismic standards, and in turn also restore storage capacity to the reservoir and improve overall water reliability.

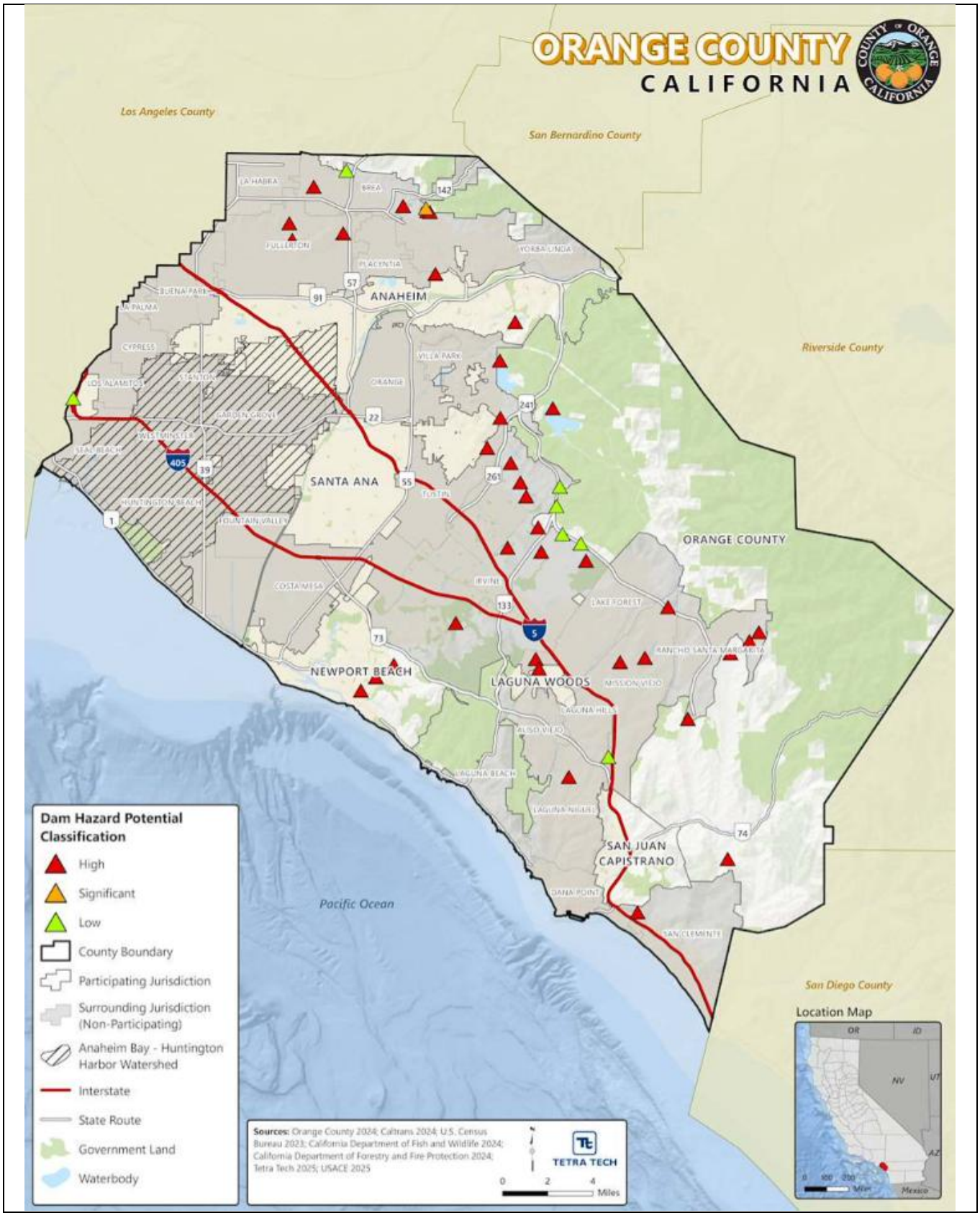
**Table 5-46. Jurisdictional Dams in Orange County**

| Dam Name | Owner Name | Dam Height (Feet) | Reservoir Capacity (Acre-Feet) | Hazard | Condition | Year Built |
|---|---|---|---|---|---|---|
| **30 MG Central Reservoir** | City of Brea | 30 | 92 | High | Satisfactory | 1924 |
| **Agua Chinon** | County of Orange | 41 | 256 | High | Satisfactory | 1998 |
| **Bee Canyon Retention Basin** | County of Orange | 62 | 243 | Low | Satisfactory | 1994 |
| **Big Canyon** | City of Newport Beach | 65 | 600 | Extremely High | Satisfactory | 1959 |
| **Diemer No. 8** | Metropolitan Water District of Southern California | 172 | 18 | Significant | Satisfactory | 1968 |
| **Diemer Ozone Contact Basin** | Metropolitan Water District of Southern California | 32 | 23 | Extremely High | Satisfactory | 2011 |
| **Diemer Reservoir** | Metropolitan Water District of Southern California | 22 | 80 | Extremely High | Satisfactory | 1963 |
| **Dove Canyon** | Dove Canyon Master Association | 88 | 415 | High | Poor | 1989 |
| **East Hicks Canyon Retarding Basin** | County of Orange | 49 | 75 | Low | Satisfactory | 1997 |
| **Eastfoot Retarding Basin** | City of Irvine | 39 | 213 | Extremely High | Satisfactory | 2007 |
| **El Toro Reservoir** | El Toro Water District | 113 | 887 | Extremely High | Satisfactory | 1967 |
| **Galivan Retarding Basin** | County of Orange | 14 | 169 | Low | Satisfactory | 2000 |
| **Harbor View** | County of Orange | 65 | 28 | High | Satisfactory | 1964 |
| **Hicks Canyon Retention** | County of Orange | 60 | 110 | Low | Satisfactory | 1997 |
| **Lake Mission Viejo** | Lake Mission Viejo Association | 123 | 4,300 | Extremely High | Satisfactory | 1990 |
| **Lower Peters Canyon Retarding Basin** | County of Orange | 52 | 206 | Extremely High | Satisfactory | 1990 |
| **Mashburn Retarding Basin** | County of Orange | 27 | 424 | Extremely High | Satisfactory | 1998 |
| **Orange County Reservoir** | Metropolitan Water District of Southern California | 103 | 217 | Low | Satisfactory | 1941 |
| **Orchard Estates Retarding Basin** | County of Orange | 21 | 138 | Extremely High | Satisfactory | 1941 |
| **Palisades Reservoir** | South Coast Water District | 146 | 147 | Extremely High | Satisfactory | 1963 |
| **Peters Canyon** | County of Orange | 54 | 1,090 | Extremely High | Satisfactory | 1932 |
| **Portola** | Santa Margarita Water District | 53 | 586 | High | Satisfactory | 1980 |

| Dam Name | Owner Name | Dam Height (Feet) | Reservoir Capacity (Acre-Feet) | Hazard | Condition | Year Built |
|---|---|---|---|---|---|---|
| **Rattlesnake Canyon** | Irvine Ranch Water District | 79 | 1,480 | Extremely High | Fair | 1959 |
| **Rossmoor No. 1** | El Toro Water District | 36 | 43 | High | Satisfactory | 1964 |
| **Rossmoor Retarding Basin** | County of Orange | 14 | 175 | Low | Satisfactory | 2002 |
| **Round Canyon Retarding Basin** | County of Orange | 98 | 286 | Low | Satisfactory | 1994 |
| **San Joaquin Reservoir** | Irvine Ranch Water District | 224 | 3,036 | Extremely High | Satisfactory | 1966 |
| **Sand Canyon** | Irvine Ranch Water District | 58 | 960 | Extremely High | Satisfactory | 1912 |
| **Santiago Creek** | Serrano Water District and Irvine Ranch Water District | 136 | 25,000 | Extremely High | Poor | 1933 |
| **Sulphur Creek** | County of Orange | 42 | 520 | High | Satisfactory | 1966 |
| **Syphon Canyon** | Irvine Ranch Water District | 59 | 578 | Extremely High | Satisfactory | 1949 |
| **Trabuco** | Trabuco Canyon Water District | 108 | 138 | High | Satisfactory | 1984 |
| **Trabuco Retarding Basin** | County of Orange | 18 | 390 | Extremely High | Satisfactory | 1996 |
| **Trampas Canyon** | Santa Margarita Water District | 229 | 5,314 | Extremely High | Satisfactory | 1975 |
| **Upper Chiquita** | Santa Margarita Water District | 177 | 754 | Extremely High | Satisfactory | 2012 |
| **Upper Oso** | Santa Margarita Water District | 142 | 3,700 | Extremely High | Satisfactory | 1979 |
| **Veeh** | Crossline Community Church | 37 | 185 | High | Satisfactory | 1936 |
| **Villa Park** | County of Orange | 118 | 15,600 | Extremely High | Satisfactory | 1963 |
| **Walnut Canyon** | City of Anaheim | 187 | 2,570 | Extremely High | Satisfactory | 1968 |
| **Yorba** | County of Orange | 45 | 1,200 | Extremely High | Satisfactory | 1907 |

Source: (California Department of Water Resources 2024)

**Figure 5-22. Dam Hazard Potential Classification within Orange County**



## 5.5.3 Severity

Jurisdictional dams have one of four hazard classifications listed in state code (California Code of Regulations (CCR) n.d.):

- Low Hazard Potential: No probable loss of human life and low economic and environmental losses (California Code of Regulations (CCR) n.d.).
- Significant Hazard Potential: No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts (California Code of Regulations (CCR) n.d.).
- High Hazard Potential: Expected to cause loss at least one human life (California Code of Regulations (CCR) n.d.).
- Extremely High Hazard Potential: Expected to cause loss of at least one human life and one of the following (California Code of Regulations (CCR) n.d.):
  - Result in an inundation area with a population of 1,000 persons or more, or
  - Result in the inundation of facilities or infrastructure, the inundation of which poses a significant threat to public safety as determined by the Division of Safety of Dams.

The hazard classification that DSOD use is based on the downstream hazard potential classification that FEMA developed. FEMA's classification include Low Hazard Potential which has low downstream risk and limit impact generally limited to the owners property should the dam fail (FEMA 2004). The Significant Hazard Potential classification has higher risk than the Low Hazard Potential and the impacts generally does not result in loss of life but can cause economic loss, environmental damage, and disruption to community lifeline facilities (FEMA 2004). Significant Hazard Potential dams are often located in rural areas or have areas with population and significant infrastructure (FEMA 2004). The High Hazard Potential classification has the highest downstream risk and the failure of the dam could result in the loss of one or more lives (FEMA 2004). The DSOD created the Extremely High Hazard Potential class to augment the 3 FEMA classes (DWR 2021)

The California Water Code requires that a dam with a hazard potential of a least Significant Hazard Potential submit to DSOD an inundation map and emergency action plan (EAP) (California Legisture n.d.). The inundation map and EAP are reviewed and approved by the DSOD and the California Office of Emergency Services (Cal OES) (California Legisture n.d.). The California Water Code also establishes the inspection schedule for jurisdictional dams based on the hazard potential classification (California Legisture n.d.). The inspection schedule for jurisdictional dams in California is as follows:

- Low Hazard Potential—Once Every Two Fiscal Years
- Significant Hazard Potential—At Least Once per Fiscal Year
- High Hazard Potential—At Least Once per Fiscal Year
- Extremely High Hazard Potential—At Least Once per Fiscal Year

Dam inspection reports are considered public records and are subject to the California Public Records Act (California Legisture n.d.). However, the DSOD in accordance with applicable laws and in consultation with the dam owner relevant public safety entities, may withhold sensitive data that discloses a dam's vulnerability or poses a security threat (California Legisture n.d.). The dam inundation maps are public available and can be viewed from the DSOD website (DWR n.d.-b)

The DSOD rates dams based on the condition assessment rating established by the USACE (DWR 2021). Table 5-47 shows the definitions used the DSOD for the rating of dams. As mentioned above, Orange County has a total of 40 jurisdictional dams and Table 5-48 and Table 5-49 shows the breakdown of the 40 dams by the hazard potential classification and condition rating. Orange County has 33 jurisdictional dams with at least a Significant Hazard Potential and a majority of these (23) have a hazard potential classification of Extremely High Hazard.

**Table 5-47. Dam Condition Assessment Ratings**

| Condition Assessment Rating | Definition |
|---|---|
| **Satisfactory** | No existing or potential dam safety deficiencies are recognized. Acceptable performance is expected under all loading conditions (static, hydrologic, seismic) in accordance with the minimum applicable state or federal regulatory criteria or tolerable risk guidelines |
| **Fair** | No existing dam safety deficiencies are recognized for normal operating conditions. Rare or extreme hydraulic and/or seismic events may result in a dam safety deficiency. Risk may be in the range to take further action. |
| **Poor** | A dam safety deficiency is recognized for normal operating conditions which may realistically occur. Remedial action is necessary. Poor may also be used when uncertainties exist as to critical analysis parameters which identify a potential dam safety deficiency. Investigations and studies are necessary. |
| **Unsatisfactory** | A dam safety deficiency is recognized and that the deficiency requires immediate or emergency remedial action for problem resolution. |
| **Not Rated** | The dam has not been inspected, is not under state jurisdiction, or has been inspected but, for whatever reasons, has not been rated. |

Source: California Department of Water Resources 2021

**Table 5-48. Dams by Hazard Classification in Orange County**

| Hazard | Number of Dams |
|---|---|
| **Low Hazard Potential** | 23 |
| **High Hazard Potential** | 9 |
| **Extremely High Hazard Potential** | 7 |
| **Significant Hazard Potential** | 1 |
| **Total** | **40** |

Source: California Department of Water Resources 2024

**Table 5-49. Dams by Condition Assessment Rating in Orange County**

| Hazard | Number of Dams |
|---|---|
| Satisfactory | 37 |
| Fair | 1 |
| Poor | 2 |
| Unsatisfactory | 0 |
| Not Rated | 0 |
| Total | **40** |

Source: California Department of Water Resources 2024

A majority (37) of the jurisdictional dams in Orange County have a Satisfactory condition rating. However, there are two jurisdictional dams in Orange County that have a Poor conditional rating and at least a High Hazard Potential class. Table 5-46 shows that Dove Canyon dam has a Poor condition rating and a High Hazard Potential classification and that Santiago Creek dam has a Poor condition rating and an Extremely High Hazard Potential classification. Both dams are privately owned, by Dove Canyon Master Association and Irvine Ranch Water District (IRWD) and the Serrano Water District (SWD), respectively. The Santiago Creek dam is of particular concern because it has a reservoir capacity of 25,000 acre-feet. The dam that is the greatest threat to Orange County is the Prado Dam in Riverside County. The Prado Dam is a USACE dam located on the Santa Ana River and has a capacity of 314,000 acre-feet (Orange County Sheriff's Department 2021).

## 5.5.4 Frequency

The 2021 Hazard Mitigation Plan for Orange County noted two previous occurrences were a dam located within the county had failed. On the morning of September 21, 1998, a 5 million-gallon precast concrete above ground water tank located in the City of Westminster ruptured, resulting in the release of a massive wall of water that injured six people, damaged 105 structures, and left 30 people temporarily homeless. In January 2005, rainfall increased the water levels behind the Prado Dam. The USACE discovered minor seepage on the downstream side of the dam near an area under construction to build new outlets. City officials for the City of Corona took precautionary measures and evacuated over 800 homes below the dam and Orange County officials relocated campers in an RV park located near the dam. To decrease the hydraulic pressure on Prado Dam, the USACE released water from behind the dam while also decreasing the water released from upstream dams (Orange County Sheriff's Department 2021).

### Climate Change Projections

Climate change can impact stored water systems as increased rainfall accumulations can cause reservoirs to overtop. Dams are designed using a hydrograph to evaluate dam safety issues for situations where the reservoir inflow peak discharge is greater than the maximum spillway capacity, the reservoir has large surcharge storage, and/or the reservoir has dedicated flood control space. Increased precipitation due to climate change may result in overtopping, as the hydrographs are based off historical events (FEMA 2013).

The California's Fourth Climate Change Assessment notes that the temperature has increased over the years and that climate projections using the different greenhouse gas emission scenarios and global climate models show that the warming trend is expected to continue with rates differing based on the greenhouse gas emissions scenarios. While California has a seasonal precipitation pattern with variability in precipitation across daily, monthly, and annual time scales, the current climate models show a regional change in the annual precipitation with northern California becoming wetter and southern California becoming drier and. The climate models also show that the extreme daily precipitation is projected to become less frequent but more intense, the year-to-year precipitation will become more variable, and the number of dry days are projected to increase. The 2021 Hazard Mitigation Plan for Orange County and the 2023 California Hazard Mitigation plan noted that probability of future dam failures is tied to storm events and unusually heavy precipitation. The combination of less frequent but more intense precipitation and aging dam infrastructure could result in more dam failures (Cal OES 2023, State of California 2018, Orange County Sheriff's Department 2021).

## 5.5.5 Warning Time

Warning time for dam failures can vary with some failures having little to no warning and others having advanced warning to allow for preparation and evacuation. The failures that have little to no advance warning typically cause

the greatest loss of life. Since dam failures can cause immense property damage and claim many lives, dam owners are required to develop an EAP that provide a set of actions to minimize the potential loss of life and property damage in the event of a dam failure. The EAP, together with training and exercises, allows the dam owners, local emergency management agencies, and state emergency management and dam safety agencies to identify when a dam is in the process of failing and adequately warning the public and take the necessary precautions (ASDSO n.d.). The AlertOC is a mass notification system that was designed to inform Orange California residents and businesses about emergencies so that they can take protective actions and such warning systems can allow the public to respond to evacuation orders for dam failures (AlertOC n.d.).

The EAP for the Santiago Creek Dam in Orange County provides an example of how the warnings are planned to be distributed once an issue with the dam has been determined. The Santiago Creek Dam is owned by the Irvine Ranch Water District (IRWD) and is in unincorporated Orange County. The communities that are at risk should the Santiago Creek Dam include the County of Orange, City of Orange, City of Villa Park, City of Garden Grove, City of Santa Ana, City of Tustin, City of Westminster, City of Fountain Valley, City of Costa Mesa, City of Huntington Beach, City of Irvine, City of Newport Beach, and the City of Seal Beach. The EAP lists the responsibilities of the dam owner and impacted jurisdictions. Since warning times are critical for the response to dam failure, the EAP includes maps that include the arrival time of the flood wave. The arrival times range from 15 minutes when the flood wave reaches the downstream Villa Park Dam, 24 minutes to reach the first area of development, and 18 hours when the flood wave reaches the Pacific Ocean at Newport Bay (IRWD 2025).

### 5.5.6 Secondary Hazards

Dam failure can cause severe downstream flooding, depending on the magnitude of the failure. Other potential secondary hazards of dam failure are landslides around the reservoir perimeter, bank erosion on the rivers, and destruction of downstream habitat. Floods caused by dam failures have caused loss of life and property damage (FEMA 2013). The water released by a failing dam can cause erosion of the stream banks downstream of the dam (FEMA 2012; FEMA 2020). This erosion can cause sedimentation downstream and could lead to the collapse or undermining of structures or infrastructure that is located near the stream (FEMA 2012). Erosion from flooding could also trigger landslides if the terrain surrounding the stream is steep enough that the erosion has destabilized the land to a point that a landslide is triggered (USGS 2008). Landslides can also create a natural dam when a large landslide blocks the flow of a stream. These natural dams can also fail and the resulting flooding downstream can cause loss of life and property damage (ASDSO n.d.).

The sudden release of water from the dam failure can also impact the environment (FEMA 2012). The sudden release of silt, sand, soil, and rocks from behind the dam and from the erosion of stream banks can threaten aquatic plants and animals (FEMA 2012). There can also be a temperature change in the water from a releasing dam and this change can also impact aquatic plants and animals because the water behind the dam may be either colder or warmer than water in the downstream habitats depending on how deep the reservoir is (FEMA 2012). There are cascading impacts from the flooding associated with dam failures. The 2021 Hazard Mitigation Plan for Orange County noted that flooding from dam failure can damage utilities, destroy or block road networks which can interfere with emergency response, and impact the water and wastewater systems (Orange County Sheriff's Department 2021). The 2020 Edenville Dam and Sanford Dam failures in Michigan show the cascading impacts (FEMA 2022). The failures of these two dams impacted the local water supply and wastewater systems, impacted the medical facilities located in the affected communities (the local hospital remained operating and protected, inundated a senior living facility that required the evacuation of residents, and impacted homes, government offices, public safety buildings, and many others (FEMA 2022).

## 5.5.7 Vulnerability Assessment

A vulnerability analysis was performed to understand the population and structures that are at risk due to a potential dam failure in Orange County. The analysis was performed at the aggregate dam inundation level (all dams combined) as well as for each individual dam. The following dams were included in the analysis:

- Big Canyon Dam (DSOD)
- Brea Dam (USACE)
- Carbon Cayon Dam (USACE)
- Diemer Dam (DSOD)
- Diemer Dam No. 8 (DSOD)
- Diemer Ozone Dam (DSOD)
- Dove Canyon Dam (DSOD)
- Fullerton Dam (USACE)
- Harbor View Dam (DSOD)
- Lake Mission Viejo (DSOD)
- Lower Peters Canyon Dam (DSOD)
- Peters Canyon Dam (DSOD)
- Portola Dam (DSOD)
- Prado Dam (USACE)
- Rattlesnake Dam (DSOD)
- Rossmoor Dam (DSOD)
- San Joaquin Dam (DSOD)
- Sand Canyon Dam (DSOD)
- Santiago Dam (DSOD)
- Sulphur Dam (DSOD)
- Syphon Dam (DSOD)
- Trampas Dam (DSOD)
- Upper Chiquita Dam (DSOD)
- Upper Oso Dam (DSOD)
- Villa Park (DSOD)
- Walnut Dam (DSOD)
- Whittier Dam (USACE)
- Yorba Dam (DSOD)

Analyses were performed for the mapped inundation area of each dam individually, as well as for the aggregate inundation area for all 28 dams.

### Land Exposure

Table 5-50 summarizes land areas exposed to the aggregate dam inundation area. Of the approximately 252 thousand acres (less water bodies) that make up the entire planning area, 47,690 thousand (or nearly 19%) acres would be exposed to the modeled dam inundation area. Dam inundation exposure within the cities of Anaheim and Santa Ana would be the largest across the planning area at nearly 69% and 82% of those cities total area, respectively. The rest of the participating jurisdictions have a lower percentage of the land area exposed to the aggregated dam inundation area. The City of Newport Beach has 18.0 percent of its land area, and the City of the San Juan Capistrano has 14.1 percent of its area in the aggregated dam inundation area. The Unincorporated Orange County and the City of Laguna Woods have the lowest percentage of its land area in the aggregated dam inundation area.

**Table 5-50. Land Area Exposed to the Aggregated Dam Inundation Hazard Area**

| Jurisdiction | Total Land Area (Acres) Excludes Water Bodies | Land Area (Excluding Water Bodies) Exposed to Aggregated Dam Inundation Hazard Area | |
|---|---|---|---|
| | | Total Area (acres) | % of Jurisdiction Total |
| **Anaheim** | 32,170 | 22,161.7 | 68.9% |
| **Laguna Woods** | 2,116 | 5.0 | 0.2% |
| **Newport Beach** | 16,450 | 2,967.0 | 18.0% |
| **San Juan Capistrano** | 9,220 | 1,301.2 | 14.1% |
| **Santa Ana** | 17,531 | 14,326.0 | 81.7% |
| **Unincorporated County** | 174,768 | 6,929.7 | 4.0% |
| **Total** | **252,255** | **47,690.6** | **18.9%** |

Source: Orange County 2024; State of California Department of Water Resources, Division of Safety of Dams 2024; USACE 2024

## Population

### Exposure

According to the 2020 decennial census, the total population of the FMP participating jurisdictions is approximately 928,007 persons. Table 5-51 summarizes the total population that would be exposed to the aggregated dam inundation hazard area for the planning area. The population of the FMP participating jurisdictions exposed to the aggregated dam inundation area is over 560,000 persons, or 61.1 percent of the total planning area population.

**Table 5-51. Population in the Aggregated Dam Inundation Hazard Area**

| Jurisdiction | Total Population (2020 Decennial) | Population in the Aggregated Dam Inundation Hazard Area | |
|---|---|---|---|
| | | Number of Persons | % of Jurisdiction Total |
| **Anaheim** | 346,824 | 273,323 | 78.8% |
| **Laguna Woods** | 17,644 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 15,574 | 18.3% |
| **San Juan Capistrano** | 35,196 | 5,928 | 16.8% |
| **Santa Ana** | 310,227 | 234,117 | 75.5% |
| **Unincorporated County** | 132,877 | 38,307 | 28.8% |
| **Total** | **928,007** | **567,249** | **61.1%** |

Source: U.S. Census Bureau 2020; USACE 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

The cities of Anaheim (346,824) and Santa Ana (310,824) would experience the greatest number of people exposed to a dam inundation event, accounting for approximately 78 and 75 percent of those cities' total population, respectively. The Unincorporated Orange County has 28.8 percent of the population located in the aggregated dam inundation while the cities of Newport Beach (18.3 percent) and San Juan Capistrano (16.8 percent) have a lower percent of their populations in the aggregated dam inundation area. The city of Laguna Woods, with a population of 17,644, is not shown in the analysis as having any direct exposure to an aggregate dam inundation area.

Table 5-52 summarizes the degree of exposure certain population groups could experience for the aggregated dam failure event. The vulnerable population groups are identified and described in further detail in Section 5.1. In short, the selected socio-demographic groups were considered more vulnerable because they, on average, have more difficulty responding to and recovering from a flood hazard event relative to other socio-demographic groups.

### Impacts

Table 5-53 shows Hazus results for the impacted population by projected inundations from each of the individual dams throughout the planning area. The Hazus analysis outputs a projected number of people displaced as well as how many of the displaced may seek short-term shelter. The dams with the highest displaced population are the Prado Dam (508,573) and the Cabon Canyon dam (240,000), both USACE dams. The dams with the highest number of persons seeking short-term shelter are the Prado Dam (23,385) and the Cabon Canyon Dam (13,206).

**Table 5-52. Vulnerable Population Exposed to the Aggregated Dam Inundation Hazard Area**

| Jurisdiction | Estimated Number of Vulnerable Persons Exposed Dam Inundation | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Persons Over 65 | % of Total | Persons Under 5 | % of Total | Non-English Speaking Persons | % of Total | Persons with a Disability | % of Total | Persons in Poverty | % of Total |
| **Anaheim** | 34,345 | 78.8% | 15,866 | 78.8% | 24,814 | 78.8% | 26,787 | 78.8% | 33,475 | 78.8% |
| **Laguna Woods** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Newport Beach** | 3,601 | 18.3% | 545 | 18.3% | 389 | 18.3% | 1,272 | 18.3% | 1,120 | 18.3% |
| **San Juan Capistrano** | 1,199 | 16.8% | 268 | 16.8% | 93 | 16.8% | 601 | 16.8% | 426 | 16.8% |
| **Santa Ana** | 26,120 | 75.5% | 12,915 | 75.5% | 21,913 | 75.5% | 19,948 | 75.5% | 25,775 | 75.5% |
| **Unincorporated County** | 5,829 | 28.8% | 2,094 | 28.8% | 1,981 | 28.8% | 3,004 | 28.8% | 2,298 | 28.8% |
| **Total** | **71,094** | **50.9%** | **31,688** | **64.6%** | **49,190** | **66.5%** | **51,612** | **59.7%** | **63,094** | **66.3%** |

Source: U.S. Census Bureau, American Community Survey 2023; USACE 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

**Table 5-53. Dam Failure Inundation Impacts on People by Individual Dam**

| Dam | Dam Failure Inundation Impacts on People | |
|---|---|---|
| | Displaced Population | Persons Seeking Short-Term Shelter |
| **USACE Dams** | | |
| Brea | 7,042 | 113 |
| Carbon Canyon | 240,000 | 13,206 |
| Fullerton | 436 | 20 |
| Prado | 508,573 | 23,385 |
| Whittier | 10,625 | 135 |
| **DSOD Dams** | | |
| Big Canyon | 719 | 99 |
| Diemer | 0 | 0 |
| Diemer No.8 | 0 | 0 |
| Diemer Ozone | 0 | 0 |
| Dove Canyon | 0 | 0 |
| Harbor View | 394 | 56 |
| Lake Mission Viejo | 2,499 | 411 |
| Lower Peters Canyon | 80 | 16 |
| Peters Canyon | 292 | 29 |
| Portola | 126 | 39 |
| Rattlesnake | 322 | 56 |
| Rossmoor | 0 | 0 |
| San Joaquin | 1,766 | 168 |
| Sand Canyon | 305 | 56 |
| Santiago | 0 | 0 |
| Sulphur Creek | 0 | 0 |
| Syphon | 308 | 56 |
| Trampas | 4,472 | 377 |
| Upper Chiquita | 81 | 0 |
| Upper Oso | 4,020 | 530 |
| Villa Park | 42,527 | 3,557 |
| Walnut | 2,283 | 114 |
| Yorba | 1,682 | 34 |
| **Total** | **828,552** | **42,457** |

Source: Hazus v6.1; U.S. Census Bureau 2020; California Department of Water Resources, Division of Safety of Dam 2024; USACE 2024

Table 5-54 shows the Hazus population results by participating jurisdictions. When looking at the participating jurisdictions, the cities of Anaheim and Santa Ana have the majority of the total displaced population from the dam inundation scenarios with displaced populations of 522,353 and 202,466, respectively. The City of Anaheim also has the majority of the persons seeking short-term shelter with 27,883.

**Table 5-54. Dam Inundation Impacts on People by Jurisdiction**

| Jurisdiction | Total Population (2020 Decennial) | Dam Inundation Impacts on People | |
|---|---|---|---|
| | | Displaced Population | Persons Seeking Short-Term Shelter |
| **Anaheim** | 346,824 | 522,353 | 27,883 |
| **Laguna Woods** | 17,644 | 0 | 0 |
| **Newport Beach** | 85,239 | 16,366 | 836 |
| **San Juan Capistrano** | 35,196 | 10,787 | 1,305 |
| **Santa Ana** | 310,227 | 202,466 | 9,678 |
| **Unincorporated County** | 132,877 | 76,580 | 2,755 |
| **Total** | **928,007** | **828,552** | **42,457** |

Source: Hazus v6.1; U.S. Census Bureau 2020; State of California Department of Water Resources, Division of Safety of Dam 2024; USACE 2024

## Buildings and Property

### Exposure

Table 5-55 summarizes the level of exposure buildings could experience during a dam inundation event. According to the exposure analysis, of the 198,051 total buildings in the planning area, 109,442 of those buildings (or 55%) would be exposed to a dam inundation flood hazard. This would equate to a projected full replacement cost value (RCV) of nearly 264 billion dollars—or over 56% of the entire planning areas' RCV for all buildings. When looking at the participating jurisdictions, both the City of Anaheim (80.4 percent) and the City of Santa Ana (74.1 percent) stand out as it relates to building exposure from dam inundation. The rest of the participating jurisdictions have less than 30 percent of their buildings exposed to the aggregated dam inundation area. Laguna Woods is the only FMP participant that does not have buildings exposed to the aggregated dam inundation area.

**Table 5-55. Buildings Exposure to the Aggregated Dam Inundation Hazard Area**

| Jurisdiction | Total Buildings | | Buildings Exposed to Aggregated Dam Inundation Hazard | | | |
|---|---|---|---|---|---|---|
| | | | Number of Buildings | | Replacement Cost Value | |
| | Count | Replacement Cost Value | Count | % of Jurisdiction Total | Value | % of Jurisdiction Total |
| **Anaheim** | 66,553 | $178,343,603,814 | 53,536 | 80.4% | $154,795,327,842 | 86.8% |
| **Laguna Woods** | 3,519 | $10,117,235,987 | 0 | 0.0% | $0 | 0.0% |
| **Newport Beach** | 31,118 | $84,976,395,506 | 5,691 | 18.3% | $6,499,286,191 | 7.6% |
| **San Juan Capistrano** | 10,465 | $19,621,067,650 | 1,970 | 18.8% | $5,073,490,581 | 25.9% |
| **Santa Ana** | 51,451 | $128,949,333,589 | 38,146 | 74.1% | $88,049,500,998 | 68.3% |
| **Unincorporated County** | 34,945 | $43,975,080,160 | 10,099 | 28.9% | $9,581,179,660 | 21.8% |
| **Total** | **198,051** | **$465,982,716,705** | **109,442** | **55.3%** | **$263,998,785,273** | **56.7%** |

Source: USACE 2022, 2024; Orange County 2021; RS Means 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

The buildings exposed to the aggregated dam inundation area can be sorted by the occupancy class. Table 5-56 shows the buildings in the aggregated dam inundation area by occupancy class. The Residential building occupancy class makes up the majority of the buildings in the aggregated dam inundation area with 94,312 buildings. The cities of Anaheim (45,390) and Santa Ana (32,751) have the most residential structures exposed to the aggregated dam inundation area. For the rest of the participating jurisdictions, Newport Beach has 5,040 residential buildings in the aggregated dam inundation area, San Juan Capistrano has 1,568 buildings, and the Unincorporated Orange County has 9,563.

**Table 5-56. Buildings in the Aggregated Dam Inundation Hazard Area by Occupancy Class**

| Jurisdiction | Buildings in the Aggregated Dam Inundation Hazard Area by Occupancy Class | | | |
|---|---|---|---|---|
| | Residential | Commercial | Industrial | Other[a] |
| **Anaheim** | 45,390 | 5,597 | 2,042 | 507 |
| **Laguna Woods** | 0 | 0 | 0 | 0 |
| **Newport Beach** | 5,040 | 559 | 71 | 21 |
| **San Juan Capistrano** | 1,568 | 297 | 73 | 32 |
| **Santa Ana** | 32,751 | 3,995 | 1,099 | 301 |
| **Unincorporated County** | 9,563 | 388 | 112 | 36 |
| **Total** | **94,312** | **10,836** | **3,397** | **897** |

Source: USACE 2022, 2024; Orange County 2021; State of California Department of Water Resources, Division of Safety of Dams 2024
a. Other = Government, Religion, Agricultural, and Education

For the commercial buildings, the participating jurisdictions have a total of 10,836 commercial buildings in the aggregated dam inundation area. The cities of Anaheim (5,597) and Santa Ana (3,995) have the majority of commercial buildings exposed to the aggregated dam inundation area. For the rest of the participating jurisdictions, Newport Beach has 559 commercial buildings in the aggregated dam inundation area, San Juan Capistrano has 297 buildings, and the Unincorporated Orange County has 388 buildings.

For the industrial buildings, the participating jurisdictions have a total of 3,397 industrial buildings in the aggregated dam inundation area. The cities of Anaheim (2,042) and Santa Ana (1,099) have the most industrial buildings in the aggregated dam inundation area. The rest of the participating jurisdictions have around 100 industrial buildings or less in the aggregated dam inundation area. Finally, the participating jurisdictions have 897 buildings that are either government, religion, agricultural, and education buildings in the aggregated dam inundation area. The cities of Anaheim (507) and Santa Ana (301) have the majority of the buildings of the occupancy class in the aggregated dam inundation area while the rest of the participating jurisdictions have less than 50.

## Impacts

Table 5-57 shows the Hazus results on inundation impacts on buildings from failure of each of the twenty-eight (28) individual dam inundation zone throughout the planning area. The estimated total losses for all of the dam inundation scenarios is $132,547,649,937. The estimated total losses can be separated by the estimate losses of buildings by occupancy classification. The total estimated losses for residential properties is $55,329,237,557 and the total estimated losses for commercial properties is $49,834,964,497. The estimated losses for all other occupancy types is $27,383,447,884.

**Table 5-57. Dam Inundation Impacts on Buildings by Dam**

| Dam | Estimated Building Losses Due to Dam Failure Inundation | | | |
|---|---|---|---|---|
| | All Occupancies | Residential | Commercial | All Other Occupancies |
| **USACE Dams** | | | | |
| Brea | $223,100,925 | $180,586,004 | $18,765,189 | $23,749,732 |
| Carbon Canyon | $9,966,362,268 | $3,136,197,890 | $4,094,422,460 | $2,735,741,918 |
| Fullerton | $72,230,602 | $2,331,568 | $26,646,150 | $43,252,884 |
| Prado | $106,647,001,312 | $42,193,091,447 | $41,235,103,653 | $23,218,806,212 |
| Whittier | $2,478,160,380 | $1,943,827,035 | $399,163,801 | $135,169,544 |
| **DSOD Dams** | | | | |
| Big Canyon | $22,209,910 | $18,834,469 | $3,375,441 | $0 |
| Diemer | $0 | $0 | $0 | $0 |
| Diemer No.8 | $0 | $0 | $0 | $0 |
| Diemer Ozone | $0 | $0 | $0 | $0 |
| Dove Canyon | $0 | $0 | $0 | $0 |
| Harbor View | $13,711,931 | $7,824,618 | $5,887,313 | $0 |
| Lake Mission Viejo | $123,217,569 | $30,615,343 | $77,169,279 | $15,432,946 |
| Lower Peters Canyon | $0 | $0 | $0 | $0 |
| Peters Canyon | $8,070,190 | $7,484,515 | $556,584 | $29,091 |
| Portola | $2,416,415 | $869,318 | $240,711 | $1,306,386 |
| Rattlesnake | $2,933,638 | $77,503 | $1,817,654 | $1,038,481 |
| Rossmoor | $0 | $0 | $0 | $0 |
| San Joaquin | $69,765,083 | $57,302,699 | $6,722,597 | $5,739,787 |
| Sand Canyon | $2,819,880 | $0 | $1,790,916 | $1,028,964 |
| Santiago | $9,892,973,357 | $5,841,311,978 | $3,162,610,939 | $889,050,440 |
| Sulphur Creek | $0 | $0 | $0 | $0 |
| Syphon | $2,974,385 | $35,533 | $1,916,283 | $1,022,568 |
| Trampas | $439,872,388 | $180,238,573 | $168,643,428 | $90,990,387 |
| Upper Chiquita | $0 | $0 | $0 | $0 |
| Upper Oso | $622,914,776 | $121,421,987 | $445,706,948 | $55,785,842 |
| Villa Park | $1,511,596,270 | $1,305,915,906 | $121,960,559 | $83,719,806 |
| Walnut | $205,551,861 | $181,610,131 | $15,829,339 | $8,112,391 |
| Yorba | $239,766,797 | $119,661,039 | $46,635,253 | $73,470,505 |
| **Total** | **$132,547,649,937** | **$55,329,237,557** | **$49,834,964,497** | **$27,383,447,884** |

Source: Source: Hazus v6.1; Orange County 2021; RS Means 2024; State of California Department of Water Resources, Division of Safety of Dams 2024; USACE 2022, 2024

Table 5-58 shows the Hazus results for impacts on buildings for the aggregated dam failure inundation area. The City of Anaheim has the highest estimated losses with $88,783,421,757. When looking at the occupancy class, the estimate loss for commercial properties in Anaheim is the highest with $34,812,906,179 while the estimated loss residential properties is $32,812,906,179 and the other occupancies have an estimated losses of $21,654,716,293. The City of Santa Ana has the next highest estimated loss with $32,233,472,245. The residential properties have the highest estimated loss for the City of Santa Ana with $14,463,770,621. The estimated loss for commercial properties in Santa Ana is $12,715,113,984 and the estimated losses for the other properties is $5,054,587,730.

**Table 5-58. Dam Inundation Impacts on Buildings by Jurisdiction**

| Jurisdiction | Total Replacement Cost Value | Dam Inundation Impacts on Buildings | | | | |
|---|---|---|---|---|---|---|
| | | Estimated Loss for All Occupancies | % of Total | Estimated Loss for Residential Properties | Estimated Loss for Commercial Properties | Estimated Loss for All Other Occupancies |
| **Anaheim** | $178,343,603,814 | $88,783,421,757 | 49.8% | $32,315,799,286 | $34,812,906,179 | $21,654,716,293 |
| **Laguna Woods** | $10,117,235,987 | $0 | 0.0% | $0 | $0 | $0 |
| **Newport Beach** | $84,976,395,506 | $2,081,272,540 | 2.4% | $1,509,349,481 | $494,814,760 | $77,108,300 |
| **San Juan Capistrano** | $19,621,067,650 | $1,154,480,284 | 5.9% | $317,253,702 | $691,519,655 | $145,706,927 |
| **Santa Ana** | $128,949,333,589 | $32,233,472,245 | 25.0% | $14,463,770,621 | $12,715,113,894 | $5,054,587,730 |
| **Unincorporated County** | $43,975,080,160 | $8,295,003,109 | 18.9% | $6,723,064,467 | $1,120,610,009 | $451,328,633 |
| **Total** | **$465,982,716,705** | **$132,547,649,937** | **28.4%** | **$55,329,237,557** | **$49,834,964,497** | **$27,383,447,884** |

Source: Source: Hazus v6.1; Orange County 2021; RS Means 2024; State of California Department of Water Resources, Division of Safety of Dams 2024; USACE 2022, 2024

The Hazus analysis can also estimate the debris that needs to be removed due the water released from dam failures. Table 5-59 shows the estimated debris created by projected building damage for each of the twenty-eight (28) projected dam inundation failure zones within the planning area. The Hazus debris results show the debris from finishes (dry wall, flooring, insulations, etc.), structure (wood, brick, etc.), and foundations (concrete slab, concrete block, rebar, etc.) (FEMA 2024).

**Table 5-59. Estimated Debris Created During the Dam Inundation by Dam**

| Dam Inundation Area | Estimated Debris Created During the Dam Inundation Hazard Events | | | |
|---|---|---|---|---|
| | Total (tons) | Finish (tons) | Structure (tons) | Foundation (tons) |
| **USACE Dams** | | | | |
| Brea | 7,791 | 7,791 | 0 | 0 |
| Carbon Canyon | 111,127 | 107,374 | 1,077 | 2,676 |
| Fullerton | 512 | 239 | 129 | 143 |
| Prado | 2,026,966 | 897,099 | 613,897 | 515,969 |
| Whittier | 129,222 | 42,659 | 53,054 | 33,508 |

| Dam Inundation Area | Estimated Debris Created During the Dam Inundation Hazard Events | | | |
|---|---|---|---|---|
| | Total (tons) | Finish (tons) | Structure (tons) | Foundation (tons) |
| **DSOD Dams** | | | | |
| Big Canyon | 653 | 453 | 98 | 103 |
| Diemer | 0 | 0 | 0 | 0 |
| Diemer No.8 | 0 | 0 | 0 | 0 |
| Diemer Ozone | 0 | 0 | 0 | 0 |
| Dove Canyon | 0 | 0 | 0 | 0 |
| Harbor View | 6,876 | 3,436 | 2,008 | 1,432 |
| Lake Mission Viejo | 1,060 | 445 | 313 | 302 |
| Lower Peters Canyon | 21 | 21 | 0 | 0 |
| Peters Canyon | 484 | 230 | 122 | 133 |
| Portola | 26 | 24 | 1 | 1 |
| Rattlesnake | 3,413 | 3,066 | 132 | 215 |
| Rossmoor | 0 | 0 | 0 | 0 |
| San Joaquin | 3,957 | 3,465 | 203 | 289 |
| Sand Canyon | 3,342 | 2,998 | 131 | 213 |
| Santiago | 250,734 | 200,327 | 26,180 | 24,227 |
| Sulphur Creek | 0 | 0 | 0 | 0 |
| Syphon | 3,327 | 2,990 | 127 | 209 |
| Trampas | 5,615 | 2,436 | 1,279 | 1,900 |
| Upper Chiquita | 0 | 0 | 0 | 0 |
| Upper Oso | 5,147 | 2,144 | 1,170 | 1,832 |
| Villa Park | 48,197 | 44,772 | 1,492 | 1,933 |
| Walnut | 739 | 508 | 127 | 104 |
| Yorba | 7,653 | 3,939 | 1,876 | 1,838 |
| **Total** | **2,616,861** | **1,326,417** | **703,416** | **587,027** |

Source: Hazus v6.1; Orange County 2021, State of California Department of Water Resources, Division of Safety of Dams 2024 USACE 2022; 2024

The total debris created by the dam inundation for Orange County is 2,616,861 tons. This includes 1,326,417 tons of finish category debris, 703,416 tons of structure category debris, and 587,027 tons of foundation debris. The Prado Dam inundation provides the highest estimated debris with a total 2,026,966 tons. The breakdown by debris categories includes 897,099 tons of finish category debris, 613,897 tons of structure category debris, and 515 tons of foundation category debris. The Diemer Dam, Upper Chiquita Dam, Diemer No.8 Dam, Diemer Ozone Dam, Dove Canyon Dam, Rossmoor Dam, and the Sulphur Creek Dam had no generated debris for the participating jurisdictions.

Table 5-60 shows the results of estimated debris for the aggregate flood inundation area by jurisdiction. The City of Anaheim has the highest estimated debris created for this dam failure scenario, at 1,289,735 tons. The finished debris category has an estimated 596,841 tons, the structure debris category has an estimated 379,355 tons, and the foundation debris category has an estimated 313,540 tons.

**Table 5-60. Estimated Debris Created During the Dam Inundation by Jurisdiction**

| Jurisdiction | Estimated Debris Created During the Dam Inundation Hazard Events | | | |
|---|---|---|---|---|
| | Total (tons) | Finish (tons) | Structure (tons) | Foundation (tons) |
| **Anaheim** | 1,289,735 | 596,841 | 379,355 | 313,540 |
| **Laguna Woods** | 0 | 0 | 0 | 0 |
| **Newport Beach** | 201,803 | 113,653 | 50,593 | 37,557 |
| **San Juan Capistrano** | 11,822 | 5,025 | 2,762 | 4,034 |
| **Santa Ana** | 661,775 | 404,901 | 130,349 | 126,525 |
| **Unincorporated County** | 451,725 | 205,997 | 140,357 | 105,371 |
| **Total** | **2,616,861** | **1,326,417** | **703,416** | **587,027** |

Source: Hazus v6.1; Orange County 2021, State of California Department of Water Resources, Division of Safety of Dams 2024 USACE 2022; 2024

## Critical Facilities

### Exposure

As shown in Table 5-61, 648 critical facilities (of the1,124 total within the planning area) are within the aggregate dam failure inundation area, representing nearly 57 percent of the total critical facilities within the planning area. Based on this analysis, and in terms of its total count of critical facilities, the City of Anaheim would have 84.3 percent of their critical facilities exposed to a dam inundation event, with the City of Santa Ana having 69.4 percent of its critical facilities exposed to such an event. The remaining participating jurisdictions have less that 25 percent of its critical facilities with San Juan Capistrano at 23.5 percent, Newport Beach at 18.4 percent, and Unincorporated Orange County at 14.9 percent. Of the various community lifeline categories, the Safety and Security group experiences the greatest exposure to a dam hazard inundation event at 213 facilities. The Hazardous Materials and Transportation lifeline groups have the next highest facilities exposed to such an event at 180 and 184 facilities, respectively.

### Impact

Impact analysis on all critical facilities by community lifeline designation were conducted for the entire planning area, which involved importing GIS data points into a GIS followed by overlaying with each of the individual, modeled dam failure inundation zones. Hazus software was then used to generate a frequency count of critical facilities and percent damage to those facilities that could result from the modeled dam failure inundation zone. Out of the twenty-eight (28) individual dam inundation zones, seven contained critical facilities with some level of projected structural damage output from the Hazus analysis. Table 5-62 lists individual dam inundation zones where projected critical facility damage has been recorded.

**Table 5-61. Critical Facilities Exposed to Aggregated Dam Failure Inundation Hazard Area**

| Jurisdiction | Critical Facilities Exposed to Dam Inundation by Community Lifeline | | | | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|
| | Communications | Energy | Hazardous Materials | Health & Medical | Safety & Security | Transportation | Other Critical Facilities | Count | % of Jurisdiction Total |
| **Anaheim** | 1 | 5 | 94 | 34 | 119 | 102 | 5 | 360 | 84.3% |
| **Laguna Woods** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Newport Beach** | 0 | 0 | 0 | 0 | 4 | 17 | 0 | 21 | 18.4% |
| **San Juan Capistrano** | 0 | 0 | 0 | 1 | 6 | 5 | 0 | 12 | 23.5% |
| **Santa Ana** | 0 | 6 | 86 | 15 | 73 | 45 | 0 | 225 | 69.4% |
| **Unincorporated County** | 0 | 1 | 0 | 2 | 11 | 15 | 1 | 30 | 14.9% |
| **(Total** | **1** | **12** | **180** | **52** | **213** | **184** | **6** | **648** | **57.7%** |

Source: California Department of Education 2024; Caltrans 2024; Homeland Infrastructure Foundation-Level Data 2022, 2023, 2024; Orange County 2022, Orange County Sheriff's Department 2024; U.S. Geological Survey 2024; USACE 2024; USACE 2024; State of California Department of Water Resources, Division of Safety of Dams 2024

**Table 5-62. Critical Facilities Impacted by Individual Dam Failure Inundation Hazard Areas**

| Dam Failure Inundation Area (Controlling Authority) | Building Damage Percentage Ranges | | | | | |
|---|---|---|---|---|---|---|
| | <5% Damage | 5 – 19% Damage | 20 – 39% Damage | 40 – 49% Damage | 50% or Greater Damage | Total |
| **Carbon Cayon Dam (USACE)** | 21 | 40 | 5 | 0 | 0 | 66 |
| **Diemer Dam (DSOD)** | 0 | 1 | 0 | 0 | 0 | 1 |
| **Lake Mission Viejo (DSOD)** | 0 | 3 | 0 | 0 | 0 | 3 |
| **Prado Dam (USACE)** | 2 | 32 | 96 | 14 | 51 | 195 |
| **Upper Oso Dam (DSOD)** | 0 | 2 | 1 | 0 | 0 | 3 |
| **Villa Park (DSOD)** | 1 | 11 | 0 | 0 | 0 | 12 |
| **Yorba Dam (DSOD)** | 2 | 11 | 2 | 0 | 0 | 15 |

Source: Source: Hazus v6.1; Orange County 2021; RS Means 2024; State of California Department of Water Resources, Division of Safety of Dams 2024; USACE 2022, 2024
Note: Dam inundation areas not shown resulted in 0% damage to its identified critical facilities

## 5.6 SEA LEVEL RISE

Global sea level is rising at an increased rate and will continue rising over the next century. The two major causes of sea level rise are the melting of glaciers and ice sheets and thermal expansion. The melting from the glaciers and icesheets add water to the oceans and the warming of the oceans causes them to expand in volume (NOAA 2023, California Coastal Commission n.d.). Since 1880, the global mean sea level has risen 8 to 9 inches (in) or 203.2 to 288.6 millimeters (mm) and there has been a change in the rate of increase with the rate of sea level rise for most of the twentieth century recorded at 0.06 in (1.4 mm) per year while the rate of increase in sea level rise between 2006 and 2015 was recorded at 0.14 in (3.6 mm) per year (NOAA 2023).

There are two types of sea level rise: global and relative. Global sea level rise is the average height of the world's oceans and is driven by adding more water to the oceans from the melting of the glaciers and ice sheets and thermal expansion of the warming oceans. Relative sea level rise is the average rise in sea level compared to the local land. The following are also drivers for relative sea level rise (NASA n.d.-a, California Ocean Protection Council 2024, California Coastal Commission n.d., U.S. Sea Level Change n.d.):

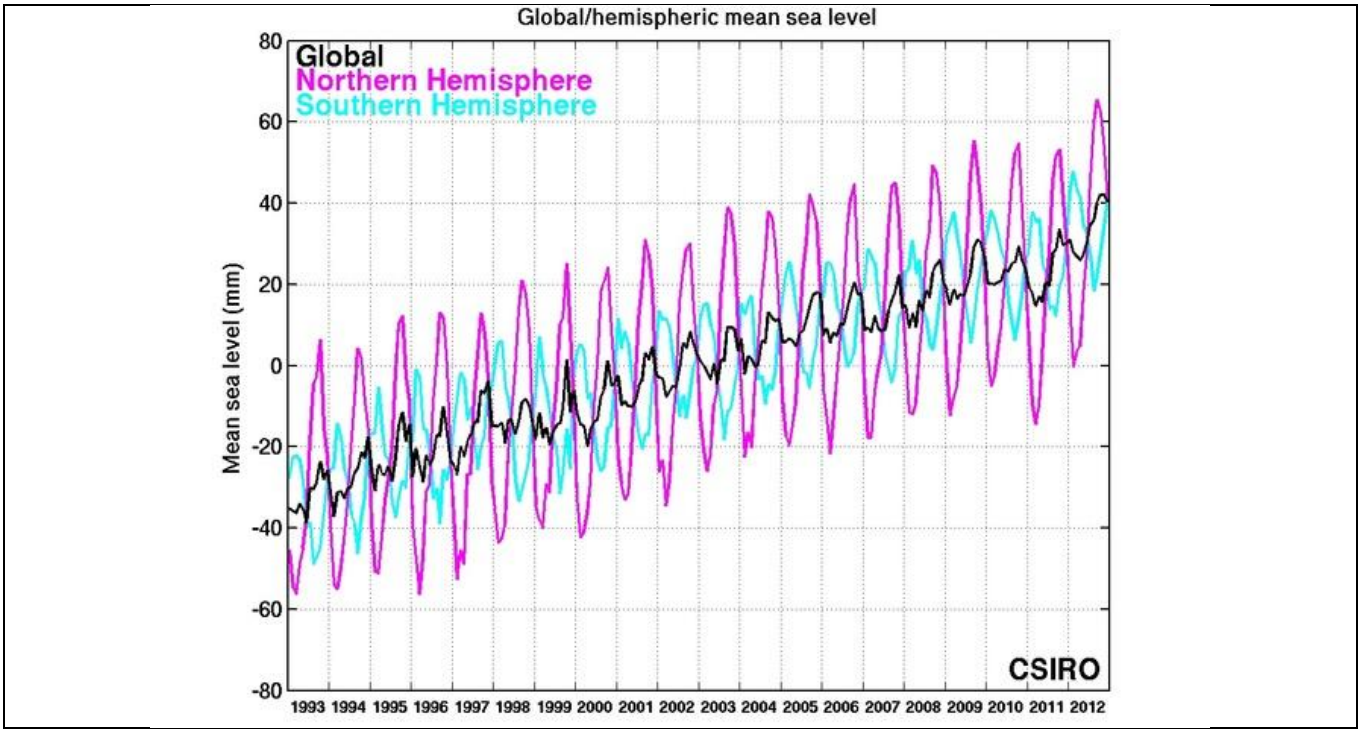
- Vertical land motion are local changes in the height of the land it can be driven by natural processes like tectonic plates or isostatic rebound or it could be due to human factors likes groundwater or petroleum extraction.
- Stereodynamic sea level change is the combined effect of changes in the density of sea water due to changes in temperature and salinity and the changes in ocean dynamics like wind patterns and ocean currents.
- Gravitational, rotational, and deformation changes due ice mass loss occur because ice exert a gravitational pull on the water due the weight of the ice sheet and a reduction in ice mass would cause the lesser gravitational pull on the water causing sea levels to decrease near the ice sheet while causing an increase in sea levels in more distant locations. This change in ice mass and water mass distribution can cause changes in the Earth's rotations which can also influence sea level heights and the reduction of glaciers and ice sheets can cause the land to deform from reduced weight of the ice and lead to vertical motion.

Short-term variations in sea level are typically caused by astronomical tides, storm surge, and waves which typically lasts for a short time period (minutes to weeks). Astronomical tides are the tides that are driven by gravity and the predictable movements of Earth, Moon, and Sun. These typically occur either diurnal (daily) or semi-diurnals (twice-daily) and there are the spring and neap tides which occur on a 14 day time frame. Storm surge is an increase in water level due strong winds blowing over the ocean surface and low pressure associate with storm systems (i.e., tropical cyclones and extratropical cyclones). Wind driven waves can also increase the sea level locally and these wind driven wave can be created by far off storms (swells) or by local (NASA n.d.-a, CSIRO n.d.).

Seasonal changes in sea level are driven by the annual warming and cooling cycle that the Earth experiences each year. Warming in summer causes the oceans to expand leading to an increase in sea level while cooling in winter causes the oceans to contract leading to a decrease in sea level. Sea level variations over years and decades are driven by complex ocean-atmosphere systems like the El Niño and La Niña events (CSIRO n.d.)

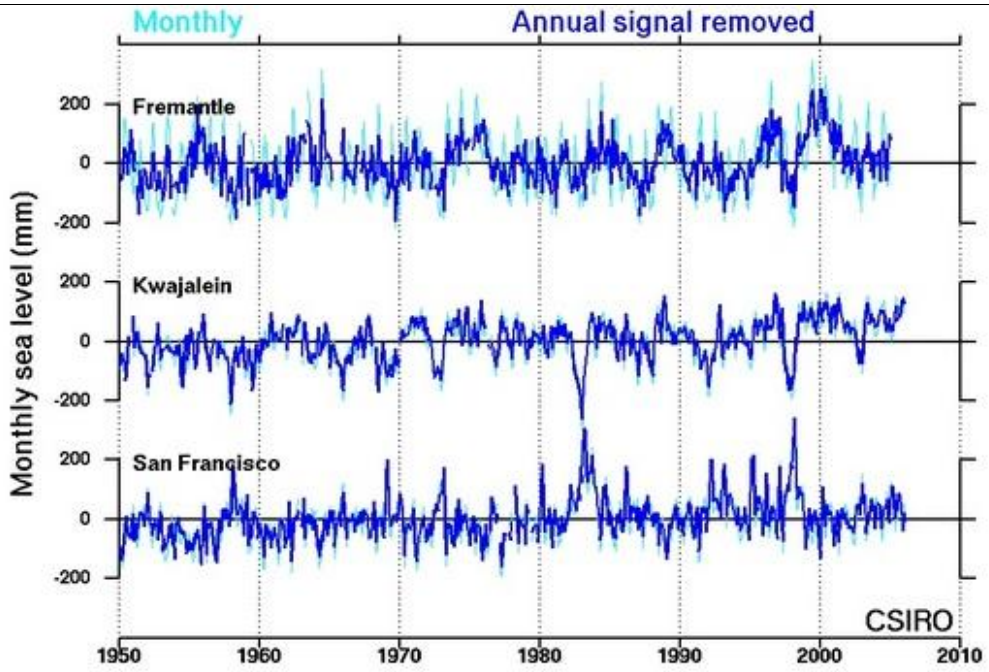
Figure 5-23 shows the variation in mean sea level from the period of 1993 to 2012 which includes the seasonal changes in mean sea level. Figure 5-24 shows the changes in monthly sea level at three tide gauges across the Pacific. The figure shows that sea level was higher at San Franisco during the 1983 and 1997 El Niño events while sea level was lower at Kwajalein Atoll.

**Figure 5-23. Seasonal Changes in Mean Sea Level 1993 – 2012**




*Source: (CSIRO n.d.)*

**Figure 5-24. Changes in Monthly Sea Level at Three Tide Gauges Across the Pacific**




Tide gauges from Fremantle (SW Australia), Kwajalein Atoll (western Pacific), and San Francisco (eastern Pacific). El Niño events are in 1983 and 1997.

*Source: (CSIRO n.d.)*

As sea levels continue to rise, the flooding for Orange County's coastal communities is expected to be exacerbated. The Orange County communities at risk to sea level rise include Seal Beach, Huntington Beach, Newport Beach, Laguna Beach, and the coastal parts of unincorporated Orange County.

## 5.6.1 Location

Being a coastal state, California is at risk to sea level rise and sea level has risen at 0.04 to 0.08 inches (in) per year along the coast. The exception of this trend is near Crecent City, CA where movements of the Earth's plates have caused the land to uplift causing the tide gauge to show a decrease in sea level. The effects associated with a rise in sea level include increased coastal flooding, beach erosion, habitat loss, and salinization of both ground and surface water (California OEHAA 2022, California Coastal Commission n.d.). Table 5-63 shows the number of National Oceanic and Atmospheric Administration (NOAA) tide gauges that are used to measure tides and to determine the relative sea level rise trends. The unit of measurement for relative sea level trend is millimeters per year (mm/year).

**Table 5-63. NOAA Tide Gauges in California**

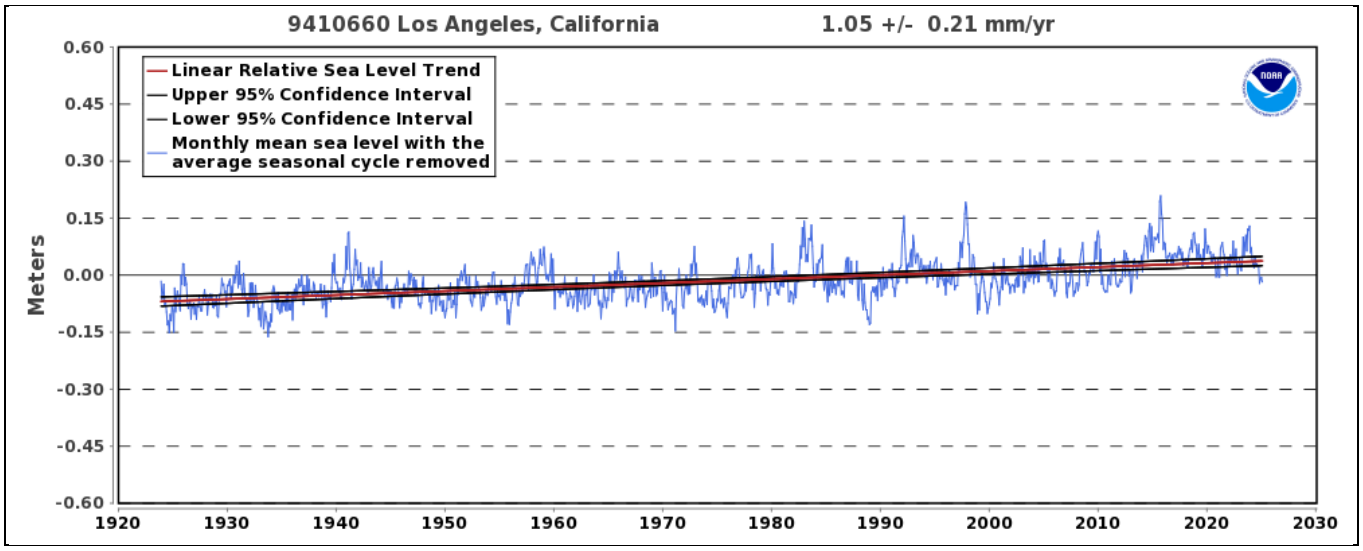
| NOAA Station ID | Location | Relative Trend (mm/year) | 95% Confidence Interval (mm/year) |
|---|---|---|---|
| **9410170** | San Diego, CA | 2.22 | 0.17 |
| **9410230** | La Jolla, CA | 2.02 | 0.22 |
| **9410660** | Los Angeles, CA | 1.05 | 0.21 |
| **9410840** | Santa Monica, CA | 1.52 | 0.28 |
| **9411340** | Santa Barbara, CA | 0.99 | 0.81 |
| **9412110** | Port San Luis, CA | 0.98 | 0.33 |
| **9413450** | Monterey, CA | 1.72 | 0.65 |
| **9414290** | San Franciso, CA | 1.98 | 0.17 |
| **9414523** | Redwood City, CA | 2.67 | 1.30 |
| **9414750** | Alameda, CA | 0.92 | 0.36 |
| **9414863** | Richmond, CA | 3.32 | 1.50 |
| **9415020** | Pointe Reyes, CA | 2.13 | 0.70 |
| **9415144** | Port Chicago, CA | 1.95 | 1.24 |
| **9416841** | Arena Cove, CA | 1.11 | 0.80 |
| **9418767** | North Spit, CA | 5.04 | 0.74 |
| **9419750** | Crescent City, CA | -0.77 | 0.26 |

Source: NOAA Tides and Currents n.d.

The closest NOAA tide gauge to Orange County is located in Los Angeles. Figure 5-25 shows the relative sea level trend for the Los Angeles tide gauge to be an increase of 1.05 mm/year.

To understand the possible projected sea level rise in California, The California Ocean Protection Council (OPC) produce the 2024 State of California Sea Level Rise Guidance report (California Ocean Protection Council 2024). This report contains scenarios for potential sea level rise, the impacts sea level rise has on the state, and how this report can provide valuable information on sea level rise for planning and decision making (California Ocean Protection Council 2024).

**Figure 5-25. Relative Sea Level Trend NOAA Los Angeles Tide Gauge**




*Source: NOAA Tides and Currents n.d.*

The projections developed for this report were based on the Shared Socioeconomic Pathways (SSP) that were developed for the Intergovernmental Panel on Climate Change 6th Assessment Report (IPCC AR6) (California Ocean Protection Council 2024). SSPs are emissions scenarios based on alternative futures of socio-economic development and the factors included to determine the alternative futures are population, economic growth, education, urbanization, and rate of technology development (California Ocean Protection Council 2024). The global sea level rise scenarios are based on the plausible range of global mean sea level rise established by the IPCC AR6 and this range from 0.3 m and 2.0 m in 2100 (California Ocean Protection Council 2024). The IPCC AR6 created medium confidence sea level projections for multiple SSPs and an ensemble of thousands of sea level projections for each SSP were modeled for the time period between 2020 and 2150 (California Ocean Protection Council 2024). 5 global sea level rise targets in 2100 that span the plausible range of 0.3 m to 2.0 m are defined and the full sample of sea level projections are filtered to the ones that fit these targets (California Ocean Protection Council 2024). Below are the 5 sea level rise targets (California Ocean Protection Council 2024):

- Plausible Range of 2100 Global Sea Level Rise of 2.0 m—High
- Plausible Range of 2100 Global Sea Level Rise of 1.5 m—Intermediate High
- Plausible Range of 2100 Global Sea Level Rise of 1.0 m—Intermediate
- Plausible Range of 2100 Global Sea Level Rise of 0.5 m—Intermediate Low
- Plausible Range of 2100 Global Sea Level Rise of 0.3 m—Low

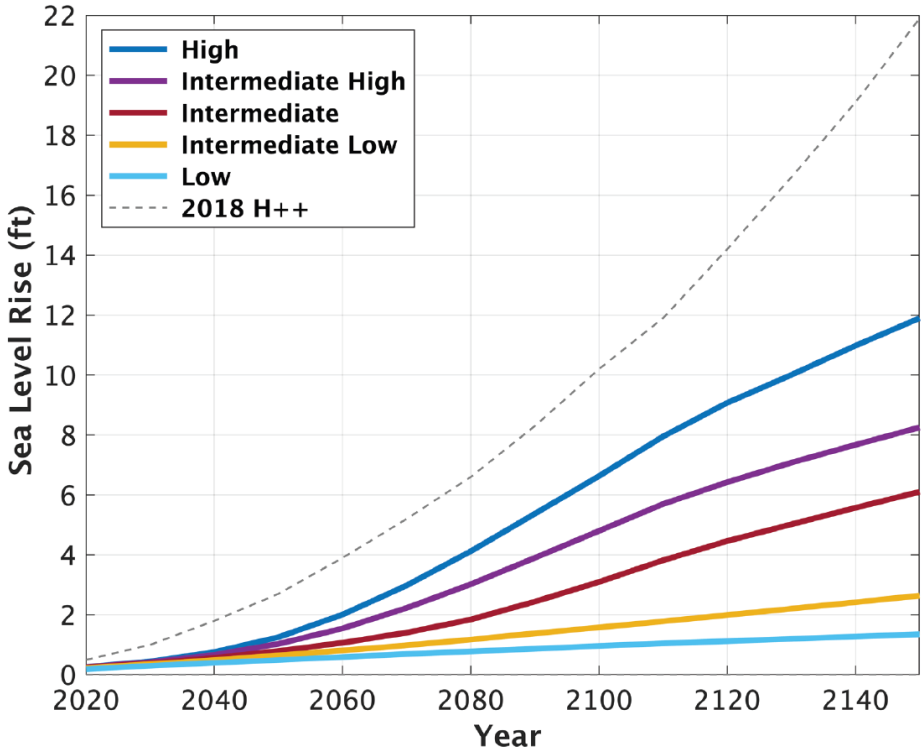
The final five sea level scenarios of global mean sea level rise and local relative sea level rise are constructed by collecting the model projections across the SSPs that fit these 5 sea level rise targets (California Ocean Protection Council 2024). SSPs with lowest emissions primarily build the lowest sea level scenarios, the SSPs that cover the low, intermediate, and high emissions build the Intermediate-Low sea level scenario, and the SSPs that with high emissions build the Intermediate sea level rise scenario, and the SSPs with highest emissions and the highest SSP emissions that include the low confidence processes (ice sheet melt) build the Intermediate-High and High sea level scenarios (California Ocean Protection Council 2024). Table 5-64 and Figure 5-26 shows the 50th percentile for sea level rise scenarios for California.

**Table 5-64. Median Values (50th Percentile) for Sea Level Scenarios for California—2000 Baseline**

| Year | Low | Intermediate Low | Intermediate | Intermediate High | High |
|---|---|---|---|---|---|
| **2020** | 0.2 | 0.2 | 0.2 | 0.2 | 0.3 |
| **2030** | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 |
| **2040** | 0.4 | 0.5 | 0.6 | 0.7 | 0.8 |
| **2050** | 0.5 | 0.6 | 0.8 | 1.0 | 1.2 |
| **2060** | 0.6 | 0.8 | 1.1 | 1.5 | 2.0 |
| **2070** | 0.7 | 1.0 | 1.4 | 2.2 | 3.0 |
| **2080** | 0.8 | 1.2 | 1.8 | 3.0 | 4.1 |
| **2090** | 0.9 | 1.4 | 2.4 | 3.9 | 5.4 |
| **2100** | 1.0 | 1.6 | 3.1 | 4.9 | 6.6 |
| **2110** | 1.1 | 1.8 | 3.8 | 5.7 | 8.0 |
| **2120** | 1.1 | 2.0 | 4.5 | 6.4 | 9.1 |
| **2130** | 1.2 | 2.2 | 5.0 | 7.1 | 10.0 |
| **2140** | 1.3 | 2.4 | 5.6 | 7.7 | 11.0 |
| **2150** | 1.3 | 2.6 | 6.1 | 8.3 | 11.9 |

Source: California Ocean Protection Council 2024

**Figure 5-26. Sea Level Scenarios, 2020 to 2150**




Baseline of 2000. The H++ Projection is from the 2018 California Sea-Level Guidance

*Source: (California Ocean Protection Council 2024)*

The 2024 State of California Sea Level Rise Guidance report also includes tables of projected sea level rise for 14 tide gauges in California (California Ocean Protection Council 2024). These regional sea level rise projections take into account regional vertical land motion and differ from the state averages shown in Table 5-64. Table 5-65 shows the regional projected sea level rise for the Los Angeles tide gauge.

**Table 5-65. Mean Value of Sea Level Scenarios (In Feet) for Los Angeles With Baseline of 2000**

| Year | Low | Intermediate Low | Intermediate | Intermediate High | High |
|---|---|---|---|---|---|
| **2020** | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 |
| **2030** | 0.2 | 0.3 | 0.3 | 0.4 | 0.4 |
| **2040** | 0.3 | 0.4 | 0.5 | 0.6 | 0.7 |
| **2050** | 0.4 | 0.5 | 0.7 | 0.9 | 1.1 |
| **2060** | 0.4 | 0.6 | 0.9 | 1.4 | 1.8 |
| **2070** | 0.5 | 0.8 | 1.2 | 2.1 | 2.7 |
| **2080** | 0.5 | 0.9 | 1.6 | 2.8 | 3.8 |
| **2090** | 0.6 | 1.1 | 2.2 | 3.6 | 5.0 |
| **2100** | 0.6 | 1.3 | 2.8 | 4.5 | 6.3 |
| **2110** | 0.7 | 1.4 | 3.5 | 5.3 | 7.6 |
| **2120** | 0.7 | 1.6 | 4.0 | 6.0 | 8.6 |
| **2130** | 0.8 | 1.8 | 4.5 | 6.6 | 9.5 |
| **2140** | 0.8 | 1.9 | 5.0 | 7.1 | 10.4 |
| **2150** | 0.8 | 2.1 | 5.5 | 7.7 | 11.3 |

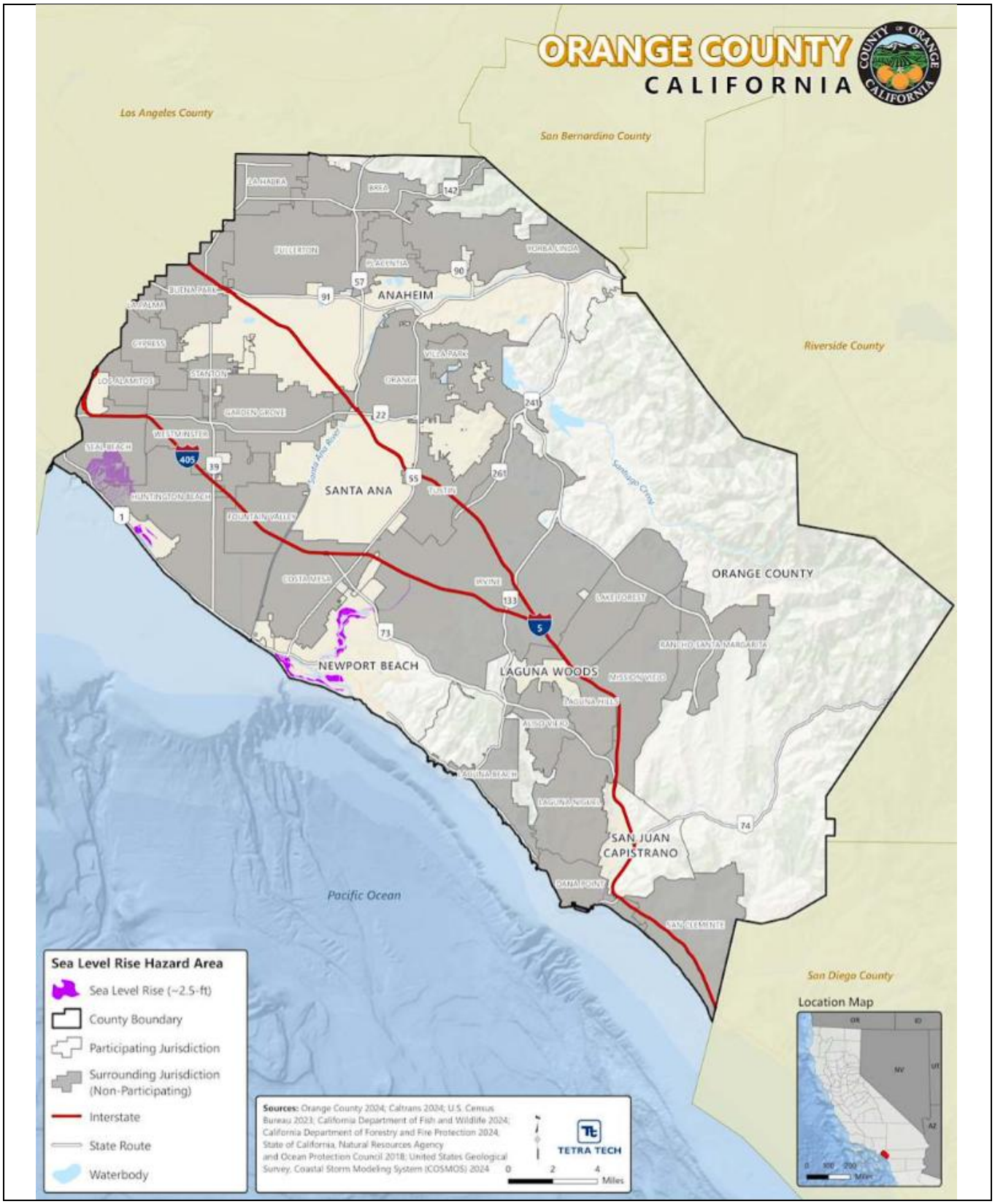
Source: California Ocean Protection Council 2024

Coastal Orange County is vulnerable to sea level rise and the sea level rise was studied as part of this FMP and the results are explained later in this section. A 2.5 foot sea level rise was chosen to study the vulnerability and Figure 5-27 below shows the areas of the county that are impacted by this increase in sea level. The participating jurisdictions that are impacted by the 2.5 foot increase in sea level rise are the City of Newport Beach and the Unincorporated Orange County. The area of Unincorporated Orange County that is impacted by the 2.5 foot increase is sea level is long the coastline of the Bolsa Chica Basin. For the City of Newport Beach, the areas impacted by the 2.5 foot increase in sea level include the coastal areas west of State Route 1 and the coastal areas along Newport Bay.

## 5.6.2 Severity

Sea level rise severity is attributed to the number of feet sea level rises and the rate at which sea level rise takes place. A faster rate of sea level rise results in less ability of coastal municipalities to protect from and adapt to higher water levels and increased coastal flooding frequency. Global mean sea level has been increasing and the rate of change in sea level rise has also increased from 0.06 in per year for the twentieth century to 0.14 in per year being recorded from 2006 to 2015 (NOAA 2023).

**Figure 5-27. Sea Level Rise Hazard Area in Orange County**



Determining Sea level rise is dependent mostly on the rate of greenhouse gas emissions, but there is uncertainty in the rate that large ice sheets, located in Antarctica and Greenland, will melt (NOAA 2023). Greenhouse gas emission scenarios are included in the climate change modeling that develops the sea level rise projections. The results provide a range of possible sea level rise scenarios in the future under different emission scenarios as shown in Table 5-64 and in Table 5-66 (California Ocean Protection Council 2024). The 2024 State of California Sea Level Rise Guidance report also includes a table of the projected sea level rise rates for California for 2050 and 2100 and the table shows that there is an increase in projected rates of sea level rise for the higher sea level rise scenarios (California Ocean Protection Council 2024).

**Table 5-66. Rates of Sea Level Rise for California in 2050 and 2100**

| Scenario | Rate in 2050 (inches/year) | Rate in 2100 (inches/year) |
|---|---|---|
| **Low** | 0.1 | 0.1 |
| **Intermediate-Low** | 0.2 | 0.2 |
| **Intermediate** | 0.3 | 0.8 |
| **Intermediate-High** | 0.5 | 1.1 |
| **High** | 0.7 | 1.3 |

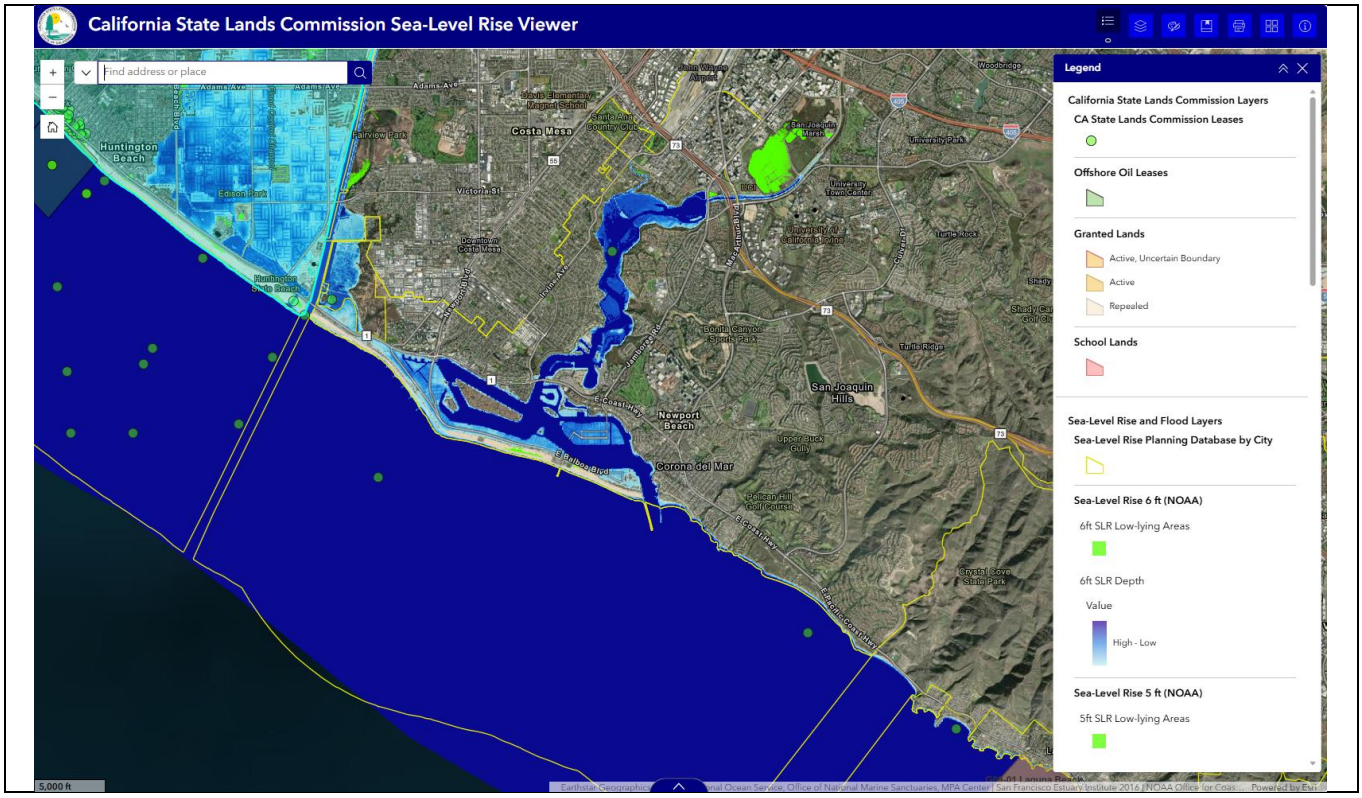
Source: California Ocean Protection Council 2024

As mentioned above, the 2024 State of California Sea Level Rise Guidance report provides guidance on how to use the sea level rise scenarios presented in the report for planning and project applications (California Ocean Protection Council 2024). The guidance provided by the OPC suggests that planners and project managers choose multiple sea level rise scenarios to understand what is at risk due to the uncertainty in the amount of sea level rise. Thus, the OPC guidance recommends using the Intermediate, Intermediate-High, and High sea level rise scenarios as they are the most precautionary approaches (California Ocean Protection Council 2024).

Several web-based mapping applications have been developed by both state and federal agencies to assist with informing the public on the impacts of sea level rise and they provide multiple sea level rise heights to show the severity sea level rise can be to coastal communities. The California State Lands Commission, the agency that manages state public lands, developed the California State Lands Commission Sea-Level Rise Viewer to display the risk that public trust lands and resources in California are at risk to sea level rise (California State Lands Commission n.d.; California State Land Commission 2019). The viewer shows the layers on the California State Land Commission leases, offshore oil leases, granted lands, school lands, critical infrastructure like power plants, sensitive habitats, and sea level rise that range from 1 foot to 6 feet (California State Lands Commission 2022). Figure 5-28 shows the California State Lands Sea Level Rise Viewer for the City of Newport Beach, located within Orange County.

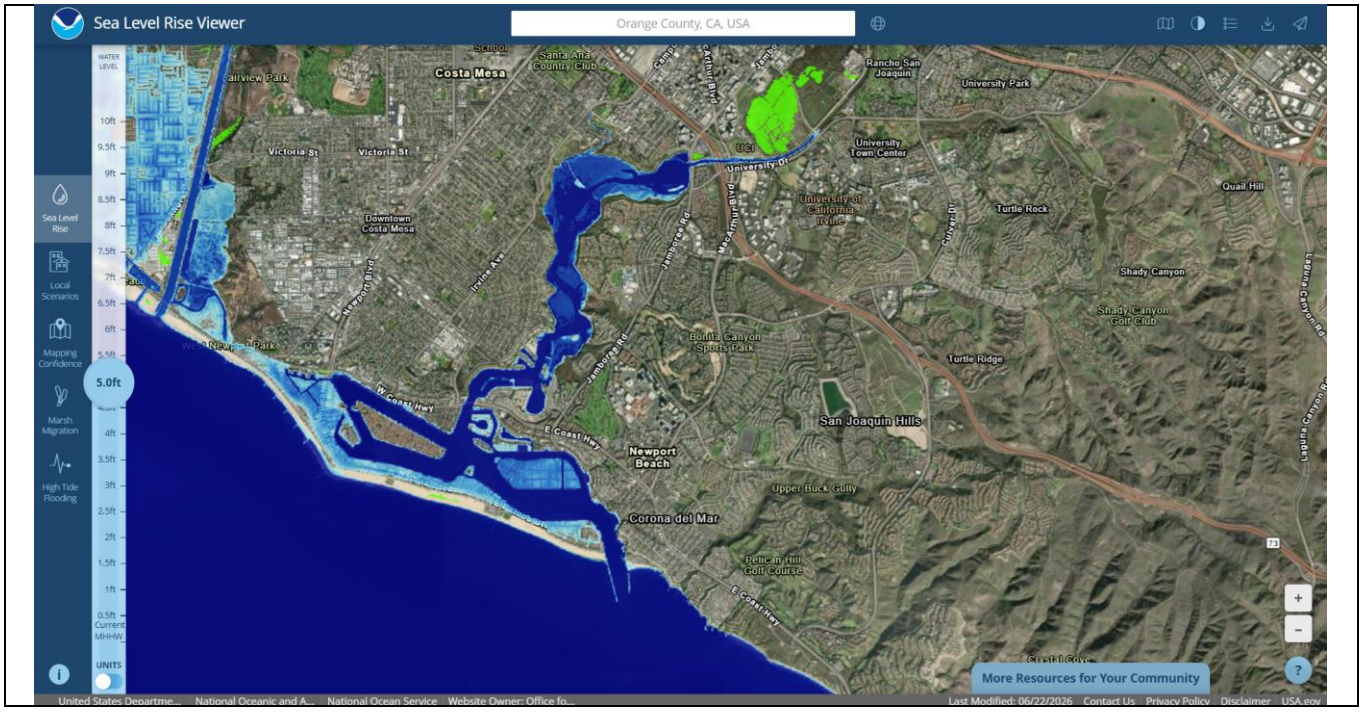
In addition to the California State Lands Commission viewer, both NOAA and USGS have developed their own sea level rise viewers. The NOAA Sea Level Rise Viewer was developed by the Office for Coastal Management and shows community level impacts from coastal flooding or sea level rise on a national scale (NOAA-OCM n.d.). The NOAA Office for Coastal Management is the agency that focuses on increasing the resiliency of the United States coastline by helping coastal communities (NOAA-OCM n.d.). The viewer shows sea level rise up to 10 feet above average high tide and includes information about location scenarios and marsh migration (NOAA-OCM n.d.). A unique feature of the NOAA sea level rise viewer is that it provides photos of local locations and shows the simulated depth of sea level rise to provide a visual explanation of how sea level rise could impact that location. Figure 5-29 is an example of the NOAA Sea Level Rise Viewer, showing how a 5-foot rise in sea level would look in the City of Newport Beach, located within Orange County.

**Figure 5-28. California State Lands Commission Sea-Level Rise Viewer for Newport Beach**




*Source: California State Land Commission 2019*

**Figure 5-29. NOAA Sea Level Rise Viewer. 5-Foot Sea Level Rise in Newport Beach**

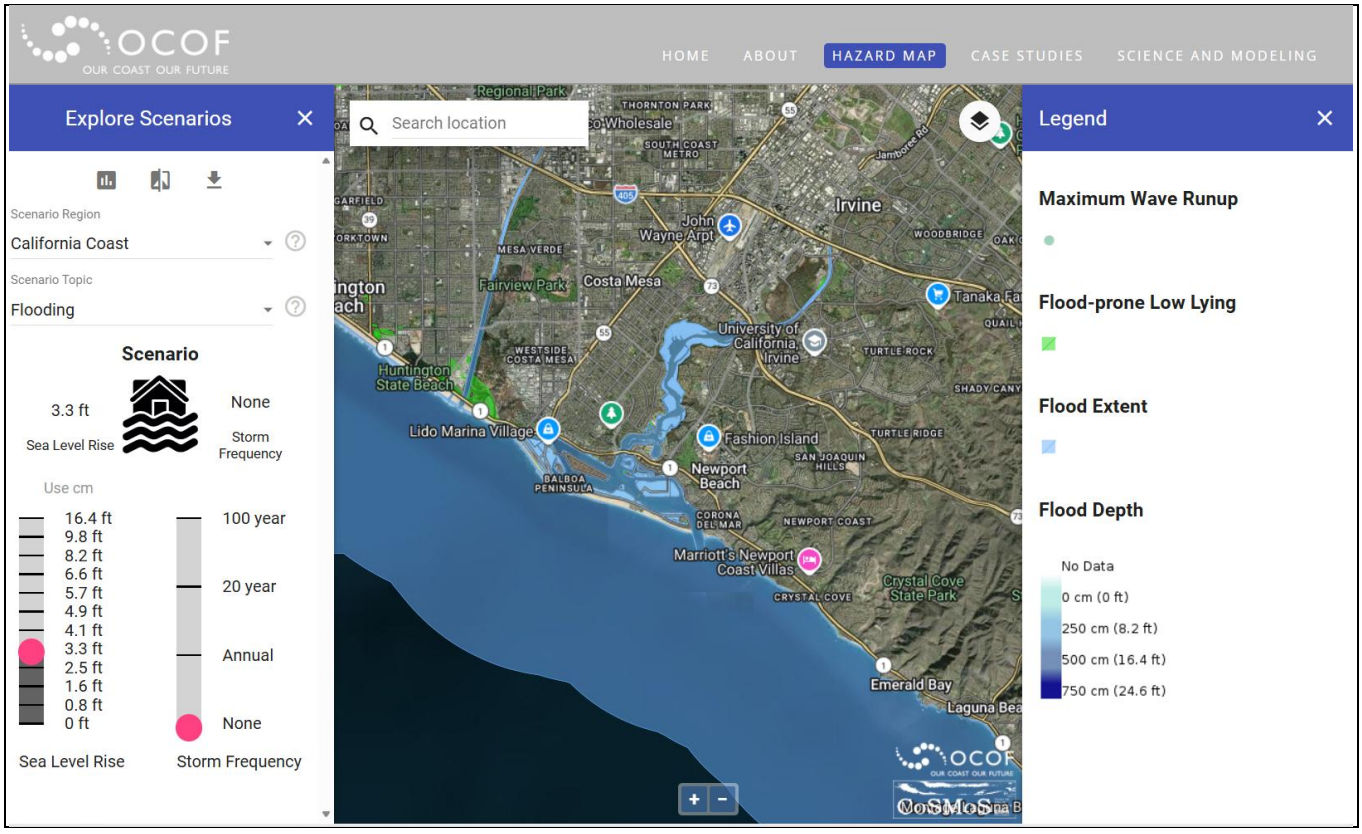



*Source: NOAA-OCM n.d.*

The Our Coast Our Future (OCOF) viewer was developed by a partnership between the Point Blue Conversation Science and the USGS Pacific Coastal and Marine Science Center (Our Coast Our Future n.d.). The Point Blue Conservation Science is non-profit conservation organization that focuses on climate smart conservation to help wildlife and communities (Point Blue Conservation Science n.d.). The USGS Pacific Coastal and Marine Science Center is a part of the USGS that studies the western U.S. coastal and offshore areas and the research conducted by this office help managers make more informed resource management and policy decisions (USGS Pacific Coastal Marine Science Center n.d.).

The OCOF viewer utilizes the USGS Coastal Storm Modeling System (COSMOS) data to show changes in sea level impact the California coastline (Our Coast Our Future n.d.). The OCOF viewer was developed to support managers in the fields of land use management, coastal resource management, hazard mitigation, and many others (Our Coast Our Future n.d.). The OCOF viewer and the USGS COSMOS data have been used in a variety of climate vulnerability and adaptation activities including sea level rise vulnerability assessments and coastal adaptation planning, municipal planning, hazard mitigation planning, and species protection plans (Our Coast Our Future n.d.). Figure 5-30 shows the OCOF viewer with a 3.3-foot sea level rise for the City of Newport Beach, within Orange County.

**Figure 5-30. Our Coast Our Future Sea Level Rise Viewer for Newport Beach with 3.3-Foot Sea Level Rise**




*Source: Our Coast Our Future n.d.*

## 5.6.3 Frequency

Sea level change is an ongoing process and can be monitored on both long-term and shorter-term scales. Global sea level changes are due to the changes in the volume of water in ocean basins through thermal expansion,

glacial melt, or net changes in the size of ocean basins. In fact, global sea rise has been occurring for the past 20,000 years as a natural result of glacial maximum decline.

Local and shorter-term sea level rise frequency is not as continuous but can still be predicted by surrounding factors. Permanent sea level rise will be more noticeable and frequent in low-lying areas already close to sea level or bayside locations. The landward side of open-coast barrier island communities are more likely to experience sea level rise as they are at a greater vulnerability for coastal erosion, which can impact sea levels near land. Sea level rise frequency can be partially predicted by nearby human activity, as mitigation measures like sea walls, levels, or dikes can affect the location and extent of the sea level rise.

While Sea level rise can be projected into the future, the factors that can lead to increase flooding due to sea level like tides and El Niño have a frequency that can lead to warnings and preparations. High tides and low tides occur twice a day at most coastal locations which includes California (NOAA NOS 2024b) (NOAA NOS n.d.). The tides follow the Lunar Day which is 24 hours and 50 minutes and this causes hide tides to occur 12 hours and 25 minutes apart (NOAA NOS n.d.). The Spring Tide or King Tide is a high tide that is higher than the usually high tide due to the combined gravitational pull of the sun and the moon (NOAA NOS 2024c). Spring tides occur twice every lunar month all year long (NOAA NOS 2024c). El Niño events do not have a set schedule but usually occur every 2 to 7 years and can last from 9 to 12 months (NOAA NOS 2024d).

## 5.6.4 Warning Time

Through NOAA, the Center for Operational Oceanographic Products and Services has measured sea level heights and rates for more than 150 years. The center calculates the mean sea level. This is calculated with sea level rises and falls, at 210 long-term water level stations. The center averages results at a monthly level to remove the effect of higher frequency phenomena and to determine a linear sea level trend.

NOAA identifies multiple factors that influence both short- and long-term sea level changes. While short-term variations fluctuate daily and include waves, tides, or flood events, long-term variations occur on a larger scale, most typically months to years. Long-term sea level changes can include gradual trends, repeatable cycles, or intermittent anomalies, and they may be influenced by seasonal weather patterns, variations in the Earth's declination, changes in coastal and ocean circulation, anthropogenic influences (such as dredging), vertical land motion, and the El Niño Southern Oscillation. Thus, while short-term sea level rises may have little warning time, long-term and consistent sea level rises are gradual and can be predicted through detailed observations, typically allowing for ample warning.

## 5.6.5 Secondary Hazards

According to the 2024 State of California Sea Level Rise Guidance report, sea level rise will have an impact on coastal hazards like coastal flooding, coastal erosion, and groundwater. As sea levels continue to rise, coastal flooding from both tides and storms are anticipated to increase. Coastal flooding associated with storms come in the form of storm surge and waves from far off storms. Flooding from high tides are also known as nuisance flooding and occur when the high tide is abnormally high and begin to flood local roads, parking lots, and other infrastructure. High tide flooding is anticipated to be more common in the future due to sea level rise (CSIRO n.d., California Coastal Commission n.d., California Ocean Protection Council 2024, NASA n.d.-a, U.S. Sea Level Change n.d., NOAA NOS 2024).

High tide flooding can be classified as follows (NOAA NOS 2024):

- Minor—High tide flooding when water levels reach 1.8 feet above high tide. This minor flooding is mostly disruptive, causing stormwater backups and road closures.
- Moderate—High tide flooding is 2.8 feet above average high tide. This can cause more disruption and can damage homes and businesses.
- Major—High tide flooding is 3.9 feet above average high tide. Floods of this severity are destructive, lead to evacuations, and require repair to infrastructure.

Coastal erosion is a natural process in which local sea level rise, strong waves action, and coastal flooding wear down and carry away rocks, soils, and sands (U.S. Climate Resilience Toolkit n.d.). Beaches provide protection to coastal communities by dissipating wave energy and will migrate landward with sea level rise (California Ocean Protection Council 2024). Beaches can become permanently inundated if the migrating beach meets a physical barrier like development (California Ocean Protection Council 2024). Much of California's coastline is made up of coastal bluffs. The rate of erosion is dependent on factors such as sea level rise, wave energy, and rock strength (USGS 2018). Coastal bluffs will experience more wave action due to rising sea levels which will lead to an increase in erosion. This increase in erosion can lead to landslides and impact bluff top developments like roads, homes, and other infrastructure (California OEHAA 2022, California Ocean Protection Council 2024, California Coastal Commission n.d., U.S. Sea Level Change n.d.).

Saltwater intrusion occurs when the lowering of freshwater groundwater levels, usually from over pumping of groundwater, allows subsurface saltwater from seawater to advance inland. This advancement of seawater into coastal aquifers will cause the freshwater to become brackish and render wells unusable for drinking or agriculture use. As the sea level continues to rise, the rate saltwater intrusion is anticipated to increase causing the saltwater to reach further inland. In addition to the sea level rise, the increase in the frequency of drought in California could lead to more reliance on groundwater and leading to a greater possibility of saltwater intrusion. The intrusion of saltwater due to sea level rise can also lead to an increase of groundwater due to the difference in density between saltwater and freshwater. Saltwater is denser than freshwater and will push freshwater up causing the groundwater to rise. This increase in groundwater could cause ponding in low laying areas where the groundwater emerges to the surface, damage subsurface infrastructure, and release pollutants (California Ocean Protection Council 2024, California OEHAA 2022, State of California 2018, EPA 2024, NASA 2024, U.S. Sea Level Change n.d., USGS Pacific Coastal and Marine Science Center 2020, USGS-California Water Science Center n.d.)

In addition to impacting coastal hazards like flooding and erosion, sea level rise will also impact coastal habitats. Coastal habitats like beaches, marshes, and dunes will experience more flooding, erosion, and increased salinity as sea levels continue to rise. This could lead to coastal habitats like marshes and beaches to retreat inland and disappear if they encounter urban development because they will be unable to continue advancing inland. The increase salinity of surface water and groundwater will impact the vegetation and could cause the non-salt tolerant plants to die off and impact the different species that inhabit these ecosystems (California OEHAA 2022, California Ocean Protection Council 2024, U.S. Sea Level Change n.d.)

## 5.6.6 Vulnerability Analysis

A vulnerability analysis was performed to understand the population and structures that are at risk to sea level rise in Orange County. An approximate 2.5 feet sea level rise was used for this analysis and the result of the analysis is presented below.

## Land Exposure

Table 5-67 shows the land area of the participating jurisdictions located in the areas that are inundated by the 2.5 feet increase in sea level. 0.5 percent of the land area of the participating jurisdiction is located in the sea level rise inundation area. The City of Newport Beach has the most of its land area (excluding waterbodies) located in the sea level rise inundation area. The City of Newport Beach has a total area of 16,450 acres with 925.4 acres exposed to the sea level rise inundation area. This is 5.6 percent of the total area for the community. The Unincorporated Orange County also has land that is located in the sea level rise inundation area. The land area of the Unincorporated Orange County is 174,768 acres and 223.0 acres are located in the sea level rise inundation area. The is 0.1 percent of the total area for the community.

**Table 5-67. Land Area in the Sea Level Rise Hazard Area**

| Jurisdiction | Total Land Area (Acres) Excludes Waterbodies | Land Area in the Sea Level Rise Hazard Area | |
|---|---|---|---|
| | | Total Area (acres) | % of Jurisdiction Total |
| **Anaheim** | 32,170 | 0.0 | 0.0% |
| **Laguna Woods** | 2,116 | 0.0 | 0.0% |
| **Newport Beach** | 16,450 | 925.4 | 5.6% |
| **San Juan Capistrano** | 9,220 | <0.1 | <0.1% |
| **Santa Ana** | 17,531 | 0.0 | 0.0% |
| **Unincorporated County** | 174,768 | 223.0 | 0.1% |
| **Total** | **252,255** | **1,148.4** | **0.5%** |

Source: Orange County 2024; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)
Note: Excludes areas designated as water

## Population

### Exposure

The total population of the participating jurisdictions based on the 2020 Decennial Census is 928,007. Table 5-68 shows the results of the sea level vulnerability analysis for Orange County. A total of 9,480 people are located in the 2.5 feet sea level rise area which is 1.0 percent of the total population of the participating jurisdiction. Only the City of Newport Beach has a population that is impacted by the increase in sea level rise which is a total of 9,480. This is 11.1 percent of the total population for Newport Beach.

**Table 5-68. Population in the Sea Level Rise Hazard Area**

| Jurisdiction | Total Population (2020 Decennial) | Population in the Sea Level Rise Hazard Area | |
|---|---|---|---|
| | | Number of Persons | % of Jurisdiction Total |
| **Anaheim** | 346,824 | 0 | 0.0% |
| **Laguna Woods** | 17,644 | 0 | 0.0% |
| **Newport Beach** | 85,239 | 9,480 | 11.1% |
| **San Juan Capistrano** | 35,196 | 0 | 0.0% |
| **Santa Ana** | 310,227 | 0 | 0.0% |
| **Unincorporated County** | 132,877 | 0 | 0.0% |
| **Total** | **928,007** | **9,480** | **1.0%** |

Source: U.S. Census Bureau 2020; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

Table 5-69 shows the results of the sea level rise vulnerability analysis on the vulnerable populations of the participating jurisdictions. The vulnerable populations include the population over the age of 65, the population under the age of 5, the population that is non-English speaking, the population with a disability, and the population below the poverty level. Since the only participating jurisdiction that is impacted by sea level rise is the City of Newport Beach, the results of the sea level rise vulnerability analysis on the total vulnerable population categories for the participating jurisdictions are around 1 percent. For the population over 65, 1.6 percent of the total population over 65 for the participating jurisdictions are in the sea level rise inundation area. For Newport Beach, 11.1 percent of the population over 65 is in the sea-level rise inundation area.

For the population under 5 years old, 0.7 percent of the population under 5 years old for the participating jurisdictions is in the sea level rise inundation area. 11.1 percent of the population under 5 years old for the City of Newport Beach is in the sea level rise inundation. When looking at the population of non-English speakers, only 0.3 percent of the non-English speaks for the participating jurisdictions are in the sea level rise inundation area. The City of Newport Beach has 11.1 percent of its Non-English speaking population being located in the sea level rise inundation area. For the population with a disability, 0.9 percent of the population with a disability for the participating jurisdictions are located in the sea level rise inundation area. For Newport Beach, 11.1 percent of the people with a disability is in the sea level rise inundation area. Finally, 0.7 percent of the population in poverty for the participating jurisdictions and 11.1 percent of the population in poverty for the City of Newport Beach is located in the sea level rise inundation area.

## Impacts

Table 5-70 shows the results of the Hazus analysis on population. The results show that the displaced population of the participating jurisdictions is 7,034 and the number of people seeking short term shelter is 136. The City of Newport Beach has the highest displaced population and persons seeking short term shelter with 7,030 displaced people and 136 people seeking short term shelter. The Unincorporated Orange County only has 4 displaced people.

**Table 5-69. Vulnerable Population Located in the Sea Level Rise Hazard Area**

| Jurisdiction | Estimated Number of Vulnerable Persons Located in the Sea Level Rise Hazard Area | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Persons Over 65 | % of Total | Persons Under 5 | % of Total | Non-English Speaking Persons | % of Total | Persons with a Disability | % of Total | Persons in Poverty | % of Total |
| **Anaheim** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Laguna Woods** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Newport Beach** | 2,192 | 11.1% | 332 | 11.1% | 236 | 11.1% | 774 | 11.1% | 682 | 11.1% |
| **San Juan Capistrano** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Santa Ana** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Unincorporated County** | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| **Total** | **2,192** | **1.6%** | **332** | **0.7%** | **236** | **0.3%** | **774** | **0.9%** | **682** | **0.7%** |

Source: U.S. Census Bureau, American Community Survey 2023; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

**Table 5-70. Sea Level Rise Impacts on People**

| Jurisdiction | Total Population (2020 Decennial) | Sea Level Rise Impacts on People | |
|---|---|---|---|
| | | Displaced Population | Persons Seeking Short-Term Shelter |
| **Anaheim** | 346,824 | 0 | 0 |
| **Laguna Woods** | 17,644 | 0 | 0 |
| **Newport Beach** | 85,239 | 7,030 | 136 |
| **San Juan Capistrano** | 35,196 | 0 | 0 |
| **Santa Ana** | 310,227 | 0 | 0 |
| **Unincorporated County** | 132,877 | 4 | 0 |
| **Total** | **928,007** | **7,034** | **136** |

Source: Hazus v6.1; U.S. Census Bureau 2020; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

## Property

### Exposure

There are a total of 198,051 buildings located in the participating jurisdictions with a replacement cost value (RCV) of $465,982,716,705. Table 5-71 shows the results of the vulnerability analysis on the structures. The participating jurisdictions have a total of 3,545 structures located in the sea level rise inundation area which is 1.8 percent of the total structures in the participating jurisdictions. The RCV for this structures is $4,145,344,185 which is 0.9 percent of the total RCV. When looking at the jurisdictions, the City of Newport Beach contains all of the structures in the participating jurisdiction that are located in the sea level rise inundation area with 3,545 structures which is 11.4 percent of the total structures in the community. The RCV for these structures in Newport Beach is $4,145,344,185 which is 4.9 percent of the total RCV for the community.

**Table 5-71. Buildings in Sea Level Rise Area**

| Jurisdiction | Total Buildings | | Buildings in the Sea Level Rise Hazard Area | | | |
|---|---|---|---|---|---|---|
| | | | Number of Buildings | | Replacement Cost Value | |
| | Count | Replacement Cost Value | Count | % of Jurisdiction Total | Value | % of Jurisdiction Total |
| **Anaheim** | 66,553 | $178,343,603,814 | 0 | 0.0% | $0 | 0.0% |
| **Laguna Woods** | 3,519 | $10,117,235,987 | 0 | 0.0% | $0 | 0.0% |
| **Newport Beach** | 31,118 | $84,976,395,506 | 3,545 | 11.4% | $4,145,344,185 | 4.9% |
| **San Juan Capistrano** | 10,465 | $19,621,067,650 | 0 | 0.0% | $0 | 0.0% |
| **Santa Ana** | 51,451 | $128,949,333,589 | 0 | 0.0% | $0 | 0.0% |
| **Unincorporated County** | 34,945 | $43,975,080,160 | 0 | 0.0% | $0 | 0.0% |
| **Total** | **198,051** | **$465,982,716,705** | **3,545** | **1.8%** | **$4,145,344,185** | **0.9%** |

Source: USACE 2022; Orange County 2021; RS Means 2024; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

The buildings located in the sea level rise inundation area can be divided into occupancy classes. Table 5-72 shows the buildings located in the sea level rise inundation area by occupancy class. For the participating jurisdictions, the residential buildings make up the majority of the structures located in the sea level rise inundation area with 3,068 structures. Commercial buildings make up the next highest number of structures located in the sea level rise inundation are with 412 structures. Industrial and Government, Agricultural, and Education structures make up the lowest number structures in the sea level rise inundation area with 50 structures and 15 structures, respectively. All of these structures are located in the City of Newport Beach.

**Table 5-72. Buildings in the Sea Level Rise Hazard Area by General Occupancy Class**

| Jurisdiction | Buildings in the Sea Level Rise Hazard Area by General Occupancy Class | | | |
|---|---|---|---|---|
| | Residential | Commercial | Industrial | Other[a] |
| **Anaheim** | 0 | 0 | 0 | 0 |
| **Laguna Woods** | 0 | 0 | 0 | 0 |
| **Newport Beach** | 3,068 | 412 | 50 | 15 |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 |
| **Santa Ana** | 0 | 0 | 0 | 0 |
| **Unincorporated County** | 0 | 0 | 0 | 0 |
| **Total** | **3,068** | **412** | **50** | **15** |

Source: USACE 2022; Orange County 2021; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

a. Other = Government, Religion, Agricultural, and Education

## Impacts

Table 5-73 show the results of the Hazus analysis on the buildings in the participating jurisdictions of Orange County. The estimated losses of buildings to sea level rise are $3,694,255,757 which is 0.8 percent of the total RCV. The City of Newport Beach contains all of the buildings impacted by sea level rise and the estimated loss of $3,694,255,757 which is 4.3 percent of the total RCV for Newport Beach.

**Table 5-73. Sea Level Impacts on Buildings**

| Jurisdiction | Total Replacement Cost Value | Estimated Building Loss Due to Sea Level Rise | | | | |
|---|---|---|---|---|---|---|
| | | All Occupancies | | | | |
| | | Loss | % of Total | Residential | Commercial | Other |
| **Anaheim** | $178,343,603,814 | $0 | 0.0% | $0 | $0 | $0 |
| **Laguna Woods** | $10,117,235,987 | $0 | 0.0% | $0 | $0 | $0 |
| **Newport Beach** | $84,976,395,506 | $3,694,255,757 | 4.3% | $2,374,979,230 | $1,159,472,075 | $159,804,452 |
| **San Juan Capistrano** | $19,621,067,650 | $0 | 0.0% | $0 | $0 | $0 |
| **Santa Ana** | $128,949,333,589 | $0 | 0.0% | $0 | $0 | $0 |
| **Unincorporated County** | $43,975,080,160 | $0 | 0.0% | $0 | $0 | $0 |
| **Total** | **$465,982,716,705** | **$3,694,255,757** | **0.8%** | **$2,374,979,230** | **$1,159,472,075** | **$159,804,452** |

Source: Hazus v6.1; USACE 2022; Orange County 2021; RS Means 2024; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

The Hazus analysis can also estimate the debris that needs to be removed due to the increasing sea levels. Table 5-74 shows the estimated debris created by dam failures in Orange County. The Hazus debris results show the debris from finishes (dry wall, flooring, insulations, etc.), structure (wood, brick, etc.), and foundations (concrete slab, concrete block, rebar, etc.) (FEMA 2024). Only two participating jurisdictions were predicted buy the Hazus analysis to see debris. The estimated debris for the Unincorporated Orange County is 582 tons. This included 135 tons of finish category debris, 206 tons of structure category debris, and 240 tons of foundation category debris. The City of Newport Beach has the majority of debris generated by the sea level rise. This is to be expected since the model sea level rise impacts Newport Beach more than the other communities. The estimated debris for Newport Beach is 630,855 tons. This includes 156,916 tons of finished category debris, 225,030 tons of structure category debris, and 248,909 tons of foundation category debris.

**Table 5-74. Estimated Debris Created During the Sea Level Rise Hazard Event**

| Jurisdiction | Estimated Debris Created During the Sea Level Rise Hazard Event | | | |
|---|---|---|---|---|
| | Total (tons) | Finish (tons) | Structure (tons) | Foundation (tons) |
| **Anaheim** | 0 | 0 | 0 | 0 |
| **Laguna Woods** | 0 | 0 | 0 | 0 |
| **Newport Beach** | 630,855 | 156,916 | 225,030 | 248,909 |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 |
| **Santa Ana** | 0 | 0 | 0 | 0 |
| **Unincorporated County** | 582 | 135 | 206 | 240 |
| **Total** | **631,437** | **157,051** | **225,237** | **249,149** |

Source: Hazus v6.1; USACE 2022; Orange County 2021; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

## Critical Facilities Exposure and Impact

An exposure analysis of was performed on all critical facilities collected throughout the County and the FMP participating jurisdictions. These critical facility points were imported into a GIS and then overlaying the projected sea-level rise inundation hazard zone zones, generating a frequency count of all critical facilities exposed to the hazard. Results are shown in Table 5-75. The exposure analysis identified seven critical facilities exposed to the projected sea-level rise inundation zone, all within the City of Newport Beach. Of the seven exposed, three were classified as a Safety and Security lifeline, where the remaining four were classified as Transportation lifelines. With regard to critical facilities being impacted by the projected sea-level rise hazard, the Hazus results reveal that no critical facilities would be damaged in such a flooding event.

In addition to critical facility potential damage and loss of function, flooded streets and roadblocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadway and bridges. In addition to travel along the roadways, public transit will be greatly impacted, causing problems for emergency responders.

**Table 5-75. Critical Facilities Exposed to Sea Level Rise Inundation Hazard Area**

| Jurisdiction | Number of Facilities by Community Lifeline Category | | | | | | | | | Total Facilities in Hazard Area | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Communication | Energy | Food, Hydration, Shelter | Hazardous Materials | Health & Medical | Safety & Security | Transportation | Water Systems | Other Critical Facilities | Count | % of Jurisdiction Total |
| **Anaheim** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Laguna Woods** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Newport Beach** | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 7 | 6.1% |
| **San Juan Capistrano** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Santa Ana** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Unincorporated County** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.0% |
| **Total** | **0** | **0** | **0** | **0** | **0** | **3** | **4** | **0** | **0** | **7** | **0.6%** |

Source: California Department of Education 2024; Caltrans 2024; Homeland Infrastructure Foundation-Level Data 2022, 2023, 2024; Orange County 2022, Orange County Sheriff's Department 2024; U.S. Geological Survey 2024; State of California, Natural Resources Agency and Ocean Protection Council 2018; (USGS 2024)

## 5.7 PREVIOUS OCCURRENCES AND LOSSES

Many sources provided flooding information regarding previous occurrences and losses associated with flooding events throughout the County. With multiple sources reviewed for the purpose of this Flood Management Plan, loss and impact information for many events could vary depending on the source and the accuracy of monetary figures is based on information available at the time of development of this plan.

The previous occurrences and losses can be measured in a variety of ways. Previous occurrences of flooding can be determined from FEMA's major disasters and emergency declarations for the County and the flooding events that impact the county but do not result in a disaster declaration that the NCEI collects. These flooding events are presented in sections 5.2.1 and 5.2.2. Another way to view the previous occurrences and losses from flooding is to look at the flood insurance participation and claims for the County. The CRS manual credits an assessment of the flood insurance coverage in a community under CRS Activity 370 Flood Insurance Promotion (FEMA 2025). The objective of CRS Activity is improving flood insurance coverage in a community and provides credits for completing 3 steps (FEMA 2025):

- Step 1: Flood insurance coverage assessment (FIA). This credit is provided for assessing the community's current level of coverage and identify shortcomings.
- Step 2: Coverage improvement plan (CP). The plan is prepared by a committee that has representation from local insurance agents.
- Step 3: Implementation of the coverage improvement plan (CPI). The plan's projects are implemented.

To collect points under the FIA element, the FIA must follow 5 steps (FEMA 2025). These steps include (FEMA 2025):

- Step 1: Collect flood insurance information
- Step 2: Determine level of flood insurance coverage
- Step 3: Prepare the document
- Step 4: Submit to the government body
- Step 5: Reassess

Step 1 of the FIA element is to collect the flood insurance information for the community and this data can be either aggregated data for the community or more detailed property specific data (FEMA 2025). The more detailed flood insurance information is protected under the Privacy Act of 1974 and cannot be shared with the public (FEMA 2025). Step 2 of the FIA element is to determine the level of flood insurance coverage, and this can be done in two ways (FEMA 2025). The first way is to compare the number of buildings with insurance coverage can be compared to the number of buildings exposed to the flood hazard (FEMA 2025). The second way to determine the average amount of coverage by FIRM Zone and occupancy type and compare this to the amount of expected flood damage from the base flood (FEMA 2025).

Step 3 is to prepare a document that provides a summary of the data and a summary of the coverage and recommendations about where improvements would help increase coverage (FEMA 2025). Step 4 is to submit the assessment document to the community's governing body (FEMA 2025). No action is needed to be taken by the governing body to receive the CRS credit under the FIA element (FEMA 2025). If the FIA is completed for a multi-jurisdictional plan, each community must submit the FIA to their governing body to receive credit. Finally, Step 5 is to update the FIA document with new update flood insurance information to determine the update level coverage for the community and new recommendation to improve coverage (FEMA 2025). This newly revised FIA

document is submitted to the community's governing body (FEMA 2025). The FIA is presented in Section 5.6.5 for the unincorporated parts of Orange County and the FIS for the participating jurisdictions can be found in the specific community annex document.

## 5.7.1 FEMA Major Disasters and Emergency Declarations

Between 1954 and 2025, FEMA included Orange County in 18 flood-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storms, flooding, hurricanes, and coastal storms. Table 5-76 lists FEMA DR and EM declarations that have been declared for Orange County related to the flood hazard.

**Table 5-76. FEMA DR and EM Declarations for Flood Events in Orange County, 1954 to 2025**

| FEMA Declaration Number | Date of Event | Date of Declaration | Event Type |
|---|---|---|---|
| **DR-253-CA** | January 26, 1969 | January 26, 1969 | Severe storms and flooding. |
| **DR-547-CA** | February 15, 1978 | February 15, 1978 | Coastal storms, mudslides and flooding. |
| **DR-566-CA** | October 9, 1978 | October 9, 1978 | Flood and landslides. |
| **DR-615-CA** | January 8, 1980 | February 21, 1980 | Severe storms, mudslides and flooding. |
| **DR-677-CA** | January 21, 1983 – March 30, 1983 | February 9, 1983 | Coastal storms, floods, slides and tornadoes. |
| **DR-812-CA** | January 17, 1988 – January 22, 1988 | February 5, 1988 | Severe storms, high tides and flooding. |
| **DR-935-CA** | February 10, 1992 – February 18, 1992 | February 25, 1992 | Rain/snow/windstorms, flooding, and mudslides. |
| **DR-979-CA** | January 5, 1993 – March 20, 1993 | February 3, 1993 | Severe winter storms, mud and landslides, and flooding. |
| **DR-1044-CA** | January 3, 1995 – February 10, 1995 | January 10, 1995 | Severe winter storms, flooding, landslides, and mud flows. |
| **DR-1046-CA** | February 13, 1995 – April 19, 1995 | March 12, 1995 | Severe winter storms, flooding landslides, and mud flow. |
| **DR-1203-CA** | February 2, 1998 – April 30, 1998 | February 9, 1998 | Severe winter storms and flooding. |
| **DR-1577-CA** | December 27, 2004 – January 11, 2005 | February 4, 2005 | Severe storms, flooding, debris flows, and mudslides. |
| **DR-1585-CA** | February 16, 2005 – February 23, 2005 | April 14, 2005 | Severe storms, flooding, landslides, and mud and debris flows. |
| **EM-3248-CA** | August 29, 2005 – October 1, 2005 | September 13, 2005 | Hurricane Katrina evacuation. |
| **DR-1952-CA** | December 17, 2010 – January 4, 2011 | January 26, 2011 | Severe winter storms, flooding, and debris and mud flows. |
| **DR-4305-CA** | January 18, 2017 – January 23, 2017 | March 16, 2017 | Severe winter storms, flooding, and mudslides. |
| **EM-3591-CA** | January 8, 2023 – January 21, 2023 | January 9, 2023 | Severe winter storms, flooding, and mudslides. |
| **EM-3592-CA** | March 9, 2023 – September 10, 2023 | March 10, 2023 | Severe winter storms, flooding, landslides, and mudslides. |

Source: FEMA, 2025

## 5.7.2 Flood Events

Known flood events, including FEMA disaster declarations, which have impacted the County between 2020 and 2024 are identified in Table 5-77.

**Table 5-77. Flooding Events in Orange County, 2020 to 2024**

| Date of Event | Event Type | FEMA Declaration Number | Estimated Damage and/or Losses |
|---|---|---|---|
| **April 6, 2020** | Flood, Flash Flood | — | Heavy rain caused severe flooding throughout the County. It was recorded that flooding in lanes 3 and 4 on Highway 55 near Yorba Linda occurred. Widespread urban flooding was also recorded in Costa Mesa with water on roadways and fast-moving shallow water in areas. A swift water rescue took place in Coyote Creek Channel near Buena Park. A person was rescued by the fire department in 3 feet of moving water. |
| **July 3, 2020** | Coastal Flood | — | High tide caused minor coastal flooding along Newport Beach. High tide was recorded at up to 6.8 feet with high surf conditions. Parking lots and streets in the area were flooded up to three blocks inland. A sailboat was washed ashore and destroyed due to the event. |
| **December 28 – 29, 2020** | Flood, Flash Flood | — | Heavy rain resulted in standing water on Route 55 and Route 91. Approximately 2.5 ft were recorded in drive lanes. |
| **January 25 – 28, 202** | Flash Flood, Debris Flow | — | High winds brought rainfall with resulted in minor flooding and debris flow near Williams Canyon. Several local roadways were closed due to unsafe conditions. Large amounts of mud and debris were covering roadways and damaging homes in Silverado Canyon area. Up to 1.5 inches of rainfall was recorded. |
| **March 3, 2021 – March 10, 2021** | Flood, Flash Flood, Debris Flow | — | Heavy rainfall caused flooding on Highway 91 and Highway 241. Lanes 1 and 2 were flooded with water moving into the HOV lanes. The rainfall rates recorded were one quarter of an inch per hour. Flash flooding caused eight vehicles to be damaged by mud and debris flow. A total of six homes had mud and water damage. A swift water rescue was performed by EMS at the peak of the mud and debris flow. Mud covered at least three locations on Silverado Canyon road. |
| **December 14, 2021 – December 30, 2021** | Flood, Flash Flood | — | Heavy rain caused flooding in the area. Pacific Coast Highway from Warner to Goldenwest was closed due to flood concerns. The estimated wind gusts were up to 30 mph. It was recorded of 1.58 inches of rainfall on average. |
| **January 15, 2022** | Tsunami | — | A tsunami advisory was issued for the Orange County Coast. The County conducted Wireless Emergency Alerts and activated sirens. The first tsunami wave arrived in the morning and damage was reported across the coastline. A buoy was reported to have broken off and drifted away off of Huntington Bay. |
| **March 28, 2022** | Flood, Debris Flow | — | Heavy rain caused the SR-73 onramp at Bristol Street North to flood. Orange County Public Works cleared mud and debris recorded at 1 feet deep from Silverado Canyon Road in the Bond Fire burn scar. |
| **September 9, 2022** | Storm Surge | — | Tropical Cyclone Kay resulted in storm surge conditions. Seal Beach experienced surges which came across the beach into the parking lots and Boardwalk 2100. High tide was recorded at 6.6 feet. A berm was erected with pumps in place and residents deployed sandbags. |

| Date of Event | Event Type | FEMA Declaration Number | Estimated Damage and/or Losses |
|---|---|---|---|
| **November 8, 2022** | Flood | — | Heavy rain across the County resulted in flooding. The Department of Highways reported flooding on off ramp I-5 at El Toro Rd. near Lake Forest, and flooding on the onramp I-5 from Oso Parkway. |
| **December 11, 2022** | Flash Flood | — | Heavy rains caused flash flooding which resulted in a swift water rescue in the Santa Ana River at Garden Grove Blvd. The area received up to 1 inch of rain. |
| **December 31, 2022** | Flood, Flash Flood | — | High winds and heavy precipitation caused flooding across all lanes on SR-22 East at Main Street. Rainfall totaled up to 1.2 inches, with localized higher totals. |
| **January 8, 2023 – January 21, 2023** | Severe Winter Storms, Flood, Flash Flood, Debris Flow and Mudslides. | EM-3591-CA | Heavy rains resulted in flooding on highway systems reported by the Highway Department. There were rapid water flows in creeks and localized flooding seen. There were records of up to 3 inches of rainfall in the upper canyons. Both lanes on I-5 north off-ramp were flooded in Santa Ana. Four vehicles were stuck in floodwaters. Three vehicles were stuck in floodwaters on the onramp northbound of I-5. |
| **February 25, 2023** | Flood | — | Heavy rain resulted in localized flooding reported by the Highway Department. |
| **March 1, 2023** | Flash Flood | — | Heavy rainfall caused flash flooding on I-5 and SR-55, resulting in road closures. Up to 0.8 inches of rainfall was recorded. |
| **March 9, 2023 – September 10, 2023** | Severe Winter Storms, Flooding, Landslides, Coastal Flood and Mudslides. | EM-3592-CA | A powerful storm which brought heavy rain and high wind caused flooding in low lying areas around SR-55 and I-5. Up to 2.5 inches of rainfall was recorded. Coastal flooding occurred near Seal Beach Pier resulting in up to 18 inches deep waters at high tide. High surf was also recorded and one car was damaged due to floodwaters. |
| **August 20, 2023 – August 21, 2023** | Tropical Storm | — | Tropical Storm Hilary produced widespread tropical storm winds across Southern California. Torrential rainfall occurred across the mountain and desert communities which resulted in devastating flash flooding and debris flows. Damage to railways and bridges were recorded, as well as the closing of major interstates including I-8 in San Diego County and I-10 in Riverside County. |
| **December 30, 2023** | Coastal Flood | — | Coastal floods caused a low-lying beach parking lot in Seal Beach to close due to unsafe conditions. |
| **January 22, 2024** | Flood | — | SR-1 reported road closure due to flood conditions. Pacific Coast Highway southbound and northbound lanes reported road closure due to flood conditions. |
| **February 1, 2024 – February 6, 2024** | Flood, Flash Flood | — | Pacific Coast Highway southbound and northbound lanes reported road closure due to flood conditions. Up to 6 inches of rainfall was recorded near Talbert Middle School in Liberty Park. The Sand Canyon Wash overflowed which led to flooding in parts of Mason Park in Irvine. The southbound ramp to SR-57 at Ball Road was closed due to flooding. |
| **March 15, 2024 – March 30, 2024** | Flood | — | Heavy rainfall resulted in flooding of the Oso Parkway at San Antonio Parkway. The Sand Canyon Wash was overflowing into Mason Park. |

Source: FEMA, 2025; NCEI, 2025.

## 5.8 PROBABILITY OF OCCURRENCE

Although each flood related hazard event is unique in itself, this risk assessment will group the identified hazards using qualitative definitions tied to quantitative frequencies of occurrence. The 2021 Orange County Hazard Mitigation Plan (HMP) assigns each hazard one of three possible probability of occurrence categories. Each probability category is range graded based on an annualized change of occurrence, and are listed as follows:

- Unlikely—Less than 1 percent annual chance of occurring
- Possible—Less than 10 percent annual chance of occurring
- Likely—Between 10 and 100 percent annual chance of occurring

These probability categories will be paired with levels of impact, also from the 2021 Orange County HMP, to provide a degree of standardization to each hazard. The level of hazard impact is also categorized into a High, Medium and Low. High represents significant damage to buildings and potentially high human casualty rate. Moderate represents modest damage to buildings and a relatively low casualty rate. in either geographic extent or magnitude. Low represents negligible impacts in terms of property damage, and no loss of life. (Orange County Sheriff's Department 2021).

Based on these categories, the OC HMP provides probability of occurrence and hazard impact as listed in Table 5-78. According to the HMP, “Flooding/Storm” events (which include SFHA, riverine flooding, coastal flooding, and sea level rise flood hazard types) have a “Likely” probability of occurring in Orange County and have been classified as having “moderate” impacts or extent to the county (Orange County Sheriff's Department 2021). The inundation from a tsunami and a dam failure event are both rated as Unlikely. However, tsunami events are given an impact classification of moderate whereas a dam failure event is classified as having a high impact and tsunamis have a Moderate impact or extent to the county (Orange County Sheriff's Department 2021).

**Table 5-78. Hazard Impact Ratings from Orange County HMP**

| Hazard Type | Probability of Occurrence | Annualized Probability Range | Impact |
|---|---|---|---|
| **Flood**[a] | Likely | 10% – 100% | Moderate |
| **Tsunami** | Unlikely | Less than 1% | Moderate |
| **Dam Failure** | Unlikely | Less than 1% | High |

Source: Orange County Sheriff's Department 2021
a. *2021 HMP: Does not distinguish between riverine, SFHA, coastal, or sea level rise-based flooding hazards.*

### 5.8.1 Effect of Climate Change on Future Occurrence Probability

Climate change is expected to significantly impact future occurrences of flood events in Orange County. One major factor is the increase in extreme precipitation events. As global temperatures rise, the atmosphere can hold more moisture, leading to heavier and more intense rainfall (California Climate Adaptation Strategy 2025). This can result in flash floods and river flooding, particularly during storm seasons. The increased frequency and severity of these events will challenge existing infrastructure and require substantial upgrades to flood management systems (California Climate Adaptation Strategy 2025).

Another critical aspect is sea level rise, which exacerbates coastal flooding. Orange County’s coastal areas are particularly vulnerable to rising sea levels, which can lead to more frequent and severe flooding during high tides and storm surges. The combination of higher sea levels and intense storms can overwhelm coastal defenses,

causing significant damage to properties and ecosystems. Efforts to mitigate these impacts include enhancing coastal barriers and implementing more robust land-use plans to reduce exposure to flood risks. Refer to Section 5.6 for more information on sea level rise impacts on the County.

Additionally, climate change can alter the hydrological cycle, affecting the timing and distribution of precipitation. This can lead to prolonged periods of drought followed by intense rainfall, increasing the risk of flooding. The variability in precipitation patterns makes it difficult to predict and manage water resources effectively. Orange County's climate resilience planning aims to address these challenges by prioritizing projects that enhance flood preparation and improve the resilience of communities to future climate impacts.

### 5.8.2 Effect of Planning on Future Occurrence Probability

Orange County continues to advance its community hazard mitigation and resilience efforts in a proactive manner. The County, via its own funding and by leveraging its relationships with the U.S. Army Corps of Engineers, provides flood protection for over 3 million residents (U.S. Census Bureau 2024). Orange County addresses current floodplain management needs through its capital improvement program (CIP). Presently, the seven-year CIP contains multiple types of flood control projects, from improvements to channels and outlet structures to increasing levee wall heights and upgrades to bridge abutments crossing area watercourses.

The Orange County General Plan calls for increased integration of floodplain management through strategic open space conservation planning, public education and outreach, and continued participation in the NFIP CRS program. The General Plan also identifies flood hazard maps as well as establishes open space/conservation program policies for natural hazard planning. These elements can be found in Chapter III Flood Hazard Map and Chapter VI-20 Open Space/Conservation Program Map in the General Plan (OCPW 2025). Once adopted, this FMP will further the floodplain management goals and objectives of Orange County by targeting frequently flooded areas.

In addition to the General Plan, the County has other functional plans and stormwater management initiatives to promote healthy watersheds. These components strive to direct future development away from areas of known flood risk, and areas with projected increased in flood risk. Refer to Section 3.9.1 for more on these plans.

Additionally, Orange County participates in the NFIP and has adopted flood damage prevention regulations in response to its requirements. The County has committed to maintaining its good standing under the NFIP through actions identified in this plan. The County exceeds the requirements of the NFIP through participation in the Community Rating System. As of October 1, 2017, Orange County is a Class 5 community within the program.

## 5.9 SCENARIO PLANNING

Areas exposed to flooding hazards have the potential to flood at regular intervals, generally in response to higher frequency events such as capacity exceedance of natural and structural stormwater control systems. These areas are also susceptible to less frequent flooding events such as multi-year climactic shifts such as El-Nino, and large-scale synoptic events such as atmospheric rivers result in moisture laden Pacific air masses aligning with the region that often trigger extreme flooding events. Southern California experiences El Nino events and/or atmospheric rivers from late December through February.

Atlantic and eastern Pacific hurricane season begins on June 1 and ends on November 30. Cool off-shore waters combined with relatively high-latitude contribute to a low-risk environment for direct impact from tropical storms. However, many heavy rain events in southern California have been attributed to tropical storms that diminished in

strength but still manage to drop copious amounts of rainfall in the planning area, which have trigger significant flooding events (NWS 2025).

A culmination and/or combination of multiple flood hazard events occurring simultaneously would present a particularly damaging and dangerous worst-case scenario for the floodplain management planning area. The worst-case scenario would be extreme rainfall events from diminishing tropical systems overlapping with the onset of an atmospheric river and/or an El Nino related seasonal storm patterns. Rainfall rates typically associated with such a worst-case scenario would lead to both coastal flooding as well as flash flooding. Tidal influence would exacerbate coastal flooding conditions should the onset of the triggering event coincide with lunar high tide.

In addition to rain falling faster than the ground and waterways can absorb it, this type of event would cause secondary effects of coastal erosion and storm surge. This could overwhelm response and floodplain management capabilities within the planning area. Major roads could be blocked, preventing evacuation and critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of a series of storms, Orange County officials may not be able to make repairs quickly enough to restore critical facilities and infrastructure. All the while, floodplains within Orange County, would continue to be impacted by extreme floods.

Impacts to the region from extreme worst case flooding events could be amplified if the area had previously experienced wildfires. Specifically, areas where burned vegetation can no longer help hold the soil in place, significant rainfall can cause landslides and mudslides. This is especially the case in areas with steeper slopes, keeping in mind the entire region is susceptible to these hazards simply based on the underlying geology being rocky in nature, where moisture absorption is not as efficient as areas with greater amounts of sedimentary soil or forms of subsurface layers with higher permeability.

## 5.10 ISSUES

Important issues associated with flood hazards in Orange County were identified by the Steering Committee and members of the public. Most of the issues deal with various deficiencies in the channelized stormwater and flood control facilities, and associated infrastructure that intersects with those channels. In many instances, the issues stem from a combination of inadequate flow through certain channel segments, which result in backups of the system and ultimately an overtopping of the channel with flows ultimately impacting adjacent properties. Other instances the flow just needs to be maintained and perform consistently in order for optimal functionality during what would otherwise be considered high frequency rainfall events. The Steering Committee cited a number of channel facilities, associated bridges, and select levee structures in need of restoration, and in some instances, full replacement in order to properly function during hazard events. Without these improvements, channel flow would remain inadequate for efficiently moving stormwaters through the County’s conveyance system. Not only do these deficiencies transfer flood waters into adjacent properties, but negative impacts are also seen with respect to reduced water storage in other basins as well as diminished wildlife habitats. Table 5-79 summarizes structural facilities the Steering Committee identified as major issues needing to be addressed, classified by facility type.

**Table 5-79. Structural Issues or Deficiencies Identified by Steering Committee**

| Channel Facility | Bridge Crossing | Levee |
|---|---|---|
| • Coyote Creek Channel (A01)<br>• Fullerton Creek Channel (A03)<br>• Imperial Channel (A07)<br>• Carbon Creek Channel (B01)<br>• EGGW Channel (C05)<br>• Santa Ana Delhi Channel (F01)<br>• Laguna Canyon Channel (I02) | • Warner Ave. Bridge—EGGW Channel (C05)<br>• Coast Hwy./Park Lantern—San Juan Creek (L01) | • Santa Ana Channel/Levee Height (E01) |

The larger facilities targeted for improvement have seen progress in recent years, particularly the removal of properties from the floodplain by virtue of completing a number of specific projects within the EGGW channel. Given the significant expense these projects entail, the County relies heavily on its partnership with the Army Corps of Engineers to fully implement each project for the entirety of a facility as large as the EGGW channel. Changes in Federal Executive authority and associated shifts in funding priority prevents projects of this size from being funded consistently within a single CIP cycle. This creates gaps in full build out project completion, and results in the community not fully realizing the stormwater or floodplain management benefits of the project.

Mitigation issues that deal with private property were also identified by the Steering Committee, including the possibility of acquiring, relocating, or even elevating private property that is at risk of coastal flooding hazards. These types of non-structural measures are very expensive for the County, and in turn, are difficult to deploy. Other issues identified by the Steering Committee are associated with disaster response. In particular, the County does not have a Post Disaster Response Action Plan. The County has known evacuation challenges during flooding events (i.e., Silverado Canyon, Williams Canyon, Modjeska Canyon, Trabuco Canyon, etc.) due to single point access from properties to the primary road network system. These conditions have resulted in property owners being cut-off during post-fire flooding events and debris flows. Moreover, if the USACE controlled Prado Dam, which is classified as a high-hazard dam, were to fail (or be mis-operated) it would likely result in loss of life and significant property damage.

## 5.11 NATURAL AND BENEFICIAL FLOODPLAIN AREAS

Although typically associated as a hazard area, floodplains also serve beneficial and natural functions (on ecological/environmental, social, and economic levels). Disruption of these natural systems can have long-term consequences on entire regions; however, this potential impact has only recently been noted. Some of the more well-known water-related functions for floodplains include (FEMA 1997):

- Natural flood and erosion control
  - Provide flood storage and conveyance
  - Reduce flood velocities
  - Reduce flood peaks
  - Reduce sedimentation
- Surface water quality maintenance
  - Filter nutrients and impurities from runoff
  - Process organic wastes
  - Moderate temperatures of water
- Groundwater recharge

- Promote infiltration and aquifer recharge
- Reduce frequency and duration of low surface flows

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. In unincorporated Orange County, floodplain areas with natural functions are located along the beach front and the natural stream channels.

The CRS program provided credits to communities that have adopted plans that protect the natural functions of floodplains (FEMA 2025). The credit is listed under Activity 510 Floodplain Management Planning Natural Floodplain Functions Plan (NFP) element (FEMA 2025). Examples of activities credited under the NFP element include:

- A habitat conservation plan that explains and recommends actions to protect rare, threatened, or endangered aquatic or riparian species.
- A habitat protection or restoration plan that identifies critical habitat within the floodplain, actions to protect remaining habitats, and/or actions to restore full functioning habitat. Frequently this will result in the preservation and/or restoration of riparian habitat that is necessary for water-dependent species.
- A “Green Infrastructure Plan” that identifies open space corridors or connected networks of wetlands, woodlands, wildlife habitats, wilderness, and other areas that support native species, maintain natural ecological processes, and/or sustain air and water resources.
- A plan or section of a comprehensive or other community includes an inventory of the ecological attributes of the watershed and/or the floodplain and recommends appropriate actions for protecting them, provided that the recommendations are implemented through a mechanism such as development regulation, development, order, grant program, or capital improvement plan.

Since the protection of natural floodplain function can be accomplished in a variety of different plans, the CRS Manual does provide credit criteria that must meet before receiving credit under the NFP element (FEMA 2025). Below are the criteria listed in the CRS Manual:

- The plan may cover more than one community, but it must identify the natural floodplain functions present with in the community and have an impact on those functions within the community seeking credits.
- The plan must be adopted. If the plan is not a community plan adopted by the community’s governing body, it must be adopted by the appropriate regional agency.
- The plan must be updated at least once every 10 years. The update must include a review any changes to the conditions as well as progress made since the original plan was prepared. Any changes to the adopted plan must be approved by the original plan must be approved by the original adopting agency.
- The plan must include an inventory of the species and/or habitat present within the floodplain and actions items for protecting one or more identified species of interest and natural floodplain functions. The action items must describe who is responsible for implementing the action, how it will be funded, and when it will be done. General policy statements with no means of implementation are not considered action items.
- There is no credit for a plan that addresses water quality issues prepared pursuant to a requirement for a National Pollution Discharge Elimination System (NPDES) permit. Plans to improve drainage, stormwater storage, or channel bank erosion may be credit under other CRS activities. Plans that are produced as a requirement for a development permit are not credited.
- The plan must include a comprehensive inventory of the natural floodplain habitat within the community. It must identify areas that warrant protection or preservation in order to maintain fully function habitat for the

species of interest. Where threatened or endangered species are present, each species must be addressed, and a restoration plan must be included.

- A community receives credits for other plans that meet the credit criteria but that do not address the entire SFHA or all of the species present. These could be single-issue or single-species plans or plans that cover only one area the community's floodplain.

Orange County uses regional plans to manage the water resources in the county and has two Integrated Regional Management (IRWM) groups (Orange County, CA n.d.). The North Orange County IRWM group covers the northern and central part of the county and includes communities, governmental agencies (federal, state, and local levels), and stakeholders with a focus on water issues (North OC IRWM n.d.). The South Orange County IRWM group covers the southern part of the county and also includes communities, governmental agencies, and stakeholders (South OC IRWM n.d.). These IRWM groups develop their own plans to manage the water resource in the area of coverage and the goals for these plans are increase water supply, project water quality, protect the environment and habitat, and provide flood risk management. The plans also includes the background of the watersheds in the county, habitats and issues of the watershed, and resource management strategies and implementation.

The most recent plan for The North Orange County IRWM group is dated back to 2018 (North OC IRWM n.d.). The goals of the plan that focus on the natural floodplain functions are listed below:

- Restore Ecosystems and Improve Native Habitat
  - Objective: Restore, enhance, and expand terrestrial and aquatic ecosystems.
    - Strategy: Increase functioning habitat that sustains viable populations of native species and restore habitat for terrestrial and aquatic species.
    - Strategy: Remove invasive species that are a danger to habitat, waters supply or other economic or beneficial use.
    - Strategy: Increase use of water quality treatment systems that also increase wildlife habitat and wetlands by restoring water balance not dependent on urban runoff.
  - Objective: Restore, enhance and expand habitat for threatened and endangered species
    - Strategy: Increase functioning habitat that sustains viable populations of threatened and endangered species
    - Strategy: Remove invasive species that negatively impact threatened species and endangered species.
- Integrate Flood Management
  - Objective: Reduce flood risk to public and private property and improve public safety.
    - Strategy: Improve flood protection based on risk management standards.
    - Strategy: Improve flood control facilities and remove properties from the FEMA 100-year floodplain with consideration for climate change on flow.
    - Strategy: Improve storm drain system where historical flooding exists, when feasible.
  - Objective: Improve floodplains.
    - Strategy: Reduce scour and erosion on canyons and channels while supporting natural systems and minimizing use of concrete and riprap.

    - Strategy: Implement stream channel naturalization efforts to promote multiple benefits such as creation or improvement of habitat and/or improvement in water quality while protecting public health.

An example project completed by the North Orange County IRWM is the Prado Basin Sediment Management Demonstration project. The goal of this project was to remove sediment located in the Prado Basin behind the Prado Dam and re-introduce the sediment below the dam into the Santa Ana River (North OC IRWM n.d.). The reason for is to retore the natural sediment transport of the Santa Ana River and to extend the life of the Prado Dam (North OC IRWM n.d.).

The most recent plan for The South Orange County IRWM group is dated back to 2018 (South OC IRWM n.d.). The goal of the plan that focuses on the natural floodplain functions is listed below:

- Integrate Flood Management
    - Objective: Improve conveyance and/or reliability of channelized flood control systems and related facilities and remove from the FEMA 100-year floodplain with consideration for climate change on flow regimes.
        - Strategy: Construct channel improvements projects to convey the 100-year storm event.
        - Strategy: Implement local watershed improvements.
        - Strategy: Remove impediments to convey the 100-year storm event.
    - Objective: Reduce scour and erosion to river, stream, and channel banks.
        - Strategy: Incorporate hydromodification retrofits to existing development
        - Strategy: Incorporate grade control structures or other improvements to reduce or eliminate scour and erosion to channel.
        - Strategy: Minimized the potential impact of stormwater on canyon and channel stability, water quality, and habitat.
    - Objective: Improve sub-regional facilities and local storm drain systems where historical flooding exists where the regional system has the capacity to accept the additional flows.
        - Strategy: Implement infrastructure improvements.
        - Strategy: Implement local improvements
    - Objective: Preserve or return floodplains as open space.
        - Strategy: Purchase land and dedicate it as open space.
        - Strategy: Implement stream channel naturalization efforts to promote riparian habitat and natural water quality treatment in concert with stable sediment transport.

An example project completed by the South Orange County IRWM group is the Aliso Creek Ecosystem Restoration Project. The goal of this project is to enhance natural resources and increase water supply (South OC IRWM n.d.). This project removed over 30 acres of the invasive plant Arundo to restore the native habitat along Aliso Creek (South OC IRWM n.d.).

The Santa Ana Watershed Project Authority (Santa Ana Watershed Project Authority n.d.) is an organization similar to The North Orange County IRWM and The South Orange County IRWM groups that handles the water resources for the Santa Ana watershed. The Santa Ana watershed covers 2,840 square miles and includes Orange County, Riverside County, San Bernardino County, and a small portion of Los Angeles County (Santa Ana Watershed Project Authority n.d.). The Santa Ana Watershed Project Authority has created a One Water One Watershed Plan that was updated in 2018 and adopted in 2019 to manage the water resources in the Santa Ana

Watershed (Santa Ana Watershed Project Authority n.d.). The plan covers the goals, the description of the watershed and its issues and species and habitats, and resource management strategies and implementation. The goal that focuses on the natural floodplain functions is listed below:

- Preserve and enhance recreational areas, open space, habitat, and natural hydrologic function.
  - Objective: Conduct regional efforts to remove and manage invasive species.
  - Objective: Preserve and restore beneficial hydrological function of streams, arroyos, water bodies, and the coastal zone.
  - Objective: Protect and restore wildlife corridors and habitat connectivity
  - Objective: Protect endangered and threatened species and species of special concern.
  - Objective: Support healthy watershed policies with local land use authority

## 5.12 FUTURE CHANGES IN VULNERABILITY

### 5.12.1 Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such as flood events and tsunamis. While predicting changes of flood events and the prevalence or intensity of tsunamis under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (EPA 2025).

### 5.12.2 Future Growth and Development

Any areas of future growth could be exposed to or impacted by flooding if located within identified hazard areas. It is the intention of each FMP participating jurisdiction to discourage development in areas vulnerable to flood hazard areas and to encourage higher regulatory standards. Goals contained in the County's Growth Management Element underscore the need to manage the development environment. In particular, these include reducing traffic congestion, ensuring adequate public infrastructure, protecting the natural environment, balancing congestion management with statewide goals for redevelopment, and promoting public health by implementing active transportation options (Orange County Public Works 2020).

Although the County's general planning documents include overarching growth and development policy statements, Orange County is for all practical purposes built out, based on prior development, environmental constraints, and the availability of supporting infrastructure. Future development will likely be through the redevelopment of currently improved parcels. The County aims to maintain the rural character of its eastern regions with a communal buffer between those regions and the urbanized western portions of the County. Policy 7 in the Growth Management Element (Transitional Areas for Rural Communities) states that the County could adopt future plans to implement additional buffering between the rural east and the urbanized west.

Maintaining or increasing the design capacity of the region's channelized floodplain and stormwater infrastructure is key to ensuring these facilities continue to function as storm events continue to increase in frequency and intensity in a warming climate. Infrastructure needs are ongoing, and in cases where there may be long periods between upgrades, local governments must manage capacity demands by enacting stormwater best

management practices (BMPs) regulations. BMPs should be leveraged along with continued implementation of capital projects to manage stormwater facilities.

System capacity can be preserved even after enhancements have been made through site level BMPs, such as requiring on-site stormwater management measures to achieve prevent any net increase in stormwater discharge. Regulatory controls such as these, when enforced consistently, can have a significant impact on local and regional stormwater management. Enacting BMPs at the local level has a cumulative effect of reducing sedimentation throughout the watershed, which in turn aids in the preservation of wetlands and associated wildlife habitats. Site level stormwater regulations are key to keeping urbanized watersheds stabilized by maintaining functional capacity, water quality, and habitat preservation.

## 5.13 ADDITIONAL DATA AND NEXT STEPS

A Hazus flood analysis was conducted for the participating jurisdictions using the most current and best available FIRM and data including updated building and critical facility inventories. As additional FEMA Risk Mapping, Assessment, and Planning (Risk MAP) products become available, these may be used to further enhance this assessment (e.g., depth grids for additional recurrence intervals). Further, as additional climate change and sea-level rise scenarios and depth grids are generated, these may also be incorporated into Hazus and potential losses calculated.

Specific mitigation actions addressing improved data collection and further vulnerability analysis are included in Chapter 6 of this plan.

# 6. MITIGATION STRATEGIES

This section presents mitigation strategies for the County to reduce potential exposure and losses identified as concerns in the risk assessment portion of this plan (Chapter 5). The Steering Committee reviewed the risk assessment to identify and develop these mitigation actions, which are presented herein.

## 6.1 BACKGROUND AND PAST MITIGATION ACCOMPLISHMENTS

In an effort to build a solid understanding of the mitigation goals, objectives, and activities outlined in this Floodplain Management Plan (FMP), this section reviews prior mitigation activities and an overview of past efforts overall. It is through these prior efforts and ongoing activities that the County shows its proactive approach to protecting its residents to the greatest extent practical against flood losses. Furthermore, it demonstrates an ongoing commitment to the NFIP program overall, and to the CRS program in particular.

Orange County has worked, and continues to work, toward improving floodplain management and fostering a community-wide reliance mindset. The County accomplishes this through implementation of infrastructure upgrades, updates to their mitigation planning as well as assistance to those property owners impacted by floods. Below is a list of selected floodplain management activities the County has accomplished.

- **County Hazard Mitigation Plan (HMP)**—The County has developed and adopted its own Hazard Mitigation Plan (HMP), which includes goals, objectives, policies, and actions focused on reducing the extent, frequency, and impacts of flooding.
- **Flood Insurance**—Orange County in an active participant in the National Flood Insurance Program (NFIP), with its initial Flood Hazard Boundary Map adopted in 1975, and accordingly, has adopted its own flood damage prevention regulations to protect life and property from areas at risk of flooding.
- **Community Rating System (CRS)**—The County participates in the NFIP's CRS Program to improve its floodplain management practices to effectively reduce flood risk, and in turn, reduce flood insurance premiums for County policy holders. The CRS program is designed to reward communities with reduced premiums when it implements standards exceeding the NFIP's minimum requirements.
- **Regulatory Tools**—Orange County has adopted an array of local regulations, adopted by ordinance, to ensure land development does not increase the risk of flooding, and where possible, incrementally improve stormwater and floodplain management infrastructure. These regulations include, but are not limited to, a Zoning Code (including a Floodplain Overlay District), Site Development Permit (SDP) requirements, the Stormwater Management Code, the Flood Damage Prevention Ordinance, a Subdivision Code, and adopted Building Codes.
- **Open Space Preservation**—Orange County has a policy to preserve open space, as found in its Open Space component contained in the Orange County General Plan. One of the stated goals of this component is to protect the public from hazardous areas, including floodplains. Actions the County has taken in this effort has been the adoption of several Coastal Protection Programs, such as the Bolsa Chica and Upper Newport Bay Ecological Reserves and the San Joaquin Marsh, to ensure natural buffer zones are maintained. Additionally, the County has an array of regional parks that serve as conservation corridors, which align with another stated Goal of the Open Space component of providing areas for outdoor recreation.
- **Beach Replenishment**—The County Department of Public Works as well as its Parks Department coordinate with both the State of California and the U.S. Army Corps of Engineers (USACE) to implement

resilient beach replenishment measures, including the Capistrano Beach and Doheny State Beach Sand Replenishment Project, completed in September 2023.

- **Social media**—Orange County provides a number of social media outlets to receive emergency alerts for all types of hazard events, including riverine, flash, and coastal floods. The County Office of Emergency Management, Department of Public Works, and County Sheriff's Department each have their own Facebook and Twitter accounts, which when followed, will keep residents informed before, during and after an event. There is also a Countywide alert system called OC Alert, where residents can sign up to receive real-time updates on storms, evacuations, road closures, and other emergencies via text, email, and phone calls.
- **Climate Action Plan**—Orange County completed phase two of the Climate Action Plan (CAP) in 2026. Among the CAP goals, is protecting natural resources through several polices, one of which is enhancing coastal resiliency. The CAP recommends continued regulation of sedimentation and other related pollutants into coastal zones so that the quality of natural flooding buffers is maintained and continues to function as intended.
- **Technical Assistance**—The County Department of Public Works offers residents and property owners an array of technical services, including review of various land development plans, professional building inspections, coordination of master planned communities, regulatory permitting and compliance review. Cumulatively, these services ensure land development does not increase risks to flooding impacts and, where feasible, increase flood resilience.
- **Completed Projects**—The County has completed a number of flood control and stormwater management projects. These projects include design and construction of flood control improvements to reaches in a number of channel facilities, including Barranca, Greenville-Banning, Los Alamitos and San Diego Creek channels.
- **Ongoing Projects**—Orange County has undertaken design and construction of several flood control improvement projects to the following specified channel facilities; Bolsa Chica, Brea Creek, Carbon Creek, EGGW, Fullerton Creek, Laguna Canyon, Lane, Oceanview, Peters Canyon, San Juan Creek, Santa Ana-Delhi, Santa Ana Gardens, Santa Ana River, Santa Ana-Santa Fe, Trabuco Creek, and Westminster (Orange County Sheriff's Dept. 2021).
- **Future CIP Projects**—The current Orange County CIP, effective July 1, 2026, includes 18 future flood control projects totaling over $494 million through the 2032-33 fiscal year. Six are within the EGGW Channel, two are within the Carbon Creek channel, one project within is the Fullerton Creek Channel, one project is within the San Juan Creek channel, and the remaining projects address a variety of flood mitigation needs throughout the county. Types of projects contained in the CIP include channel reconstruction to increase flood capacity, channel debris removal, capacity improvements to the Bolsa Bay outlet structure, and increasing levee heights along portions of the Santa Ana channel (OCPW 2026).

These past and ongoing activities have contributed to the County's understanding of its preparedness and future mitigation activity needs, costs, and benefits. These efforts provide a foundation for the Steering Committee to use in developing this FMP.

## 6.2 FEMA GENERAL MITIGATION PLANNING APPROACH

As is summarized in Chapter 3 of this FMP, to ensure a well-prepared, dynamic and easily updated FMP, this document was developed utilizing the FEMA Community Rating System (CRS) 10-step process. Furthermore, this FMP is consistent with FEMA's Local Planning Requirements, which contains seven local planning elements that are required by FEMA. Each of those local planning elements are listed below (FEMA 2025).

- Planning Process

- Risk Assessment
- Mitigation Strategy
- Plan Maintenance
- Plan Update
- Plan Adoption
- High Hazard Potential Dams (optional; required for Rehabilitation of High Hazard Potential Dams grant program)

## 6.3 GOALS AND OBJECTIVES

This section documents the participating jurisdiction's efforts in identifying the floodplain management goals and objectives to reduce or avoid long-term vulnerabilities to the flood hazard. From the goals and objectives identified, recommended mitigation actions were selected and prioritized. These planning components all directly support one another. Mitigation actions were prioritized based on meeting multiple objectives.

The Steering Committee developed mitigation goals based on the risk assessment results, discussions, research, and input from among the committee, existing authorities, policies, programs, resources, stakeholders, and the public. For the purpose of this plan, goals are defined as follows:

Goals are general guidelines that explain what is to be achieved. They are usually broad, long-term, policy-type statements and represent global visions. Goals help define the benefits the FMP is trying to achieve. The success of the FMP, once implemented, should be measured by the degree to which its goals have been met (that is, by the actual benefits in terms of hazard mitigation).

The Orange County FMP goals are compatible with the needs and goals expressed in other available community planning documents, including:

- Orange County Hazard Mitigation Plan Update (2021)
- City of Los Angeles Local Hazard Mitigation Plan (2024)
- California State Hazard Mitigation Plan Update (2023)

Objectives are short-term aims, which when combined form a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable. The objectives were developed by the Steering Committee through its knowledge of Orange County, review of past efforts, findings of the risk assessment, qualitative evaluations, and identification of mitigation options. The objectives are used to (1) measure the success of the FMP once implemented, and (2) help prioritize identified mitigation actions.

Table 6-1 presents the goals and objectives for the FMP.

**Table 6-1. Orange County Floodplain Management Plan Goals and Objectives**

| Goal | Objective |
|---|---|
| **Protect Life and Property from the flood hazards through planning, preparing, and mitigating.** | • Objective 1.a: Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.<br>• Objective 1.b: Reduce losses and repetitive damage for chronic hazard events, while promoting insurance coverage for catastrophic hazards.<br>• Objective 1.c: Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.<br>• Objective 1.d: Discourage new development in the flood hazard area, that if development does occur, ensure that it is done in a way that minimizes flood risk. |
| **Enhance community resilience through Public Awareness opportunities such as outreach programs to provide resources to the public on flood risks, resilience strategies, and safety measures.** | • Objective 2.a: Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.<br>• Objective 2.b: Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.<br>• Objective 2.c: Utilize the best available data and technologies to improve understanding of potential impacts and location of flood hazards. |
| **Protect Natural Systems from flooding impacts through sustainable watershed planning and coordinated resource management practices across public and private sectors.** | • Objective 3.a: Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.<br>• Objective 3.b: Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.<br>• Objective 3.c: Provide the highest degree of flood hazard protection by prioritizing prevention and when practical, consider natural systems that enhance floodplain functions.<br>• Objective 3.d: Consider climate change implications in planning for and mitigating flood or inundation hazards. |
| **Encourage, expand, and strengthen the Partnerships and Implementation of flood mitigation strategies between government agencies, private sector businesses, and non-profit organizations before, during, and after flood events.** | • Objective 4.a: Strengthen communication and coordinate participation among and within public agencies, residents, non-profit organizations, business, and industry to gain a vested interest in implementation.<br>• Objective 4.b: Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.<br>• Objective 4.c: Provide flood protection by maintaining and enhancing flood control systems. |
| **Enhance Emergency Services planning to include flood hazard event planning impacts on populations and property.** | • Objective 5.a: Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.<br>• Objective 5.b: Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.<br>• Objective 5.c: Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures. |

## 6.4 CAPABILITY ASSESSMENT

According to FEMA 386-3, a capability assessment is an inventory of a community's missions, programs, and policies and an analysis of its capability to carry them out. This assessment is an integral part of the planning process. The assessment process enables identification, review, and analysis of current local and state programs, policies, regulations, funding, and practices that could either facilitate or hinder mitigation.

During the planning process, the participating jurisdictions identified and assessed its capabilities in the areas of planning and regulatory, administrative and technical, and fiscal. By completing this assessment, the Steering Committee learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Limitations that could exist on undertaking actions;
- The range of local and state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing their mitigation actions;
- Actions deemed infeasible, as they are currently outside the scope of capabilities;
- Types of mitigation actions that could be technically, legally (regulatory), administratively, politically, or fiscally challenging or infeasible; and
- Opportunities to enhance local capabilities to support long-term mitigation and risk reduction.

Participating jurisdictions' specific capabilities are assessed in each jurisdictional annex in Volume II. All participating jurisdictions were tasked with developing or updating their capability assessment for this update, evaluating the effectiveness of their capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities. Each jurisdiction identified how it has integrated hazard mitigation into its existing planning, regulatory, and operational/administrative framework and how it intends to promote ongoing integration.

The contracted consultant met with Orange County and each participating jurisdiction virtually to review the capability assessment. The consultant also reviewed plans, codes, and ordinances to enhance the information provided by the jurisdictions.

### 6.4.1 Planning and Regulatory Capability

Planning and regulatory capabilities are based on ordinances, policies, local laws, state statutes, plans, and programs that relate to managing growth and development. Planning and regulatory capabilities refer not only to current plans and regulations, but also to the jurisdiction's ability to change and improve those plans and regulations as needed. This section summarizes planning and regulatory capabilities for Orange County. Further information is provided in the jurisdictional annexes in Volume II.

#### Participating in Other Programs

Other programs, such as the CRS, part of the National Flood Insurance Program (NFIP) which recognizes and encourages floodplain management practices, and Firewise USA, a program which provides a framework for reducing the risk of wildfire, can enhance a jurisdiction's ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum regulatory requirements in order to create a more resilient community. These programs focus on communication, mitigation, and community preparedness to minimize the impact of natural hazards on a community. Classifications under various community mitigation programs are presented in Table 6-2.

Table 6-2. Orange County Classifications

| | Participation | Classification | Date Classified |
|---|---|---|---|
| **Community Rating System (CRS)** | Yes | Class 5 | Originally classified on October 1, 1991. Current Classification date is May 1, 2017. |
| **Building Code Effectiveness Grading Schedule** | Yes | Class 3 for both residential and commercial properties | October 2, 2024 |
| **Firewise USA** | Yes | Fire Safe Council East Orange County Canyons | January 6, 2025 |
| **Storm Ready Community** | Yes | NOAA | November 16, 2005 |
| **Tsunami Ready Community** | Yes | NOAA | March 8, 2024 |

### Warning and Evacuation

The Orange County Emergency Operations Plan (EOP) is currently used to assist the County in ensuring timely identification of impending flood threats and disseminating warnings to appropriate floodplain occupants in addition to coordinating flood response activities to reduce the threat to life and property. The County EOP was last updated in 2019 and includes annexes and revisions to address specific hazards and operational needs. Further information may be obtained from the Orange County Sheriff's Department of Emergency Management Division (Orange County 2019).

## 6.4.2 Federal Floodplain Management Programs

### National Flood Insurance Program

The U.S. Congress established the National Flood Insurance Program (NFIP) with the passage of the National Flood Insurance Act of 1968 (FEMA 2016). The NFIP is a Federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for State and community floodplain management regulations that reduce future flood damages. The flood hazard profile in Chapter 5 provides further information on the NFIP as implemented in Orange County.

There are three components to the NFIP: flood insurance, floodplain management and flood hazard mapping. Communities participate in the NFIP by adopting and enforcing floodplain management ordinances to reduce future flood damage. In exchange, the NFIP makes federally backed flood insurance available to homeowners, renters, and business owners in these communities. Community participation in the NFIP is voluntary. Flood insurance is designed to provide an alternative to disaster assistance to reduce the escalating costs of repairing damage to buildings and their contents caused by floods. Flood damage in the U.S. is reduced by nearly $1 billion each year through communities implementing sound floodplain management requirements and property owners purchasing flood insurance. Additionally, buildings constructed in compliance with NFIP building standards suffer approximately 80 percent less damage annually than those not built in compliance (American Institutes for Research 2006).

Municipal compliance with the NFIP is described in the jurisdictional annexes in Volume II. The County's municipalities have been compliant with the NFIP. To enhance their flood damage prevention programs and enhance compliance with the NFIP in the future, several municipalities propose actions in their mitigation strategies to ensure that their floodplain administrators complete training on floodplain management and the NFIP or update their flood damage prevention ordinance to adopt the Code Coordinated Ordinance, if they have not already. All municipalities have included an action to improve Substantial Damage determination procedures and develop substantial damage response plans if they do not currently have one. Additional information on the NFIP program and its implementation throughout the County may be found in Section 5.2.6.

The state and municipalities within it may adopt higher regulatory standards when implementing the provisions of the NFIP. Specifically identified are the following:

- **Freeboard:** The State of California's freeboard requirement mandates that surface impoundments must have a minimum freeboard of 2 feet to accommodate seasonal precipitation and design storms, ensuring they do not overflow due to wind or other conditions. This regulation, specified in Title 27, Section 20375 of the California Code of Regulations, aims to prevent overtopping and protect water quality by managing stormwater effectively. The requirement also includes provisions for operational plans, fail-safe mechanisms, and inspections to ensure compliance and environmental safety
- **Cumulative Substantial Improvements/Damages:** The NFIP allows improvements valued at up to 50 percent of the building's pre-improvement value to be permitted without meeting the flood protection requirements. Over the years, a community may issue a succession of permits for different repairs or improvement to the same structures. This can greatly increase the overall flood damage potential for structures within a community. The community may wish to deem "substantial improvement" cumulatively so that once a threshold of improvement within a certain length of time is reached, the structure is considered to be substantially improved and must meet flood protection requirements.

## NFIP Community Rating System

As an additional component of the NFIP, the Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses; (2) facilitate accurate insurance rating; and (3) promote the awareness of flood insurance (FEMA 2024).

As of 2026, eight communities besides the County of Orange, participate in the CRS program, which include Anaheim, Fountain Valley, Huntington Beach, Irvine, Mission Viejo, Newport Beach, City of Orange, and San Juan Capistrano, as shown in Table 6-3.

**Table 6-3. Community Rating System Participation in Orange County**

| Jurisdiction | CRS Entry Date | Current Class | Premium Discount |
|---|---|---|---|
| **City of Anaheim** | October 1, 1991 | 6 | 20 percent |
| **City of Fountain Valley** | October 1, 1996 | 9 | 5 percent |
| **City of Huntington Beach** | October 1, 1995 | 7 | 15 percent |
| **City of Irvine** | October 1, 1991 | 9 | 5 percent |
| **City of Mission Viejo** | October 1, 2005 | 7 | 15 percent |
| **City of Newport Beach** | October 1, 1993 | 6 | 20 percent |
| **City of Orange** | October 1, 1992 | 9 | 5 percent |
| **City of San Juan Capistrano** | October 1, 1991 | 8 | 10 percent |
| **City of Yorba Linda** | October 1, 1993 | 10 | NP* |

Source: FEMA 2026

* Class 10 communities are not participants in the CRS community and therefore do not receive a premium discount through this program.

## Risk Rating 2.0: Equity in Action

FEMA introduced Risk Rating 2.0: Equity in Action to consider specific characteristics of a building to provide a more modern, individualized, and equitable flood insurance rates. The new rating methodology considers frequency of flooding, multiple flood types, proximity to flood sources, and building characteristics such as first floor heights and costs to rebuilt. The update was rolled out in October 2021 through April 2022, and as of April 1, 2023 has been fully implemented (FEMA 2022).

Across the country, official are finding it to be increasingly difficult to communicate the benefits of mitigation to some property owners where insurance rates are likely to stay high even after mitigation due to factors such as proximity to flood sources and frequency of flooding. Continued shifts in flood insurance costs, coverage, impacts to mitigation of flood prone properties, and potential updates to Risk Rating 2.0 will be monitored by Orange County throughout the period of performance of the 2026 FMP.

## Risk Mapping, Assessment, and Planning (Risk MAP)

FEMA works with federal, state, tribal, and local partners across the nation to identify flood risk and promote informed planning and development practices to help reduce that risk through the Risk MAP program. Risk MAP provides high-quality flood maps and information, tools to better assess the risk from flooding, and planning and outreach support to communities to help them take action to reduce (or mitigate) flood risk. Each Risk MAP flood risk project is tailored to the needs of each community and may involve different products and services.

According to FEMA's Risk MAP Progress Interactive Map, numerous active Risk MAP projects are underway throughout California. The number of active projects changes over time as studies are initiated, updated, and completed (FEMA 2025). FEMA coordinates and works directly with municipal floodplain managers during the Risk MAP project process. The State NFIP Coordinator is kept appraised of project activities and consultations as needed.

## Disaster Mitigation Act of 2000

The Disaster Mitigation Act (DMA 2000) is the current federal legislation addressing hazard mitigation planning. DMA 2000 provides an opportunity for states, tribes, and local governments to take a new approach to mitigation planning. DMA 2000 amended the Robert T. Stafford Disaster Relief and Emergency Assistance Act (the Act) by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of mitigation plan requirements (Section 322) (Congress.gov n.d.). This new section emphasizes the need for state, tribal, and local entities to coordinate mitigation planning and implementation efforts. It emphasizes planning for disasters before they occur. It also specifically addresses planning at the local level and requires plans to be in place before Hazard Mitigation Assistance (HMA) grant funds are available to communities. FMPs designed to meet the requirements of DMA will remain eligible for future FEMA HMA funds. This plan is designed to meet the requirements of DMA and in turn improve the eligibility for future hazard mitigation funds.

## Robert T. Stafford Disaster Relief and Emergency Assistance Act

The Act provides an orderly and continuing means of assistance by the federal government to state and local governments in carrying out their responsibilities to alleviate the damage that results from disasters. The provisions of the Act include (Congress.gov n.d.):

- Revising and broadening the scope of existing disaster relief programs;
- Encouraging the development of comprehensive disaster preparedness plans, programs, capabilities, and organizations by state or local governments;

- Achieving coordination and responsiveness of disaster preparedness and relief programs;
- Encouraging individuals and governments to protect themselves by obtaining insurance coverage to replace governmental assistance;
- Encouraging hazard mitigation measures to reduce losses from disasters and to develop land-use and construction regulations; and
- Providing federal assistance programs for both public and private losses as a result of disasters.

## Disaster Recovery Reform Act

The Disaster Recovery Reform Act amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act to modify the Pre-disaster Hazard Mitigation Grant Program. This Act permits the use of technical and financial assistance in order to carry out enforcement activities to implement codes that incorporate the latest hazard-resistant designs. It also directs the President for establishing a National Public Infrastructure Pre-Disaster Mitigation Fund and authorize the President's contribution to the cost of hazard mitigation measures in any area affected by a major disaster. This Act directs FEMA to issue a final rulemaking that defines the terms *resilient* and *resiliency* (FEMA 2021).

## Bunning-Bereuter-Blumenauer Flood Insurance Reform Act of 2004

The Flood Insurance Reform Act of 2004 amended the 1994 National Flood Insurance Reform Act of 1968 to reduce losses to properties for which repetitive flood insurance claim payments have been made. This Act established a program for mitigation of severe repetitive loss properties and gave FEMA the authority to fund mitigation activities for individual repetitive loss properties. The Act provides additional coverage for compliance with land use measures (Congress.gov 2004).

## Biggert Waters National Flood Insurance Reform Act of 2012

Under the Biggert-Waters National Flood Insurance Reform Act of 2012, long-term changes to the National Flood Insurance Program have been adopted that have increased rates overall to reflect the flood risk to buildings in flood hazard areas. This Act has significantly influenced construction and reconstruction activities within flood hazard areas. Property owners are encouraged to consider long-term insurance costs when undertaking reconstruction or elevation of flood impacted buildings. An investment to reconstruct the lowest floor of a building an additional foot or two higher today may translate into significant future flood insurance savings (FEMA 2012).

## Homeowner's Flood Insurance Affordability Act 2014

This law repeals and modifies certain provisions of the Biggert-Waters Flood Insurance Reform Act of 2012 and makes additional changes to other aspects of the program not covered by the Act. The new law lowers the recent rate increases on policies, prevents future rate increases, and implements a surcharge on policyholders. The Act also rolls back certain rate increases that have already gone into effect and provides refunds to those policyholders. The Act also authorizes additional resources for the National Academy of Sciences (NAS) to complete the affordability study. FEMA, Congress, the private insurance companies, work together to implement these Congressionally mandated reforms. The goal is to help families maintain affordable flood insurance, ensuring the financial stability of the NFIP, and reduce the risks of flooding nationwide (House.gov 2014).

## Emergency Support Function (ESF) #14, Long-Term Recovery Planning

Long-Term Community Recovery provides a mechanism for coordinating Federal support to State, tribal, regional, and local governments, NGOs, and the private sector to enable community recovery from long-term consequences

of disasters. ESF #14 accomplishes this by identifying and facilitating the use of recovery funding and providing technical assistance (such as impact analyses) for community recovery planning (FEMA 2008). ESF #14 may be activated for incidents that require a coordinated Federal response to address long-term impacts and to foster sustainable recovery (FEMA 2008). Actions coordinated under ESF #14 include pre-incident planning and coordination prior to the incident, post-event planning, and also operations (FEMA 2008).

### U.S. Army Corps of Engineers

Under Section 404(e) of the Clean Water Act, the U.S. Army Corps of Engineers (USACE) can issue general permits to authorize activities that have only minimal individual and cumulative adverse environmental effects. A nationwide permit (NWP) is a general permit that authorizes activities across the country unless a district or division commander revokes the nationwide permit in a state or other geographic region. There are 54 nationwide permits, and they authorize a wide variety of activities, including linear transportation projects, bank stabilization activities, residential development, commercial and industrial developments, aids to navigation and certain maintenance activities (USACE 2017). There are three types of USACE permits: standard, nationwide (described above), and regional. Standard permits are individual permits that involve full public interest review of an individual permit application and include the issuance of a public notice for any project that does not meet the terms and conditions of an NWP or a Letter of Permission (LOP). Regional general permits are for small, specialized projects.

## 6.4.3 State Floodplain Management Programs

### Municipal Land Use Law

California's municipal land use law is designed to guide development and land use planning at the local level to ensure sustainable community growth. Every city and county must adopt a General Plan which serves as a long-term blueprint for development and includes elements such as Land Use, Housing, Conservation, and Safety. Zoning ordinances implement the policies of the General Plan by regulating land use and development standards. This often includes specific provisions for flood-prone areas. Subdivision regulations govern the division of land into parcels and ensure new developments comply with floodplain management standards. The California Environmental Quality Act (CEQA) requires environmental impact assessments for projects including potential measures to mitigate flood risks.

### California State Building Code

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, and implementation of California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California, except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission published new editions of Title 24 every three years (CALDGS n.d.).

In 2014, California Building Code Accessibility Standards (Chapter 11B) incorporated the 2010 Americans with Disabilities Act (ADA) Standards as the model accessibility code for California. The purpose was to ensure consistency with federal guidelines. As a result of this, the California standards fully implement and include 2010 ADA Standards within the California Building Code and maintain high levels of accessibility provided by existing California accessibility regulations (CALDGS n.d.).

## Growth Management Policy

California's growth management policy aims to guide sustainable development while preserving natural resources and mitigating environmental impact. Key components of this policy include urban growth boundaries which limit urban sprawl by defining areas where development can occur. These boundaries help manage population growth and ensure development is concentrated in designated areas.

Floodplain management is an integral part of California's growth management strategy because it controls where development occurs and can help prevent construction in flood-prone areas. This further reduces the risk of flood damage. Additionally, local governments are required to incorporate floodplain management practices into their planning processes to identify flood hazard areas and implement land use controls to minimize flood risks.

## AB 70: Flood Liability

The Flood Liability bill states that a city or county may be required to contribute a fair share of compensation for property damage caused by a flood. This is to the extent that it has increased the State's exposure to the hazard for property damages by approving new development in a previously undeveloped area that is protected by a state flood control project (Ca.gov n.d.).

## AB 162: Flood Planning

This California State Assembly Bill passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and review the areas covered by the general plan that are subject to flooding (identified in floodplain mapping by FEMA or the California Department of Water Resources (CADWR)). The conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purpose of groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards, including:

- Flood hazard zones.
- Maps published by FEMA, DWR, the USACE, the Central Valley Flood Protection Board, and Cal OES.
- Historical data on flooding.
- Existing and planned development in flood hazard zones.

The general plan must establish goals and objectives related to flooding risks, including:

- Avoiding/minimizing the risks of flooding to new development.
- Evaluating if new development should be located in flood hazard zones.
- Identifying construction methods to minimize damage.

AB 162 establishes goals, policies and objectives related to flooding risks. It establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has concluded that the flood management infrastructure is not adequate to avoid the risk of flooding.

## AB 747: Required Information for General Plan Safety Elements

This bill requires California communities with general plans to address evacuation routes in the safety element of their general plan. Information on the evacuation routes and capacity, safety and viability under a range of emergency scenarios must be provided. For communities that have not adopted a local hazard mitigation plan,

the safety element must be updated with this information by January 2022. For those with a local hazard mitigation plan, the requirement applies for the next revision of the hazard mitigation plan after January 2022. Communities that have adopted a local hazard mitigation plan, emergency operations plan, or other document that fulfills the goals and objectives of this law comply with this requirement by summarizing and incorporating the other plan or document in the safety element. In subsequent revisions to the safety element, communities also will be required to identify new information relating to flood and fire hazards and climate adaptation and resiliency strategies applicable to the city or county that was not available during the previous revision of the safety element (Assembly.ca.gov 2019).

## California Department of Water Resources

In California, the DWR is the coordinating agency for floodplain management. They work with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide floodplain management planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by the DWR (DWR 2025).

## California Division of Safety of Dams

California's Division of Safety of Dams (DSOD) (a division of the DWR) monitors the dam safety program at the state level and maintains a working list of dams in the state. When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface. Upon submittal of an application, the Division reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the Division inspects all aspects of the construction to ensure that the work is done in accordance with the approved plans and specifications. After construction, the Division inspects each dam to ensure that it is performing as intended and is not developing problems. The Division periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California. Over 1,200 dams are inspected by Division engineers on a yearly schedule to ensure performance and maintenance of dams (DWR n.d.).

## California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970 to create a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of public disclosure for potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California agency's decision-making process. CEQA establishes a statewide environmental policy, and mandates actions all agencies must take to advance the policy. Jurisdictions conduct analysis of the project to determine if there are potentially significant environmental impacts and identify mitigation measures. Jurisdictions also explore possible project alternatives by preparing environmental reports for projects that require CEQA review. This environmental review is required before an agency acts on any policy, program, or project. Any project action identified in this plan will seek full CEQA compliance upon implementation (LCI 2025).

## California Multi-Hazard Mitigation Plan

Under the federal Disaster Mitigation Act (DMA), California must adopt a federally approved state multi-hazard mitigation plan to be eligible for certain disaster assistance and mitigation funding. The intent of the State of California Multi-Hazard Mitigation Plan is to reduce or prevent injury and damage from hazards in the state. The plan is an annex to the State Emergency Plan and it identifies past and present mitigation activities, current

policies/programs, and mitigation strategies. It also establishes hazard mitigation goals and objectives. The plan is reviewed and updated annually to reflect changing conditions and new information. Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state's hazard mitigation plan.

## Governor's Executive Order S-13-08

Governor's Executive Order S-13-08 enhances the state's management of climate impacts from sea-level rise, increased temperatures, shifting precipitation and extreme weather events. There are four key actions in the executive order:

- Initiate California's first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state's water supply and the economy.
- Request that the National Academy of Science establish an expert panel to report on sea-level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea-level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea-level rise.

## SB 92: Public Resources Portion of Biennial Budget Bill

- The State of California updated its requirements regarding emergency action plans (EAPs) via SB 92, which became effective in June 2017 as part of the state Legislature's biennial budget process. The bill required dam owners to submit EAPs to Cal OES and the Department of Water Resources for approval by January 1, 2018 (for extremely high hazard dams), January 1, 2019 (for high-hazard dams), and January 1, 2021 (for significant hazard dams). The EAPs were to include the following (California Government Code Section 8589.5; Cal OES, 2018):
- Emergency notification flow charts
- Information on a four-step response process
- Description of agencies' roles and actions in response to an emergency incident
- Description of actions to be taken in advance of an emergency
- Inundation maps
- Additional information such as revision records and distribution lists

After the EAPs are approved by the state, the law requires dam owners to send the approved EAPs to relevant stakeholders. Local public agencies can then adopt emergency procedures that incorporate the information in the EAP in a manner that conforms to local needs and includes methods and procedures for alerting and warning the public and other response and preparedness related items (State of California, 2018).

SB 92 also requires dams other than low-risk dams to have current inundation mapping, which must be updated every 10 years, or sooner if specific circumstances change. EAPs also must be updated every 10 years. It provides DWR with enforcement tools, including fines and operational restrictions for failure to comply. Cal OES is required by the law to work with state and federal agencies, dam owners, planners, and the public to make dam failure inundation maps available to residents interested in learning their dam failure inundation risk.

### SB 99: Evacuation Route Planning

SB 99, enacted in 2019, requires that general plans adopted by cities and counties address evacuation routes from any hazard area identified in the safety element. Under this law, the safety element must include information to identify residential developments in hazard areas that do not have at least two emergency evacuation routes. Each city or county must update its safety element with the new information upon the next revision of its housing element on or after January 1, 2020.

### SB 1000: General Plan Amendments—Safety and Environmental Justice Elements

In 2016, SB 1000 amended California's Planning and Zoning Law in two ways:

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

### SB 1035: Fire, Flood, and Adaptation Safety Element Updates

SB 1035 clarifies those revisions to a community's General Plan Safety Element—to address fire hazards, flood hazards, and climate adaptation and resilience strategies—must occur upon each revision to a Housing Element or Local Hazard Mitigation Program.

## 6.4.4 County and Local Floodplain Management Programs

The following summarizes the planning and regulatory capabilities available to Orange County, at the county and local levels.

### Orange County Master Plan or General Plan

The Orange County Master Plan (also called General Plan) is a comprehensive framework guiding the county's development, land use, and infrastructure projects. It balances growth with environmental sustainability and community well-being. A key component of the plan is floodplain management, which is addressed through strategies and regulations. The plan includes the Floodplain Management Plan (this plan), which identifies flood hazard areas and outlines measures to reduce flood risks, such as maintaining natural floodplains and implementing flood control projects. Additionally, the county adheres to the NFIP and participates in the CRS program to encourage higher standards of floodplain management and provide flood insurance premium discounts. These efforts collectively enhance the county's resilience to flooding and protect its residents and properties.

### Orange County Emergency Operations Plan

The Orange County Emergency Operations Plan (EOP) is a comprehensive framework designed to coordinate response efforts during emergencies, including hazard events such as floods. The EOP outlines the roles and responsibilities of various agencies and departments, ensuring a coordinated and response to emergencies. It includes specific annexes for different types of hazards which details procedures for managing flood risks and

responding to flood events (OCPW 2019). Floodplain management is a critical component of the EOP. The plan incorporates floodplain management practices, identifies flood hazard areas, and outlines measures to reduce flood risks. Examples include maintaining natural floodplains and implementing flood control projects. The EOP also emphasizes the importance of public awareness and preparedness to encourage residents to take proactive steps to protect themselves and their properties from flooding. Additionally, the plan ensures compliance with the NFIP and integrates the CRS program to promote higher standards of floodplain management and provide flood insurance premium discounts (OCPW n.d.).

### Orange County Subdivision Manual

The Orange County Subdivision Manual is a supplementary guide that outlines procedures for administering and implementing the State Subdivision Map Act and the Orange County Subdivision Code. It provides detailed instructions on the subdivision process and includes tentative maps, tract maps, parcel maps, lot line adjustments, and digital submissions. The manual ensures that subdivisions comply with local, state, and federal regulations, promoting orderly and sustainable development (OCPW 2015).

### Orange County Hazard Mitigation Plan

The Orange County Hazard Mitigation Plan (HMP) is a strategic plan designed to reduce the risks posed by natural hazards, such as floods. The plan identifies other various hazards such as earthquakes, wildfires, and hazardous material spills and outlines actions and projects to mitigate these risks. Floodplain management is a key component of the HMP and is outlined in the flood hazard profile section of the plan. By integrating floodplain management strategies into hazard mitigation practices, the plan enhances the county's resilience to flooding and other natural disasters (Orange County Sheriff's Department n.d.).

## 6.4.5 Fiscal Capabilities

Assessing a jurisdiction's fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees. An assessment of fiscal capabilities is presented in Table 6-4.

**Table 6-4. Financial Resources**

| Financial Resources | Accessible or Eligible to Use (Y or N) |
|---|---|
| **Community Development Block Grants** | Yes |
| **Capital Improvements Project Funding** | Yes |
| **Authority to Levy Taxes for Specific Purposes** | Yes |
| **User Fees for Water, Sewer, Gas or Electric Service** | Yes |
| **Incur Debt through General Obligation Bonds** | Yes |
| **Incur Debt through Special Tax Bonds** | Yes |
| **Incur Debt through Private Activity Bonds** | Yes |
| **Withhold Public Expenditures in Hazard-Prone Areas** | Yes |
| **State-Sponsored Grant Programs** | Yes |
| **Development Impact Fees for Homebuyers or Developers** | Yes |

## FEMA

As noted on the FEMA hazard mitigation assistance website (FEMA n.d.), FEMA administers four programs that provide funding for eligible mitigation planning and projects that reduce disaster losses and protect life and property from future disaster damages. The programs are the Hazard Mitigation Grant Program (HMGP), and the HMGP Post Fire Grant, the Flood Mitigation Assistance (FMA) Program, and the Pre-Disaster Mitigation (PDM) Program. Table 6-5 provides an overview of program funding eligibility and cost share.

**Table 6-5. FEMA HMA Grant Cost Share Requirements**

| Programs | Cost Share (Percent of Federal/Non-Federal Share) |
|---|---|
| **HMGP** | 75/25 |
| **HMGP Post Fire** | 75/25 |
| **FMA (community flood mitigation, project scoping, individual mitigation of insured properties, and planning grants)** | 75/25 |
| **FMA—repetitive loss property** | 90/10 |
| **FMA—severe repetitive loss property** | 100/0 |
| **PDM** | 75/25 |
| **PDM—small and impoverished community** | 90/10 |

*Source: FEMA 2023; FEMA 2023*

*Sub applicants should consult their State Hazard Mitigation Officer (SHMO) for the percentage of HMGP subrecipient management cost funding their State has determined to be passed through subrecipients.*

*To be eligible for an increased federal cost share, a FEMA-approved state or tribal (standard or enhanced) mitigation plan that addressed repetitive loss properties must be in effect at the time of award, and the property is being submitted for consideration must be a repetitive loss property.*

HMGP assists in implementing long-term hazard mitigation planning and projects following a Presidential major disaster declaration. PDM provides funds for hazard mitigation planning and projects on an annual basis. FMA provides funds for planning and projects to reduce or eliminate risk of flood damage to buildings that are insured under the National Flood Insurance Program (NFIP) on an annual basis.

HMGP funding is generally 15 percent of the total amount of Federal assistance provided to a State, Territory, or federally recognized tribe following a major disaster declaration. PDM and FMA funding depends on the amount congress appropriates each year for those programs.

Individual homeowners and business owners may not apply directly to FEMA. Eligible local governments may apply on their behalf (FEMA 2023).

Federal mitigation grant funding is available to all communities with a current hazard mitigation plan; however, most of these grants require a “local share” in the range of 10 to 25 percent of the total grant amount.

### Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) is a post-disaster mitigation program. It is made available to states by FEMA after each Federal disaster declaration. The HMGP can provide up to 75 percent funding for hazard mitigation measures. The HMGP can be used to fund cost-effective projects that will protect public or private property in an area covered by a federal disaster declaration or that will reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard-prone areas, flood-

proofing or elevation to reduce future damage, minor structural improvements, and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved hazard mitigation plan (this plan).

Applicants who are eligible for the HMGP are state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available.

### Flood Mitigation Assistance Program

The FMA program combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. The FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal cost share for an FMA project is at least 75 percent. At most, 25 percent of the total eligible costs must be provided by a non-federal source. Of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At minimum, a FEMA-approved local floodplain management plan is required before a project can be approved. The FMA funds are distributed from FEMA to the state.

### Rehabilitation of High Hazard Potential Dams Program

The Rehabilitation of High Hazard Potential Dams (HHPD) grant program provides technical, planning, design, and construction assistance for eligible rehabilitation activities that reduce dam risk and increase community preparedness.

The HHPD Grant Program will aid with technical, planning, design, and construction activities toward:

- Repair
- Removal
- Structural/nonstructural rehabilitation of eligible high hazard potential dams

## Disaster and Recovery Assistance Programs

Following a disaster, various types of assistance may be made available by local, state, and federal governments. The types and levels of disaster assistance depend on the severity of the damage and the declarations that result from the disaster event. Among the general types of assistance that may be provided should the President of the United States declare the event a major disaster includes the following:

### Individual Assistance

Individual Assistance (IA) provides help for homeowners, renters, businesses, and some nonprofit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses may be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals may borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal

property, and an additional 20 percent for mitigation. For businesses, loans may be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Businesses of any size are eligible. Nonprofit organizations such as charities, churches, private universities, etc. are also eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster. These loans are restricted, by law, to small businesses only.

### Public Assistance

Public Assistance (PA) provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain nonprofit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required.

### Small Business Administration Loans

The Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets.

Homeowners may apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners may borrow up to $40,000 to replace or repair personal property (such as clothing, furniture, cars, and appliances) damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations.

## U.S. Department of Housing and Urban Development

### Community Development Block Grants

Community Development Block Grants (CDBG) are federal funds intended to provide low and moderate-income households with viable communities, including decent housing, as suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, planning, and administration. Public improvements may include flood and drainage improvements. In limited instances, and during the times of “urgent need” (e.g., post-disaster) as defined by the CDBG National Objectives, CDBG funding may be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event.

Community Development Block Grant Disaster Recovery (CDBG-DR) grant funds are appropriated by Congress and allocated by HUD to rebuild disaster-impacted areas and provide crucial seed money to start the long-term recovery process. These flexible grants help cities, counties, Indian tribes, and States recover from presidentially declared disasters, especially in low-income areas, subject to the availability of supplemental appropriations. Since CDBG-DR assistance may fund a broad range of recovery activities, HUD can help communities and neighborhoods that otherwise might not recover due to limited resources.

### Disaster Housing Assistance Program

The Disaster Housing Assistance Program provides emergency assistance for housing, including minor repairs of the home to establish livable conditions, mortgage, and rental assistance.

## Federal Highway Administration Emergency Relief

Federal Highway Administration (FHWA) Emergency Relief is a grant program that can be used for the repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of a disaster.

## Federal Transit Administration Emergency Relief

Federal Transit Authority (FTA) Emergency Relief is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the FTA and directly allocated to mass transit and port authorities, this transportation-specific fund was created as an alternative to FEMA's PA.

## U.S. Department of Agriculture

### Emergency Loan Program

The Emergency loan program is triggered when a natural disaster is designated by the Secretary of Agriculture, or a natural disaster or emergency is declared by the President under the Stafford Act. These loans help producers who suffer qualifying farm-related losses directly caused by the disaster in a county declared or designated as a primary disaster or quarantine area. Also, farmers located in counties that are contiguous to the declared, designated, or quarantined area may qualify for emergency loans.

For production losses, a 30 percent reduction in a primary crop in a designated or contiguous county is required. Losses to quality, such as receiving a 30 percent reduced price for flood-damaged crops, may be eligible for assistance, too.

### Emergency Watershed Protection Program

The Emergency Watershed Protection (EWP) Program, a federal emergency recovery program, helps local communities recover after a natural disaster. The EWP program offers technical and financial assistance to help local communities relieve imminent threats to life and property caused by floods, fires, windstorms, and other natural disasters that impair a watershed. EWP does not require a disaster declaration by federal or state government officials for program assistance to begin. The Natural Resources Conservation Service (NRCS) state conservationist can declare a local watershed emergency and initiate EWP program assistance in cooperation with an eligible sponsor. The sponsor must sign a cooperative agreement with NRCS. The EWP program offers financial and technical assistance for various activities, including the following:

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded streambanks
- Correct damaged or destroyed drainage facilities
- Establish vegetative cover on critically eroding lands
- Repair levees and structures
- Repair certain conservation practices
- Buyouts

# 6.5 MITIGATION STRATEGY DEVELOPMENT

This subsection discusses the identification, prioritization, analysis, and implementation plan of mitigation actions for the Orange County Floodplain Management Plan.

## 6.5.1 Mitigation Alternatives

The planning team developed a catalog of floodplain management alternatives through a facilitated process with the Steering Committee. On April 30, 2025, a Steering Committee work session was held to review possible actions and was the basis for the alternatives considered as well as the mitigation actions selected for implementation. The floodplain management catalog represents the full range of mitigation alternatives needing consideration to comply with Step 7 (i.e., Review Possible Activities) of the 10-step CRS FMP process. The Steering Committee reviewed this floodplain management catalog along with findings generated as a result of public outreach, risk assessment results, as well as the Orange County HMP. Based on this review by the Steering Committee, the floodplain management catalog was further refined, then utilized by the Steering Committee to ultimately select the final hazard mitigation actions.

Floodplain management catalogs were developed in a manner that ensures the broadest range of alternatives were considered for use in the FMP area (CRS Step 7). The floodplain management catalogs are separated into two primary categories. Category 1 is by the scale of governance and implementation for the actions listed. The first is at the Personal Scale, where the responsibility for implementation is left to individuals and/or private property owners. Compare this to the Corporate Scale, whereby business or their parent corporations hold the responsibility for implementing a particular action. At the Government Scale, the public sector (i.e., Orange County) is the entity tasked with implementation of the specified action listed.

The actions listed in the mitigation sub-catalogs are categorized by what they would do and who would be responsible for implementation, as summarized in Table 6-6.

**Table 6-6. Mitigation Action Catalog Question Types and Summary Descriptions**

| Category 1—"What the alternative would do?" | Category 2—"Who would have responsibility for implementation" |
|---|---|
| • Manipulate a hazard<br>• Reduce exposure to a hazard<br>• Reduce vulnerability to a hazard<br>• Build local capacity to respond to or be prepared for a hazard | • Individuals (Personal Scale)<br>• Businesses (Corporate Scale)<br>• Orange County (Government Scale) |

Finalized floodplain management actions recommended in the FMP were selected from among the list of possible activities provided in the three floodplain management catalogs. Collectively, the three mitigation catalogs presented in Table 6-7, Table 6-8, and Table 6-9 provide possible actions based on Category 1 and Category 2 establish a baseline of floodplain management alternatives supported by the FMP planning process, are consistent with the FMP's goals and objectives, and are within the capabilities of Orange County to implement.

**Table 6-7. Mitigation Catalog: Personal Scale**

| | |
|---|---|
| **Manipulate the Hazard** | • Clear storm drains<br>• Install local stormwater capture systems<br>• Use low-impact development techniques |
| **Reduce Hazard Vulnerability** | • Relocation homes outside flood hazard areas<br>• Elevate utilities and/or other mechanicals above the regulatory flood elevation<br>• Use low-impact development technique<br>• Assess projects to determine if they may inadvertently increase flood risk |
| **Reduce Hazard Impact** | • Retrofit structures (e.g., elevate structures above the regulatory flood elevation)<br>• Elevate items within homes above the regulatory flood elevation<br>• Construct new homes above the regulatory flood elevation<br>• Floodproof existing structures |
| **Build Local Response Capacity/Hazard Preparation** | • Clear storm drains<br>• Develop household mitigation plans, such as retrofit savings, communication capability with outside sources, and 72-hour self-sufficiency during and after an event<br>• Understand the location of evacuation routes in the community<br>• Educate individuals on flood risk from related hazards such as coastal storms and severe rain events<br>• Participate in Community Emergency Response Team (CERT) training |

**Table 6-8. Mitigation Catalog: Corporate Scale**

| | |
|---|---|
| **Manipulate the Hazard** | • Clear storm drains<br>• Install local stormwater capture systems<br>• Use low-impact development techniques |
| **Reduce Hazard Vulnerability** | • Relocate critical facilities or functions outside of flood area<br>• Institute low-impact development techniques on property<br>• Assess projects to determine if they may inadvertently increase flood risk<br>• Use porous pavement, vegetative buffers, and islands in large parking areas<br>• Raise utilities or other mechanical devices above regulatory flood elevation |
| **Reduce Hazard Impact** | • Build redundancy for critical functions or retrofit critical buildings<br>• Provide flood-proofing measures when new critical infrastructure must be located in floodplains |
| **Build Local Response Capacity/Hazard Preparation** | • Support and implement hazard disclosure for the sale/re-sale of property in identified flood areas<br>• Solicit cost-sharing through partnerships with private-sector stakeholders on projects with multiple benefits<br>• Increase capability by having cash reserves for reconstruction<br>• Buy flood insurance |

**Table 6-9. Mitigation Catalog: Government Scale**

| | |
|---|---|
| **Manipulate the Hazard** | • Work with USACE, State of CA, and the U.S. Coast Guard to ensure Navigability of channels are properly maintained via proper marking and targeted dredging when needed<br>• Enhance stormwater management regulations and master planning<br>• Clear stormwater drains, culverts, and enhance outlet structures. |
| **Reduce Hazard Vulnerability** | • Promote open space uses in identified high hazard areas via techniques such as planned unit developments, easements, setbacks, greenways, and sensitive areas<br>• Install additional tide flex valves to prevent backflow<br>• Locate or relocate critical facilities outside of flood hazard area<br>• Acquire or relocate identified repetitive loss properties<br>• Work with local universities and schools to develop erosion documentation program<br>• Institute low-impact development techniques on property<br>• Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff<br>• Enforce more stringent parking standards to ensure vehicles are not being parked in flood prone areas or acquired properties<br>• Preserve undeveloped and vulnerable shoreline<br>• Restore existing flood control and riparian corridors<br>• Utilize alternative funding sources for property buyouts that do not have the same restrictions as FEMA buyout programs |
| **Reduce Hazard Impact** | • Increase floodplain standards within municipal ordinances, and include provisions for enforcing best practice standards within floodplains and using FEMA flood maps<br>• Increase size of undersized bridges and culverts<br>• Implement higher regulatory standards such as higher freeboard and lower substantial damage threshold<br>• Identify critical infrastructure such as those on single-entry roads and prioritize for replacement or resizing<br>• Provide redundancy for critical functions and infrastructure<br>• Review stormwater management regulations and master planning<br>• Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities<br>• Require accounting for sea-level rise in all applications for new development in shoreline areas<br>• Implement standards for bulkhead replacement (required height) |

| | |
|---|---|
| **Build Local Response Capacity/Hazard Preparation** | • Apply for Climate Smart Community status in order to apply for grant funding (e.g., CSC Grant Program)<br>• Develop and implement a public information strategy<br>• Develop a flood information page on the city's website<br>• Provide outreach to residents to inform them on how to notify Public Works of backflow device clogs<br>• Educate residents on how backflow valves work and how to help keep storm drains free of trash and debris<br>• Establish flood warning system using the Stevens flood modeling system<br>• Develop a Flood Warning and Response Plan<br>• Provide better communication systems and back-up communication systems to inform public of hazards and to communicate during the hazard event<br>• Develop an adaptive management plan to address long-term impacts of sea-level rise<br>• Consider the probable impacts of climate change on the risk associated with the flood hazard<br>• Work with insurance agencies and real estate agents to provide workshops on tools and resources to get more information on flood hazard zones and FIRMs<br>• Enact tools to help manage development in hazard areas (stronger controls, tax incentives, information)<br>• Incorporate retrofitting/replacement of critical system elements in capital improvement plan<br>• Develop strategy to take advantage of post-disaster opportunities<br>• Warehouse critical infrastructure components<br>• Maintain existing data and gather new data needed to define risks and vulnerability<br>• Enforce NFIP requirements<br>• Create an elevation inventory of structures in the floodplain<br>• Charge a hazard mitigation fee on all new permits to a create a hazard mitigation funding source for grant cost share requirements<br>• Integrate floodplain management policies into other planning mechanisms within the community<br>• Be proactive in buyouts for contiguous open space<br>• Establish incentives to promote floodplain management of private property<br>• Join National Weather Service (NWS) "Storm Ready" Program<br>• Disseminate evacuation procedures<br>• Ensure public safety personnel and ambulance drivers know safe evacuation routes<br>• Install rain gauge or flood warning system<br>• Capture/survey high-water marks during flood events<br>• Produce County post-disaster manuals to provide efficient recovery procedures and reimbursement of funds<br>• Develop better education and outreach regarding flood insurance and NFIP programs<br>• Floodproof/harden critical infrastructure<br>• Provide mitigation outreach campaign for businesses<br>• Promote available mitigation-related training in the area<br>• Where applicable, have municipal officials attend FEMA flood training and provide incentive for officials to get training<br>• Work on engaging the public with progress on floodplain management projects to demonstrate progress<br>• Conduct proactive planning for buyouts to ensure more comprehensive buyout programs |

## 6.5.2 County Mitigation Strategy Development

Throughout the course of the planning process, Orange County and participating jurisdictions have had their respective mitigation actions identified through the following:

- Review of the results and findings of the risk assessment;
- Review of available regional and local plans, reports and studies;
- Direct input from Orange County departments and other County and regional agencies, including:
  - Orange County Workforce and Economic Development
  - Orange County Parks
  - Orange County Sheriff's Department Emergency Management Division
  - Orange County Public Works—Building Safety
  - Orange County Public Works—Floodplain Management & Hydrology
  - Orange County Office of Sustainability
  - Orange County Sanitation District
  - Orange County Fire Authority
  - Orange County Chamber of Commerce and Visitors Bureau
- Input received through the public and stakeholder outreach process

The Steering Committee determined that some actions from the floodplain management catalog could be implemented to provide floodplain management benefits. Table 6-10 lists the recommended flood mitigation actions, the lead agency or department for each, and the proposed timeline. The parameters for the timeline are as follows:

- Short-term—to be completed in 1 to 5 years
- Long-term—to be completed in more than 5 years
- Ongoing—ongoing or annual projects

### Benefit/Cost Review

The action plan is prioritized according to a benefit/cost analysis of the proposed projects and their associated costs (CRS Step 8). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis in this FMP is not needing to perform at the level of detail and scope as would otherwise be required by FEMA for project grant eligibility under the HMGP and PDM grant program. This FMP incorporates a less formal approach to the benefit/cost analysis since some projects may not be implemented for up to 10 years, and associated projects costs and benefits may experience significant changes in that time. To this end, a comparison of apparent benefits versus apparent costs for each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Costs shown are the total cost for the action or project, inclusive of possible administrative, maintenance, and construction (including engineering, design and permitting) costs.

**Table 6-10. Analysis of Floodplain Management Actions**

| Action Number | Action | Lead Agency | Possible Funding Sources or Resources | Hazards of Concern | Timeline[a] | Project Category[b] | Priority (High, Med., Low) |
|---|---|---|---|---|---|---|---|
| **2026-OC-FMP1** | Carbon Creek Channel (B01) | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | PR, SP, PP | High |
| **2026-OC-FMP2** | Debris Booms Project (A01, A07, B01, F01) | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | PR, SP, PP, NRP | High |
| **2026-OC-FMP3** | East Garden Grove-Wintersburg Channel (C05) | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | PR, SP, PP | High |
| **2026-OC-FMP4** | San Juan Creek Channel (L01) Reach 1 | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | PR, SP, PP | Medium |
| **2026-OC-FMP5** | San Juan Creek Channel (L01) Reach 2 | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | PR, SP, PP | High |
| **2026-OC-FMP6** | San Juan Creek Channel (L01) Reach 3 | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | PR, SP, PP | High |
| **2026-OC-FMP7** | Bolsa Bay Outlet Flood Control Improvements | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood, Coastal Flood | Long-term | SP, PP | Medium |
| **2026-OC-FMP8** | Fullerton Creek Channel (A03) | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | SP, PP | High |
| **2026-OC-FMP9** | Santa Ana-Delhi Channel (F01) | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood | Long-term | SP, PP, NRP | High |
| **2026-OC-FMP10** | Santa Ana River Channel Reach 5 Levee Height Correction (E01) | Orange County Public Works Infrastructure Programs | CIP | Flood, Riverine Flood, Dam Failure | Short-term | SP, PP | High |

| Action Number | Action | Lead Agency | Possible Funding Sources or Resources | Hazards of Concern | Timeline[a] | Project Category[b] | Priority (High, Med., Low) |
|---|---|---|---|---|---|---|---|
| **2026-OC-FMP11** | Coordination with FEMA Region IX | Orange County Public Works Infrastructure Programs | FMA, BRIC, HMGP, HMGP-post fire | Flood, Coastal Flood, Riverine Flood, Sea Level Rise, Tsunami, Dam Failure | Long-term | PR, PI | High |
| **2026-OC-FMP12** | Hydrology Manual Updated | Orange County Public Works Infrastructure Programs | HMGP, BRIC, NOAA Coastal Resilience Grants | Coastal Flood, Sea Level Rise | Long-term | PR, PI, NRP | High |
| **2026-OC-FMP13** | East Garden Grove-Wintersburg Channel: LOMR Properties | Orange County Public Works Infrastructure Programs | FMA, HMGP, BRIC, Annual budget | Flood, Riverine Flood | Long-term | PP, SP | High |
| **2026-OC-FMP14** | Evacuation for Flood and Post-Fire Debris Flows | Orange County Public Works/Orange County Sheriff's Department Emergency Management Division | HMGP, BRIC, Annual budget | Flood, Riverine Flood, Debris Flow | Long-term | ES | High |
| **2026-OC-FMP15** | Prado Dam Mitigation | Orange County Public Works Infrastructure Programs | HMGP, BRIC, Annual budget | Flood, Dam Failure | Long-term | SP, PI | High |
| **2026-Anaheim-FMP1** | Substantial Damage Management Plan | Planning and Building Department | Annual budget, State funding opportunities, HMA, CDBG | All Flood Hazards | Short-term | PP, PR | High |
| **2026-Anaheim-FMP2** | La Palma Ave and Fairview St. Roadway Elevation Feasibility | Highway Department | HMGP, State funding opportunities | All Flood Hazards | Long-term | SP | Medium |
| **2026-Anaheim-FMP3** | Upsize Storm Drain System and Backflow Prevention Valve | Highway Department | HMGP, State funding opportunities | Flood, Riverine Flood | Short-term | SP | High |
| **2026-LagunaWoods-FMP1** | El Toro Road Green Street and Flood Relief Project | Engineering and Infrastructure Services Department | Funding has not yet been identified. The City will continue to seek grant opportunities. | Flood, Riverine Flood | Long-term | SP | High |

| Action Number | Action | Lead Agency | Possible Funding Sources or Resources | Hazards of Concern | Timeline[a] | Project Category[b] | Priority (High, Med., Low) |
|---|---|---|---|---|---|---|---|
| **2026-LagunaWoods-FMP2** | Dam Failure Public Outreach | City Manager's Office | Annual budget, Staff time | Flood, Dam Failure | Short-term | PI | High |
| **2026-LagunaWoods-FMP3** | Post Disaster response Action Plan Development | City Manager's Office | CDBG-DR, EDA Disaster Recovery Grants, HMA | All Flood Hazards | Short-term | ES, PI | High |
| **2026-LagunaWoods-FMP4** | City Website Flood Risk Information | City Manager's Office | Annual budget, Staff time | All Flood Hazards | Short-term | PP | High |
| **2026-LagunaWoods-FMP5** | Updates to the General Plan Safety Element and Local Hazard Mitigation Plan | Planning and Environmental Services Department | Annual budget, Staff time | All Flood Hazards | Short-term | PR | High |
| **2026-LagunaWoods-FMP6** | Public Safety and Hazard Mitigation Webpage | City Manager's Office | Annual budget, Staff time | All Flood Hazards | Short-term | PI | High |
| **2026-LagunaWoods-FMP7** | City General Plan Conservation Element Update | City Manager's Office | Annual budget, Staff time | All Flood Hazards | Short-term | NRP | High |
| **2026-NewportBeach-FMP1** | Bilboa Island Drainage Master Plan/Pump Station | Department of Public Works | CIP – General Fund, Neighborhood Enhancement, Tidelands Capital | Flood, Riverine Flood | Long-term | NRP, SP | High |
| **2026-NewportBeach-FMP2** | Big Canyon Restoration – Phase 3 | Department of Public Works | CIP – Ocean Protection Council, State Coastal Conservancy, Wildlife | Coastal Flood, Sea Level Rise | Short-term | NRP | Medium |
| **2026-NewportBeach-FMP3** | Environmental Habitat Restoration – Monitoring and Maintenance | Department of Public Works | CIP – Oceanfront encroachment, Upper Newport Bay Restoration, Environmental Liability | Coastal Flood, Sea Level Rise | Short-term | NRP | Medium |

| Action Number | Action | Lead Agency | Possible Funding Sources or Resources | Hazards of Concern | Timeline[a] | Project Category[b] | Priority (High, Med., Low) |
|---|---|---|---|---|---|---|---|
| **2026-NewportBeach-FMP4** | Newport Dunes Infiltration Basin | Department of Public Works | CIP – Tidelands Captial, Measure M (Competitive), Contributions | Coastal Flood, Sea Level Rise | Short-term | NRP, SP | Medium |
| **2026-NewportBeach-FMP5** | TMDL Compliance/Water Quality Improvements | Department of Public Works | CIP – Tidelands Maintenance | Coastal Flood, Sea Level Rise | Ongoing | PR, PI NRP, SP | Medium |
| **2026-NewportBeach-FMP6** | Bilboa Island Seawall | Department of Public Works | CIP – Tidelands Capital | Coastal Flood, Sea Level Rise | Short-term | SP | High |
| **2026-NewportBeach-FMP7** | Harbor & Ocean Bulkheads/Seawalls/Structure Repairs | Department of Public Works | CIP – Tidelands Capital, Tidelands Maintenance | Coastal Flood, Sea Level Rise | Long-term | SP | High |
| **2026-NewportBeach-FMP8** | Newport Harbor wide Dredging | USACE | CIP – Tidelands Capital | Coastal Flood, Sea Level Rise | Short-term | NRP | Medium |
| **2026-NewportBeach-FMP9** | Tide Valve Replacement - Peninsula | Department of Public Works | CIP – Tidelands Capital | Coastal Flood | Long-term | SP | Medium |
| **2026-SanJuanCapistrano-FMP1** | CRS FEMA Training | City Engineering and Environmental Services | Annual budget, Staff time | Flood, Riverine Flood. Coastal Flood, Sea Level Rise, Dam Failure, Tsunami | Short-term | PI | High |
| **2026-SanJuanCapistrano-FMP2** | Public Floodplain Outreach | City Engineering and Environmental Services | Annual budget, Staff time | Flood, Riverine Flood. Coastal Flood, Sea Level Rise, Dam Failure, Tsunami | Short-term | PI, ES | High |
| **2026-SanJuanCapistrano-FMP3** | Grant Funding Opportunity Summary | City Engineering and Environmental Services | Annual budget, Staff time | Flood, Riverine Flood. Coastal Flood, Sea Level Rise, Dam Failure, Tsunami | Short-term | PI | High |
| **2026-SanJuanCapistrano-FMP4** | Sea Level Rise Data and Modeling | City Engineering and Environmental Services | Annual budget, Staff time | Flood, Sea Level Rise, Coastal Flood | Ongoing | PI, PR | Medium |

| Action Number | Action | Lead Agency | Possible Funding Sources or Resources | Hazards of Concern | Timeline[a] | Project Category[b] | Priority (High, Med., Low) |
|---|---|---|---|---|---|---|---|
| **2026-SanJuanCapistrano-FMP5** | Incorporate Coastal Flood and Planning | City Engineering and Environmental Services | HMGP, FMA, Annual budget | Flood, Coastal Flood | Short-term | PI, PR | Low |
| **2026-SanJuanCapistrano-FMP6** | State Grant Manager Coordination | City Engineering and Environmental Services, State Grant Manager | Annual budget, Staff time | Flood, Riverine Flood | Short-term | PI, SP | Low |
| **2026-SanJuanCapistrano-FMP7** | USACE H&H Modeling Training | City Engineering and Environmental Services | Annual budget, Staff time | Flood, Riverine Flood | Short-term | PI, ES | Medium |
| **2026-SanJuanCapistrano-FMP8** | Tsunami Ready: Public Outreach | City Engineering and Environmental Services | Annual budget, Staff time | Tsunami | Short-term | PI, ES | Low |
| **2026-SanJuanCapistrano-FMP9** | Tsunami Evacuation Routes and Evacuation Plan | City Engineering and Environmental Services | Annual budget, HMGP, PDM, BRIC | Tsunami | Short-term | PI, ES | Low |
| **2026-SanJuanCapistrano-FMP10** | Update Emergency Response Plan | City Engineering and Environmental Services | Annual budget | Flood, dam Failure | Short-term | PI, ES | High |
| **2026-SanJuanCapistrano-FMP11** | Regional Watershed Agency Coordination | City Engineering and Environmental Services | Annual budget | Flood, Sea Level Rise, Coastal Flood | Short-term | PI, ES, PR | High |
| **2026-SanJuanCapistrano-FMP12** | Storm Drain Master Plan | City Engineering and Environmental Services | Annual budget | Flood, Sea Level Rise, Coastal Flood, Riverine Flood, Tsunami, Dam Failure | Short-term | PI, SP | High |
| **2026-SanJuanCapistrano-FMP13** | Emergency Warning System | City Engineering and Environmental Services | Annual budget | Flood, Riverine Flood | Short-term | PI, ES | High |
| **2026-SantaAna-FMP1** | Disaster Debris Management Plan | Public Works | Municipal budget | All Natural Hazards | Short-term | ES | High |
| **2026-SantaAna-FMP2** | Post Disaster Response Action Plan | Public Works | Municipal budget | All Natural Hazards | Short-term | ES | High |

| Action Number | Action | Lead Agency | Possible Funding Sources or Resources | Hazards of Concern | Timeline[a] | Project Category[b] | Priority (High, Med., Low) |
|---|---|---|---|---|---|---|---|
| **2026-SantaAna-FMP3** | Santa Ana River Inundation Mapping | Engineering Department and Public Works Department | USACE, FMA, HMGP, other FEMA | Riverine Flooding | TBD | PP | High |
| **2026-SantaAna-FMP4** | Establish a CRS Coordinator | Public Works | Municipal budget | All Natural Hazards | Short-term | PR | High |
| **2026-SantaAna-FMP5** | Rousselle Street Flood Protection Project | Public Works | Municipal budget | Riverine Flooding | Short-term | SP | High |

a. Timeline: Short-term = 1 to 5 years; Long-term = more than 5 years; Ongoing = Ongoing or Annual Projects
b. Project Category: PR = Prevention; PP = Property Protection; NRP = Natural Resource Protection; ES = Emergency Services; SP = Structural Projects; PI = Public Information/Outreach

Benefits are the savings from losses avoided attributed to the implementation of the project, and may include life-safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When available, the County provided the actual or estimated dollar value for project costs and associated benefits. Having defined costs and benefits allows a direct comparison of benefits versus costs, and a quantitative evaluation of project cost-effectiveness. Often, however, numerical costs and/or benefits have not been identified or may be impossible to quantitatively assess.

For the purposes of this planning process, the County was tasked with evaluating project cost-effectiveness with both costs and benefits assigned to “High,” “Medium,” and “Low” ratings. Where quantitative estimates of costs and benefits were available, ratings/ranges were defined as:

- Low: < $10,000
- Medium: $10,000 to $100,000
- High: > $100,000

Where quantitative estimates of costs and/or benefits were not available, qualitative ratings were provided using the following definitions:

- Costs
  - High—Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
  - Medium—The project could be implemented with existing funding but would require a reapportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
  - Low—The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.
- Benefits
  - High—Project will have an immediate impact on the reduction of risk exposure to life and property.
  - Medium—Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
  - Low—Long-term benefits of the project are difficult to quantify in the short-term.

Using this approach, projects with positive benefit versus cost ratios (such as high-over-high, high-over-medium, medium-over-low, etc.) are considered cost-beneficial and are prioritized accordingly.

For some of the actions identified by Orange County, the Steering Committee may seek financial assistance under FEMA’s Hazard Mitigation Assistance (HMA) or Hazard Management Grant Programs (HMGP). These programs require detailed benefit/cost analysis as part of the application process. These analyses will be performed when funding applications are prepared, using the FEMA benefit/cost analysis model process. The Steering Committee is committed to implementing mitigation strategies with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the Steering Committee reserves the right to define “benefits” according to parameters that meet its needs and the goals and objectives of this FMP.

## Prioritization

A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **High Priority**—A project that meets multiple objectives, has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for a grant program. High priority projects can be completed in the short-term (1 to 5 years). The key factors for high priority projects are that they have funding secured and can be completed in the short-term.
- **Medium Priority**—A project that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible. Project can be completed in the short-term once funding is secured. Medium priority projects will become high priority projects once funding is secured. The key factors for medium priority projects are that they are eligible for funding, but do not yet have funding secured, and they can be completed within the short-term.
- **Low Priority**—A project that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for FEMA grant funding, and for which the timeline for completion is long-term (1 to 10 years). Low priority projects may be eligible for grant funding from other programs. Low priority projects are “blue-sky” projects. How they will be financed is unknown, and they can be completed over a long-term.

Table 6-11 lists the priority of each action as assigned by the planning team, using the same parameters used in selecting the actions.

## Analysis of Mitigation Actions

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Mitigation types used for this categorization are as follows:

- **Prevention**—Government, administrative, or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about flood hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school- age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, and wetland restoration and preservation.
- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, levee setbacks, floodwalls, retaining walls, and safe rooms.

Table 6-10 presents the results of this analysis.

## Table 6-11. Prioritization of Mitigation Actions

| Project Number | Project Name | Scores for Evaluation Criteria | | | | | | | | | | | | | | | High / Medium / Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Life Safety | Property Protection | Cost-Effectiveness | Political | Legal | Fiscal | Environmental | Social Vulnerability | Administrative | Hazards of Concern | Climate Change | Timeline | Community Lifelines | Other Local Objectives | Total | |
| **2025-OC-FMP1** | Carbon Creek Channel (B01) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 11 | High |
| **2025-OC-FMP2** | Debris Booms Project (A01, A07, B01, F01) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 11 | High |
| **2025-OC-FMP3** | East Garden Grove-Wintersburg Channel (C05) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 11 | High |
| **2025-OC-FMP4** | San Juan Creek Channel (L01) Reach 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 10 | Medium |
| **2025-OC-FMP5** | San Juan Creek Channel (L01) Reach 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 11 | High |
| **2025-OC-FMP6** | San Juan Creek Channel (L01) Reach 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 11 | High |
| **2025-OC-FMP7** | Bolsa Bay Outlet Flood Control Improvements | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 10 | Medium |
| **2025-OC-FMP8** | Fullerton Creek Channel (A03) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 11 | High |
| **2025-OC-FMP9** | Santa Ana-Delhi Channel (F01) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-OC-FMP10** | Santa Ana River Channel Reach 5 Levee Height Correction (E01) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 11 | High |
| **2025-OC-FMP11** | Coordination with FEMA Region IX | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 12 | High |
| **2025-OC-FMP12** | Hydrology Manual Update | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 13 | High |

| Project Number | Project Name | Scores for Evaluation Criteria | | | | | | | | | | | | | | | High / Medium / Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Life Safety | Property Protection | Cost-Effectiveness | Political | Legal | Fiscal | Environmental | Social Vulnerability | Administrative | Hazards of Concern | Climate Change | Timeline | Community Lifelines | Other Local Objectives | Total | |
| **2025-OC-FMP13** | RL Properties East Garden Grove-Wintersburg Channel: LOMR Properties | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-OC-FMP14** | Evacuation for Flood and Post-Fire Debris Flows | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-OC-FMP15** | Prado Dam Mitigation | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-Anaheim-FMP1** | Substantial Damage Management Plan | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 12 | High |
| **2025-Anaheim-FMP2** | Fairview St. Roadway Elevation Feasibility | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 8 | Medium |
| **2025-Anaheim-FMP3** | Upsize Storm Drain System and Backflow Prevention Valve | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 11 | High |
| **2025-LagunaWoods-FMP1** | El Toro Road Green Street and Flood Relief Project | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 11 | High |
| **2025-LagunaWoods-FMP2** | Dam Failure Public Outreach | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 11 | High |
| **2025-LagunaWoods-FMP3** | Develop a Post Disaster Response Action Plan | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 11 | High |
| **2025-LagunaWoods-FMP4** | City Website Flood Risk Information | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 12 | High |
| **2025-LagunaWoods-FMP5** | Updates to the General Plan Safety Element and Local Hazard Mitigation Plan | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |

| Project Number | Project Name | Scores for Evaluation Criteria | | | | | | | | | | | | | | | High / Medium / Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Life Safety | Property Protection | Cost-Effectiveness | Political | Legal | Fiscal | Environmental | Social Vulnerability | Administrative | Hazards of Concern | Climate Change | Timeline | Community Lifelines | Other Local Objectives | Total | |
| **2025-LagunaWoods-FMP6** | Public Safety and Hazard Mitigation Webpage | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-LagunaWoods-FMP7** | City General Plan Conservation Element Update | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 13 | High |
| **2025-NewportBeach-FMP1** | Balboa Island Drainage Master Plan / Pump Station | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-NewportBeach-FMP2** | Big Canyon Restoration - Phase 3 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 9 | Medium |
| **2025-NewportBeach-FMP3** | Environmental Habitat Restoration - Monitoring and Maintenance | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 8 | Medium |
| **2025-NewportBeach-FMP4** | Newport Dunes Infiltration Basin | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 8 | Medium |
| **2025-NewportBeach-FMP5** | TMDL Compliance / Water Quality Improvements | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 7 | Medium |
| **2025-NewportBeach-FMP6** | Balboa Island Seawall | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-NewportBeach-FMP7** | Harbor & Ocean Bulkheads / Seawalls / Structure Repairs | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-NewportBeach-FMP8** | Newport Harbor-Wide Dredging | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 8 | Medium |

| Project Number | Project Name | Scores for Evaluation Criteria | | | | | | | | | | | | | | | High / Medium / Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Life Safety | Property Protection | Cost-Effectiveness | Political | Legal | Fiscal | Environmental | Social Vulnerability | Administrative | Hazards of Concern | Climate Change | Timeline | Community Lifelines | Other Local Objectives | Total | |
| **2025-NewportBeach-FMP9** | Tide Valve Replacement - Peninsula | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 8 | Medium |
| **2025-SanJuanCapistrano-FMP1** | CRS FEMA Training | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-SanJuanCapistrano-FMP2** | Public Floodplain Outreach | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-SanJuanCapistrano-FMP3** | Grant Funding Opportunity Summary | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-SanJuanCapistrano-FMP4** | Sea Level Rise Data and Modeling | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 10 | Medium |
| **2025-SanJuanCapistrano-FMP5** | Incorporate Coastal Flood into Planning | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | Low |
| **2025-SanJuanCapistrano-FMP6** | State Grant Manager Coordination | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | Low |
| **2025-SanJuanCapistrano-FMP7** | USACE H&H Modeling Training | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 10 | Medium |
| **2025-SanJuanCapistrano-FMP8** | Tsunami Ready: Public Outreach | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | Low |
| **2025-SanJuanCapistrano-FMP9** | Tsunami Evacuation Routes and Evacuation Plan | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 6 | Low |

| Project Number | Project Name | Scores for Evaluation Criteria | | | | | | | | | | | | | | | High / Medium / Low |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Life Safety | Property Protection | Cost-Effectiveness | Political | Legal | Fiscal | Environmental | Social Vulnerability | Administrative | Hazards of Concern | Climate Change | Timeline | Community Lifelines | Other Local Objectives | Total | |
| **2025-SanJuanCapistrano-FMP10** | Update Emergency Response Plan | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-SanJuanCapistrano-FMP11** | Regional Watershed Agency Coordination | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-SanJuanCapistrano-FMP12** | Storm Drain Master Plan | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 11 | High |
| **2025-SanJuanCapistrano-FMP13** | Emergency Warning System | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 11 | High |
| **2025-SantaAna-FMP1** | Disaster Debris Management Plan | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 12 | High |
| **2025-SantaAna-FMP2** | Post Disaster Response Action Plan | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 12 | High |
| **2025-SantaAna-FMP3** | Santa Ana River Inundation Mapping | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 | High |
| **2025-SantaAna-FMP4** | Establish a CRS Coordinator | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 | High |
| **2025-SantaAna-FMP5** | Rousselle Street Flood Protection Project | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 13 | High |

Note: Low (0-6), Medium (7-10), High (11-14).

# 7. PLAN MAINTENANCE PROCEDURES

This section details the formal procedures that ensure that the Floodplain Management Plan (FMP) remains a living document, one that is active, dynamic and relevant. The FMP maintenance procedures include a schedule for monitoring and evaluating the plan on an ongoing basis and producing an updated plan every 5 years. Additionally, this section will explain how the mitigation action plan (from Chapter 6) will be incorporated into existing planning mechanisms, including comprehensive plans, area specific plans, capital improvement program planning, various building, development, zoning, and subdivision codes, as well as code enforcement procedures. Given the critical nature of keeping the public involved in the plan maintenance process, this section will also outline how public participation is integrated into the FMP plan maintenance procedures. The format of this FMP allows sections to be reviewed and updated when new data becomes available, which effectively keeps the plan timely and relevant.

## 7.1 EVALUATING, AND UPDATING THE PLAN

This section presents the process by which the FMP document will be monitored and evaluated (CRS Step 10). The process will be summarized with the aid of an FMP annual evaluation schedule, showing how, when, and by whom the FMP monitoring and review process will take place. The schedule will include times and dates for FMP review, time(s) and date(s) for the adoption of an FMP Annual Report, as well as a description of how annual review revisions are incorporated into an updated FMP at the end of each Communities 5-year CRS Cycle. Also included in this section will be a description of how the County incorporates FMP revisions into other planning mechanisms (plans, regulations, capital programs, codes, etc.) when appropriate, and a discussion on how the County will continue public participation in the FMP maintenance process.

### 7.1.1 Monitoring

The Steering Committee will be responsible for monitoring progress and evaluating the effectiveness of the FMP as well as documenting annual progress. The FMP Steering Committee will meet at least quarterly to discuss floodplain management issues.

Understanding that individual commitments change over time, each member of the Steering Committee is responsible for informing the Orange County CRS Coordinator of any changes in participation by formal letter. The CRS Coordinator will strive to keep the Steering Committee a uniform representation of planning partners and stakeholders, such that at least half of the members of the Steering Committee come from outside Orange County government. The CRS Coordinator will maintain the current membership of the Steering Committee in publicly accessible County records.

The Steering Committee representatives will be expected to document the following, as needed and as appropriate:

- Flood-related hazard events and losses occurring in the County, including type of flooding hazard, the scope of the hazard impact, as well as the effects floodplain management actions have on reducing negative impacts and losses;
- Progress on the implementation of actions, solvency of existing sources of funding, and if needed, a summary of efforts to obtain funding outside the organization;
- Any obstacles or impediments to the implementation of actions;

- Additional actions that are believed to be appropriate and feasible; and
- Public and stakeholder input and comment on the FMP.

## 7.1.2 Evaluating

The evaluation of the FMP is an assessment of whether the planning process and actions have been effective, if the FMP goals are being reached, and whether changes are needed. The FMP will be evaluated on a quarterly basis to determine the effectiveness of the actions, and to reflect changes that may affect priorities or available funding. Quarterly Steering Committee meetings will include the following topics:

- Summary of any flood hazard events that occurred during the performance period and the impact these events had on the planning area;
- Review of mitigation success stories;
- Review of continuing public involvement;
- Brief discussion about why targeted strategies were not completed;
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding);
- Recommendations for new projects;
- Changes in or potential for new funding options (grant opportunities); and
- Impact of any other planning programs or initiatives that involve flood-related hazard mitigation.

The CRS Coordinator will prepare an annual progress report to document action updates to the FMP based on the quarterly plan review meetings. The progress report will be publicly available and should be:

- Posted on the Orange County website page dedicated to floodplain management;
- Provided to the local media through a press release;
- Presented to the Orange County Board of Commissioners to inform them of the progress of mitigation actions implemented during the reporting period;
- Provided to the public library; and
- Provided as part of the CRS annual re-certification package.
- The CRS Program requires an annual recertification to be submitted by August 1 of every calendar year for which the community has not received a formal audit. To meet this recertification date, the Steering Committee aims to complete progress reports between March and June each year. A progress report template is included in Appendix F.

## 7.1.3 Updating

Orange County intends to update the FMP on a 5-year cycle from the date of initial plan adoption (CRS Step 10). The 2025 CRS Coordinator's Manual states that the 5-year update must be submitted on October 1. Full updates of the FMP will be initiated in the fourth year following plan approval, to ensure that the updated FMP can be adopted prior to the existing FMP's expiration. This cycle may be accelerated to less than 5 years based on the following triggers:

- A Presidential Disaster Declaration that impacts the County;
- Implementation of a mitigation project that greatly modifies the flood hazard;

- A hazard event that causes loss of life; or
- Adoption of an update to the Orange County General Plan.

Updates to the FMP will, at a minimum, include the following elements:

- The update process will be convened through the FMP Steering Committee.
- The risk assessment will be reviewed and, if necessary, updated using the best available information and technologies.
- The action plan will be reviewed and revised to account for any actions completed, dropped, or changed and to account for changes in risk assessment or new policies identified under other planning mechanisms (such as the comprehensive plan).
- The draft update will be sent to appropriate agencies and organizations for comment.
- The public will be given an opportunity to comment on the update prior to adoption.
- The Orange County Board of Supervisors will adopt the updated plan.

## 7.2 PLAN IMPLEMENTATION

The effectiveness of the FMP depends on its implementation and incorporation of its action items into existing local plans, policies, and programs. Together, the action items in the FMP provide a framework for activities that the Orange County can implement over the next 5 years. The Steering Committee has established goals and objectives and has prioritized mitigation actions that will be implemented through existing plans, policies, and programs. Further, the sample adoption resolution (located in Appendix G) includes an item stating the intent of the County Board of Supervisors to incorporate the FMP as an integral component of government and partner operations.

The principal role of the Steering Committee in this plan maintenance strategy will be to review the progress reports and provide input to the CRS Coordinator on possible enhancements to be considered at the next update. Future plan updates will be overseen by the Steering Committee.

### 7.2.1 Incorporation Into Other Planning Mechanisms

Other planning processes and programs to be coordinated with the recommendations of the FMP include the following:

- Orange County Hazard Mitigation Plan (HMP)
- Orange County Emergency Operations Plan (EOP)
- Orange County Capital Improvement Plans (CIP)
- Orange County Ordinances and Codes (Flood, Stormwater, Site Development, Grading, Erosion Control, Subdivision, Site Development)
- Regional County Water Quality Improvement Plans
- Regional, County, or Municipal Stormwater Permit Compliance (NPDES Geneal Permit)

The 2021 Orange County Hazard Mitigation Plan addresses the hazards that face Orange County and the mitigation measures that can be used to mitigate the effects of those hazards (Orange County Sheriff's Department 2021). Since this plan covers all the hazards that threaten Orange County, this FMP can augment

what is presented in the hazard mitigation plan by addressing solely the flooding hazards of the county and the specific mitigation measures to address the flooding in the county.

The FMP can also complement the General Plan of Orange County. Chapter 9 of the General Plan covers the safety element of the plan and (like the Orange County Hazard Mitigation Plan) includes goals and objectives on addressing the flooding hazard in Orange County (OCPW 2025). The FMP can augment the General Plan much like the hazard mitigation plan by addressing the flood hazard in depth and providing specific mitigation measures. The General Plan and the FMP are complementary documents that work together to achieve the goal of reducing risk exposure. Update of the General Plan draft may trigger an update to the FMP. Orange County will create a link between the FMP and the General Plan by identifying a mitigation action and giving that action a high priority.

The Capital Improvement Program (CIP) for Orange County has several projects that address floodplain management in the county (OCPW 2026). The projects are structural in nature seeking to repair the structures that contain and convey the 1-percent annual change flood (100-year flood) (OCPW 2026). Since the CIP for Orange County focuses on the structural floodplain management measures, the FMP can provide the nonstructural floodplain management measures so that Orange County has access to the various mitigation measures that can mitigate the impact of flooding within the community.

Additionally, the County, through adoption of a flood damage prevention ordinance incorporated into the Orange County building code, is planning for the impact of flooding.

Some action items do not need to be implemented through regulation. Instead, they can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be incorporated during the update process.

## 7.3 CONTINUED PUBLIC INVOLVEMENT

The public will continue to be kept informed of the plan's progress through the Orange County Public Works Floodplain Management website (Orange County Public Works n.d.) and by providing copies of the progress reports to the media. The website will not only house the final plan and progress reports, but it will also become the one-stop shop for information regarding the plan and plan implementation. Copies of the plan and progress reports will be available at the Orange County Public Works and throughout the Orange County Public Library system.

The Orange County CRS Coordinator will be responsible for receiving, tracking, and filing public comments on the FMP. The public will have the opportunity to comment on the plan at the review meeting of the FMP and during the 5-year plan update. Additional meetings may also be held as deemed necessary by the Committee. The purpose of these meetings would be to provide an opportunity for the public to express concerns, opinions, and ideas about the plan.

During future FMP updates, a new public involvement strategy will be initiated based on guidance from the new Steering Committee established by the Orange County PPI Program. This PPI Program will be based on the needs and capabilities of Orange County at the time of the update. At a minimum, this PPI Program will include the use of local media outlets within Orange County.

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# APPENDIX A. ACRONYMS AND ABBREVIATIONS

This resource identifies the acronyms and abbreviations used in the Floodplain Management Plan.

**ACS—**American Community Survey

**ADA—**Americans with Disabilities Act

**ADU—**Alternative Dwelling Unit

**AMI—**Area Median Income

**ASDSO—**Association of State Dam Safety Officials

**ASCE—**American Society of Civil Engineers

**BFE—**Base Flood Elevation

**BRIC—**Building Resilient Infrastructure and Communities

**CADWR—**California Department of Water Resources

**Cal OES—**California Office of Emergency Services

**CCC—**California Coastal Commission

**CCR—**California Code of Regulations

**CDC—**Center for Disease Control and Prevention

**CDBG—**Community Development Block Grant

**CDBG-DR—**Community Development Block Grant—Disaster Recovery

**CEQA—**California Environmental Quality Act

**CERT—**Community Emergency Response Team

**CFM—**Certified Floodplain Manager

**CFR—**Code of Federal Regulations

**CGS—**California Geologic Survey

**CIP—**Capital Improvement Program

**CMP—**Coastal Management Program

**COSMOS—**Coastal Storm Modeling System

**CRS—**Community Rating System

**CSC—**Climate Smart Communities

**CWRCB—**California Water Resources Control Board

**DPW—**Department of Public Works

**DMA 2000—**Disaster Mitigation Act of 2000

**DR—**Major Disaster Declaration (FEMA)

**DSOD—**Division of Safety of Dams (CADWR)

**EAP—**Emergency Action Plan

**EM—**Emergency Declaration (FEMA)

**EMI—**Emergency Management Institute

**EMS—**Emergency Medical Services

**EOP—**Emergency Operations Plan

**EPA—**U.S. Environmental Protection Agency

**ES—**Emergency Services

**ESRI—**Earth Systems Research Institute (GIS software developer)

**EWP—**Emergency Watershed Protection Program

**FEMA—**Federal Emergency Management Agency

**FDR—**Flood Damage Reduction

**FHWA—**Federal Highways Administration

**FIRM—**Flood Insurance Rate Map

**FIA—**Flood Insurance Assessment

**FIS—**Flood Insurance Study

**FMA—**Flood Mitigation Assistance

**FMP—**Floodplain Management Plan

**FTA—**Federal Transit Authority**—**

**GIS—**Geographic Information System

**HEC-RAS—**Hydrologic Engineering Center's River Analysis System (USACE)

**HMA—**Hazard Mitigation Assistance

**HMGP—**Hazard Mitigation Grant Program

**HMP—**Hazard Mitigation Plan

**HUC—**Hydrologic Unit Code

**HUC-8—**Hydrologic Unit Code—8 Digit (Watershed)

**HUC-10—**Hydrologic Unit Code—10 Digit (Sub-watershed)

**HUD—**Housing and Urban Development

**IA—**Individual Assistance

**ISO—**Insurance Services Office

**IRWM—**Integrated Regional Water Management

**LiMWA—**Limit of Moderate Wave Action

**LPP—**Locally Preferred Plan

**MiWA—**Minimal Wave Action area

**MPH—**Miles per Hour

**MoWA—**Moderate Wave Action Area

**MSA—**Metropolitan Statistical Area

**MWDOC—**Municipal Water District of Orange County

**NAS—**National Academy of Science

**NASA—**National Aeronautics and Space Administration

**NAVD—**North American Vertical Datum of 1988

**NCEI—**National Centers for Environmental Information

**NFIP—**National Flood Insurance Program

**NGVD—**National Geodetic Vertical Datum

**NLCD—**National Land Cover Dataset

**NOAA—**National Oceanic and Atmospheric Administration

**NOS—**National Ocean Service (NOAA)

**NRCS—**Natural Resources Conservation Service

**NRP—**Natural Resources Protection

**NWS—**National Weather Service

**OCFCD—**Orange County Flood Control District

**OCOF—**Our Coast Our Future (GIS data viewing interface)

**OCPW—**Orange County Public Works

**OEHHA—**Office of Environmental Health Hazard Assessment (CA)

**OMB—**Office of Management and Budget

**PA—**Public Assistance

**PDM—**Pre-Disaster Mitigation Program

**PP—**Property Protection

**PI—**Public Information/Outreach

**PR—**Preventive Measures

**RCV—**Replacement Cost Value

**RL—**Repetitive Loss

**RLAA—**Repetitive Loss Area Analysis

**RWQCB—**Regional Water Quality Control Board

**SBA—**Small Business Administration

**SCWRP—**Southern California Wetlands Recovery Project

**SFHA—**Special Flood Hazard Area

**SHMO—**State Hazard Mitigation Officer

**SP—**Structural Projects

**SRL—**Severe Repetitive Loss

**USACE—**U.S. Army Corps of Engineers

**USCB—**U.S. Census Bureau

**USFWS—**U.S. Fish and Wildlife Service

**USGS—**U.S. Geological Survey

**WMA—**Water Management Area

# APPENDIX B. GLOSSARY

**0.2% flood (500-year flood)**—A flood that has a 0.2-percent chance of being equaled or exceeded in any one year.

**1% flood (100-year flood)**—A flood that has a 1-percent chance of being equaled or exceeded in any given year. This flood event is also referred to as the base flood. The term “100-year flood” can be misleading; it is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1- percent chance of being equaled or exceeded each year. Therefore, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the National Flood Insurance Program (NFIP) as the standard for floodplain management to determine the need for flood insurance.

**Asset—**Any man-made or natural feature that has value, including but not limited to people, buildings, infrastructure (such as bridges, roads, and sewer and water systems), and lifelines (such as electricity and communication resources or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks).

**At-Risk—**Exposure values that include the entire building inventory value in census blocks that lie within or border the inundation areas or any area potentially exposed to a hazard based on location.

**Base Flood—**Flood that has a 1-percent probability of being equaled or exceeded in any given year. It is also known as the 100-year flood.

**Base Flood Elevation—**Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The BFE is used as the standard for the National Flood Insurance Program.

**Benefit—**Net project outcomes, usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of conducting a benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including a reduction in expected property losses (building, content, and function) and protection of human life.

**Benefit-cost analysis (BCA)—**Benefit-cost analysis is a systematic, quantitative method of comparing the projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

**Building—**A structure that is walled and roofed, principally aboveground and permanently fixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

**Building Codes—**Regulations that set forth standards and requirements for construction, maintenance, operation, occupancy, use, or appearance of buildings, premises, and dwelling units. Building codes can include standards for structures to withstand natural disasters.

**Capability Assessment—**An assessment that provides a description and analysis of a community or state’s current capacity to address the threats associated with hazards. The capability assessment attempts to identify and evaluate existing policies, regulations, programs, and practices that positively or negatively affect the community or state’s vulnerability to hazards or specific threats.

**Climate—**The meteorological elements, including temperature, precipitation, and wind, that characterizes the general conditions of the atmosphere over a period of time (typically 30-years) for a particular region.

**Community Lifeline—**A subset of critical facilities that are fundamental services and systems that support a community's ability to survive and recover from disasters. A lifeline enables the continuous operation of critical business and government functions and is essential to human health and safety or economic security.

**Community Rating System (CRS)—**CRS is a program that provides incentives for National Flood Insurance Program communities to complete activities that reduce flood hazard risk. When the community completes specific activities, the insurance premiums of these policyholders in communities are reduced.

**Comprehensive Plan—**A document, also known as a "general plan," covering the entire geographic area of a community and expressing community goals and objectives. The plan lays out the vision, policies, and strategies for the future of the community, including all of the physical elements that will determine the community's future development. This plan can discuss the community's desired physical development, desired rate and quantity of growth, community character, transportation services, location of growth, and siting of public facilities and transportation. In most states, the comprehensive plan has no authority in and of itself but serves as a guide for community decision-making.

**Critical Facility—**Facilities that are critical to the health and welfare of the population and that are especially important following a hazard.

**Debris—**The scattered remains of assets broken or destroyed during the occurrence of a hazard. Debris caused by a wind or water hazard event can cause additional damage to other assets.

**Digital Elevation Model—**U.S. Geological Survey (USGS) Digital Elevation Model data files that are digital representations of cartographic information in a raster form. These include a sampled array of elevations for a number of ground positions at regularly spaced intervals. These digital cartographic/geographic data files are produced by USGS as part of the National Mapping Program.

**Disaster Mitigation Act of 2000 (DMA 2000)—**Law that requires and rewards local and state pre-disaster planning, promotes sustainability as a strategy for disaster resistance, and is intended to integrate state and local planning with the aim of strengthening state-wide mitigation planning.

**Essential Facility—**A facility that is important to ensure a full recovery of a community or state following the occurrence of a hazard. These facilities can include government facilities, major employers, banks, schools, and certain commercial establishments (such as grocery stores, hardware stores, and gas stations). For the Otsego County risk assessment, this category was defined to include schools, colleges, shelters, adult living and adult care facilities, medical facilities and health clinics, hospitals.

**Exposure—**The number and dollar value of assets that are considered to be at risk during the occurrence of a specific hazard.

**Extent—**The size of an area affected by a hazard or the occurrence of a hazard.

**Flash Flood—**A flood occurring with little or no warning where water levels rise at an extremely fast rate.

**Flood—**A general and temporary condition of partial or complete inundation of normally dry land areas resulting from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

**Flood Depth—**Height of the flood water surface above the ground surface.

**Flood Elevation—**Height of the water surface above an established datum (for example, the National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or mean sea level).

**Flood Hazard Area—**Area shown to be inundated by a flood of a given magnitude on a map.

**Flood Insurance Rate Map (FIRM)—**Map of a community, prepared by the FEMA that shows both the special flood hazard areas and the risk premium zones applicable to the community.

**Flood Insurance Study (FIS)—**A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.

**Flood Mitigation Assistance (FMA) Program—**A program created as a part of the National Flood Insurance Report Act of 1994. FMA provides funding to assist communities and states in implementing actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other NFIP insurance structures, with a focus on repetitive loss properties.

**Flood Polygon—**A geographic information system vector file outlining the area exposed to the flood hazard. Hazus generates this polygon at the end of the flood computations in order to analyze the inventory at risk.

**Floodplain—**Any land area, including a watercourse, susceptible to partial or complete inundation by water from any source.

**Floodplain Management**—A community-based effort to prevent or reduce the risk of flooding, resulting in a more resilient community.

**Frequency—**A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average and would have a 1-percent chance of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.

**Geographic Information Systems (GIS)—**A computer software application that relates data regarding physical and other features on the earth to a database to be used for mapping and analysis.

**Geology—**The scientific study of the earth, including its composition, structure, physical properties, and history.

**GIS Shape Files—**A type of GIS vector file developed by ESRI for their ArcView software. This type of file contains a table and a graphic. The records in the table are linked to corresponding objects in the graphic.

**Goals**—General guidelines that explain what you want to achieve. They are usually broad policy-type statements, long term in nature, and represent global visions.

**Hazard—**A source of potential danger or an adverse condition that can cause harm to people or cause property damage. For this risk assessment, priority hazards were identified and selected for the pilot project effort. A natural hazard is a hazard that occurs naturally (such as flood, wind, and earthquake). A man-made hazard is one that is caused by humans (for example, a terrorist act or a hazardous material spill). Hazards are of concern if they have the potential to harm people or property.

**Hazard Identification—**The process of identifying hazards that threaten an area.

**Hazard Mitigation—**Sustained actions taken to reduce or eliminate the long-term risk and effects that can result from the occurrence of a specific hazard. For example, building a retaining wall can protect an area from flooding.

**Hazard Mitigation Grant Program (HMGP)**—Authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, HMGP is administered by FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.

**Hazard Mitigation Plan**—A collaborative document in which hazards affecting the community are identified, vulnerability to hazards assessed, and consensus reached on how to minimize or eliminate the effects of these hazards.

**Hazard Profile—**A description of the physical characteristics of a hazard, including a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

**Hazardous Material Facilities—**Facilities housing industrial and hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins.

**Hazus**—A GIS-based nationally standardized earthquake, flood, and wind loss estimation tool developed by FEMA.

**High Potential Loss Facilities**—Facilities that would have a high loss associated with them, such as nuclear power plants, dams, and military installations.

**Hurricane—**An intense tropical cyclone, formed in the atmosphere over warm ocean areas, in which wind speeds reach 74 miles-per-hour or more and blow in a large spiral around a relatively calm center or “eye.” Hurricanes develop over the North Atlantic Ocean, northeast Pacific Ocean, or the South Pacific Ocean (east of 160°E longitude). Hurricane circulation is counter-clockwise in the Northern Hemisphere and clockwise in the Southern Hemisphere.

**Hydraulics—**That branch of science, or of engineering, which addresses fluids (especially, water) in motion, its action in rivers and canals, the works and machinery for conducting or raising it, its use as a prime mover, and other fluid-related areas.

**Infrastructure—**The public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, transportation system (such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways, canals, locks, seaports, ferries, harbors, dry docks, piers and regional dams).

**Intensity—**A measure of the effects of a hazard occurring at a particular place.

**Inventory—**The assets identified in a study region. It includes assets that can be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

**Level 1 Analysis—**A Hazus analysis that yields a rough estimate or preliminary analysis based on the nationwide default database included in Hazus. A Level 1 analysis is a great way to begin the risk assessment process and prioritize high-risk communities without collecting or using local data.

**Level 2 Analysis—**A Hazus analysis that requires the input of additional or refined data and hazard maps that will produce more accurate risk and loss estimates. Assistance from local emergency management personnel, city planners, GIS professionals, and others may be necessary for this level of analysis.

**Level 3 Analysis—**A Hazus analysis that yields the most accurate estimate of loss and typically requires the involvement of technical experts such as structural and geotechnical engineers who can modify loss parameters based on the specific conditions of a community. This level analysis will allow users to supply their own techniques to study special conditions such as dam breaks and tsunamis. Engineering and other expertise is needed at this level.

**Lifelines—**Specified sub-set of critical facilities that include utility systems (potable water, wastewater, oil, natural gas, electric power facilities and communication systems) and transportation systems (airways, bridges, roads, tunnels and waterways).

**Loss Estimation—**The process of assigning hazard-related damage and loss estimates to inventory, infrastructure, lifelines, and population data. Hazus can estimate the economic and social loss for specific hazard occurrences. Loss estimation is essential to decision making at all levels of government and provides a basis for developing mitigation plans and policies. It also supports planning for emergency preparedness, response, and recovery.

**Lowest Floor—**Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure. For the Hazus flood model, this information can be used to assist in assessing the damage to buildings.

**Magnitude—**A measure of the strength of a hazard occurrence. The magnitude (also referred to as severity) of a given hazard occurrence is usually determined using technical measures specific to the hazard. For example, ranges of wind speeds are used to categorize tornados.

**Major Disaster Declarations**—Post-disaster status requested by a state's governor when local and state resources are not sufficient to meet disaster needs. It is based on the damage assessment, and an agreement to commit state funds and resources to the long-term recovery. The event must be clearly more than the state or local government can handle alone.

**Mitigation Actions—**Specific actions that help you achieve your goals and objectives.

**Mitigation Goals—**General guidelines that explain what you want to achieve. They are usually broad policy- type statements, long term, and represent global visions.

**Mitigation Objectives—**Strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.

**Mitigation Plan—**A plan that documents the process used for a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in a state or community. The plan includes a description of actions to minimize future vulnerability to hazards. This plan should be developed with local experts and significant community involvement.

**National Flood Insurance Program (NFIP)—**Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 Code of Federal Regulations (CFR) §60.3.

**Objectives—**Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.

**Occupancy Classes—**Categories of buildings used by Hazus (for example, commercial, residential, industrial, government, and "other").

**Ordinance—A term for a law or regulation adopted by local government.**

**Planning—**The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.

**Post-disaster mitigation—**Mitigation actions taken after a disaster has occurred, usually during recovery and reconstruction.

**Preparedness—**Actions that strengthen the capability of government, residents, and communities to respond to disasters.

**Presidential Disaster Declaration—**A post-disaster status that puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities in the areas of human services, public assistance (infrastructure support), and hazard mitigation. If declared, funding comes from the President's Disaster Relief Fund and disaster aid programs of other participating federal agencies.

**Probability—**A statistical measure of the likelihood that a hazard event will occur.

**Provided Data—**The databases included in the Hazus software that allow users to run a preliminary analysis without collecting or using local data.

**Public Education and Outreach Programs—**Any campaign to make the public more aware of hazard mitigation and mitigation programs, including hazard information centers, mailings, public meetings, etc.

**Recovery—**The actions taken by an individual or community after a catastrophic event to restore order and lifelines in the community.

**Recurrence Interval—**The average time between the occurrences of hazardous events of similar size in a given location. This interval is based on the probability that the given event will be equaled or exceeded in any given year.

**Regulation—**Most states have granted local jurisdictions broad regulatory powers to enable the enactment and enforcement of ordinances that deal with public health, safety, and welfare. These include building codes, building inspections, zoning, floodplain and subdivision ordinances, and growth management initiatives.

**Repetitive Loss Property—**A property that is currently NFIP insured for which two or more flood insurance claims (occurring more than 10 days apart) of more than $1,000 each have been paid by the NFIP within any 10-year period since 1978 Note: The term SRL property can refer to a given building, the contents within said building, or both the building and the contents within it.

**Replacement Value—**The cost of rebuilding a structure. This cost is usually expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality.

**Resolutions—**Expressions of a governing body's opinion, will, or intention that can be executive or administrative in nature. Most planning documents must undergo a council resolution, which must be supported in an official vote by a majority of representatives to be adopted. Other methods of making a statement or announcement about a particular issue or topic include proclamations or declarations.

**Resources—**Resources include the people, materials, technologies, money, etc., required to implement strategies or processes. The costs of these resources are often included in the budget.

**Risk—**The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

**Risk Assessment—**A methodology used to assess potential exposure and estimated losses associated with priority hazards. The risk assessment process includes four steps: (1) identifying hazards, (2) profiling hazards, (3) conducting an inventory of assets, and (4) estimating losses.

**Risk Factors—**Characteristics of a hazard that contribute to the severity of potential losses.

**Riverine—**Of or produced by a river (for example, a riverine flood is one that is caused by a river overflowing its banks).

**Scale—**A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

**Scour—**Removal of soil or fill material by the flow of floodwaters. This term is frequently used to describe storm-induced, localized, conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

**Severe Repetitive Loss (SRL) Property—** structure that is currently insured by an NFIP policy that has incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or For which at least two separate claims payments (building payments only) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the building. Note: The term SRL property can refer to a given building, the contents within said building, or both the building and the contents within it.

**Social Vulnerability**—Social vulnerability is the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood.

**Special Flood Hazard Area (SFHA)—**An area within a floodplain having a 1-percent or greater chance of flood occurrence in any given year (that is, the 100-year or base flood zone); represented on FIRMs as darkly shaded areas with zone designations that include the letter "A" or "V."

**Stafford Act—**The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law (PL) 100- 107 was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

**Stakeholder—**Stakeholders are individuals or groups, including businesses, private organizations, and residents, that will be affected in any way by an action or policy.

**State Hazard Mitigation Officer (SHMO)—**The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

**Structure—**Something constructed (for example, a residential or commercial building).

**Substantial Damage—**Damage of any origin sustained by a structure in a SFHA, for which the cost of restoring the structure to its pre-hazard event condition would equal or exceed 50 percent of its pre-hazard event market value.

This resource provides definitions for terms used in or support the Floodplain Management Plan. These are based on documents included in the reference section, with modifications as appropriate to address the Orange County specific identifications and requirements.

**Topographic—**Map that shows natural features and indicate the physical shape of the land using contour lines based on land elevation. These maps also can include man-made features.

**Transportation Systems—**One of the lifeline system categories. This category includes airways (airports, heliports, highways), bridges, tunnels, roadbeds, overpasses, transfer centers; railways (tracks, tunnels, bridges, rail yards, depots), and waterways (canals, locks, seaports, ferries, harbors, dry docks, piers).

**Tropical Cyclone—**A generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters containing a warm core of low barometric pressure which typically produces heavy rainfall, powerful winds and storm surge.

**Tropical Depression—**An organized system of clouds and thunderstorms with a defined surface circulation and maximum sustained winds of less than 38 mph. It has no “eye”(the calm area in the center of the storm) and does not typically have the organization or the spiral shape of more powerful storms.

**Tropical Storm—**An organized system of strong thunderstorms with a defined surface circulation and maximum sustained wind between 39 to 73 mph.

**Utility Systems—**One of the lifeline systems categories. This category includes potable water, wastewater, oil, natural gas, electric power facilities and communication systems.

**Vulnerability—**Description of how exposed or susceptible an asset is to damage. This value depends on an asset’s construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. If an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect affects can be much more widespread and damaging than direct affects.

**Vulnerability Assessment—**Evaluation of the extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard occurrences on the existing and future built environment.

**Watershed—**Area of land that drains down gradient (from areas of higher land to areas of lower land) to the lowest point; a common drainage basin. The water moves through a network of drainage pathways, both underground and on the surface. Generally, these pathways converge into streams and rivers, which become progressively larger as the water moves downstream, eventually reaching an estuary, lake, or ocean.

**Zone—**A geographical area shown on a National FIRM that reflects the severity or type of flooding in the area.

**Zoning Ordinance—**Designation of allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

# APPENDIX C. FEMA COMMUNITY RATING SYSTEM (CRS) ACTIVITY 510

For CRS credit requirements, at the time of a CRS modification and/or CRS Cycle Verification, a copy of the adopted plan, resolution, and CRS 510 checklist will be required for credit consideration.

| Manual Version: Insert version | | Community: Insert Community Name) | |
|---|---|---|---|
| **510 FLOODPLAIN MANAGEMENT PLANNING** | | Insert Name of Plan | |
| **512.a Floodplain Management Planning (FMP)** | | | |
| **Credit Points:** *Enter the section or page number in the plan where each credited item can be found. Add notes on AW-510-4.* | | | |
| **CRS Step** | **Section/Page** | **Item Score** | **Step Total** |
| 1. Organize to prepare the plan. (15 Max) | | | |
| a. Involvment of Office Responsible for Community Planning (4) | | | |
| b. Planning committee of department staff (9) | | | |
| c. Process formally created by the community's governing board (2) | | | |
| 2. Involve the public. (120 Max) | | | |
| a. Planning process conducted through a planning committee (60) | | | |
| b. Public meetings held at the beginning of the planning process (15) | | | |
| c. Public meeting held on draft plan (15) | | | |
| d . Other public information activities to encourage input (Up to 30) | | | |
| 3. Coordinate with other agencies. (35 Max) | | | |
| a. Review of existing studies and plans (required) (5) | | | |
| b.Coordinating with communities and other agencies ( Up to 30) | | | |
| 4. Assess the hazard. (Max 35) | | | |
| a. Plan includes an assessment of the flood hazard (REQUIRED) with: | | | |
| (1) A map of known flood hazards (5) | | | |
| (2) A description of known flood hazard (5) | | | |
| (3) A discussion of past floods (5) | | | |
| b. Plan includes assessment of less frequent floods (10) | | | |
| c. Plan includes assessment of areas likely to flood (5) | | | |
| d. The plan describes other natural hazards (REQUIRED FOR DMA) (5) | | | |

| **CRS Step** | **Section/Page** | **Score** | **Total** |
|---|---|---|---|
| 5. Assess the problem. (Max 52) | | | |
| a. Summary of each hazard identified in the hazard assessment and their community impact (REQUIRED) (2) | | | |
| b. Description of the impact of the hazards on: (Max 25) | | | |
| (1) Life, safety, health, procedures for warning and evacuation (5) | | | |
| (2) Public health including health hazards to floodwaters/mold (5) | | | |
| (3) Critical facilities and infrastructure (5) | | | |
| (4) The community's economy and tax base (5) | | | |
| (5) Number and type of affected buildings (5) | | | |
| **c. Review of all damaged buildings/flood insurance claims (5) | | | |
| d. Areas that provide natural floodplain functions (5) | | | |
| e. Development/redevelopment/Population Trends (7) | | | |
| f. Impact of future flooding conditions outlined in Step 4, item c (8) | | | |
| ** RL Category: (Insert A, B or C) | | | |
| 6. Set goals. (required) (2) | | | |
| 7. Review possible activities. (Max 35) | | | |
| a. Preventive activities (5) | | | |
| b. Floodplain Management Regulatory/current & future conditions (5) | | | |
| c. Property protection activities (5) | | | |
| d. Natural resource protection activities (5) | | | |
| e. Emergency services activities (5) | | | |
| f. Structural projects (5) | | | |
| g . Public information activities (5) | | | |

| CRS Step | Section/Page | Score | Total |
|---|---|---|---|
| 8. Draft an action plan. (Max 60) | | | |
| a. Actions must be prioritized (required) | | | |
| 1. Recommendations for activities from two of the six categories (10) | | | |
| 2. Recommendations for activities from three of the six categories (20) | | | |
| 3. Recommendations for activities from four of the six categories (30) | | | |
| 4. Recommendations for activities from five of the six categories (45) | | | |
| b. Post-disaster mitigation policies and procedures (10) | | | |
| c. Action items for mitigation of other hazards (5) | | | |
| 9. Adopt the plan. (2) | (Insert date of adoption) | | |
| 10. Implement, evaluate and revise.(Max 26) | | | |
| a. Procedures to monitor and recommend revisions (required) (2) | | | |
| b. Same planning committee or successor committee that qualifies under Section 511.a.2 (a) does the evaluation (24) | | | |
| | | FMP= | |

**Notes/Comments: Note if step 5c is missed, or if score is capped at 50 points, reference FEMA approval**

# APPENDIX D. MEETING DOCUMENTATION

## FMP STEERING COMMITTEE MEMBERSHIP

| Name | Organization | 1st Alternate | 2nd Alternate | 3rd Alternate |
|---|---|---|---|---|
| ***Government Representatives*** | | | | |
| Keith Linker | City of Anaheim | William Grigsby | Jannine Wilmoth | Charles Guiam |
| Nadia Cook | City of Laguna Woods | Chris Macon | - | - |
| Melissa Kubischta | City of Newport Beach | Tonee Thai | - | - |
| Shawn Mousavi | City of San Juan Capistrano | Justin Inducil | Paul Meshkin | Noreen Swiontek |
| Jason Kwak | City of Santa Ana | Tung Le | - | - |
| Joyce Drysdale* | Unincorporated Orange County | Giatho Tran* | - | - |
| ***Non-Government Representatives*** | | | | |
| Jayme Laber | NOAA | - | - | - |

* = Voting Member

## FMP Meetings Summary

| Date | Meeting Title | Purpose of Meeting |
|---|---|---|
| **April 24, 2024** | Core Planning Team Meeting | Coordinate and discuss FMP development, Steering Committee membership, PPI, RLAA, and public outreach strategy |
| **August 14, 2024** | FMP Overview & Steering Committee Kick-Off Meeting | Overview of FMP Process, Scope of Project, Detailed discussion on RLAA PPI, and structure of participants across all groups (Core Planning Team, Steering Committee, General Public, FEMA/ISO). |
| **October 23, 2024** | FMP Question & Answer Meeting | Informational meeting on FMP, Project Organization, Steering Committee responsibilities, schedule of plan phases. |
| **January 29, 2025** | Goal Setting and Objectives Review Meeting | Informational meeting on FMP, Program for Public Information (PPI), goal setting, and solicit feedback on revisions to goals and objectives. |
| **April 30, 2025** | Risk Assessment / Mitigation Action Workshop | Review risk assessment results, identify mitigation strategies, develop new mitigation actions. |
| **May – July, 2025** | Jurisdictional Mitigation Action “1-on-1” Meeting(s) | Individual meetings with FMP participating jurisdictions to review mitigation catalog(s), and to collect additional information for the FMP. |
| **August 25, 2025** | Public Open House #1 | Review Draft FMP, answer questions and receive feedback on the FMP for review, consideration, and potential change to the FMP draft. |
| **August 25, 2025** | Public Open House #2 | Review Draft FMP, answer questions and receive feedback on the FMP for review, consideration, and potential change to the FMP draft. |
| **August 26, 2025** | Public Open House #3 | Review Draft FMP, answer questions and receive feedback on the FMP for review, consideration, and potential change to the FMP draft. |

# MEETING NO. 1–AGENDA

## ORANGE COUNTY FLOODPLAIN MANAGEMENT PLAN (FMP) CORE PLANNING TEAM (CPT) MEETING

**Wednesday, April 24th 2024 | 9:30 AM – 11:00 AM PST**

1. **Introductions—CPT Composition**
2. **Comprehensive Floodplain Management Overview**
3. **Phase 1 Standing**
4. **Phase 2 Direction**
5. **Tasks**
6. **Phase 2 Schedule**

**Orange County Public Works**
**Orange County Floodplain Management Plan – Phase 2**
Core Planning Team Kick Off Meeting
Wednesday, April 24, 2024, 9:30 a.m. to 11 a.m. PST

OC Public Works

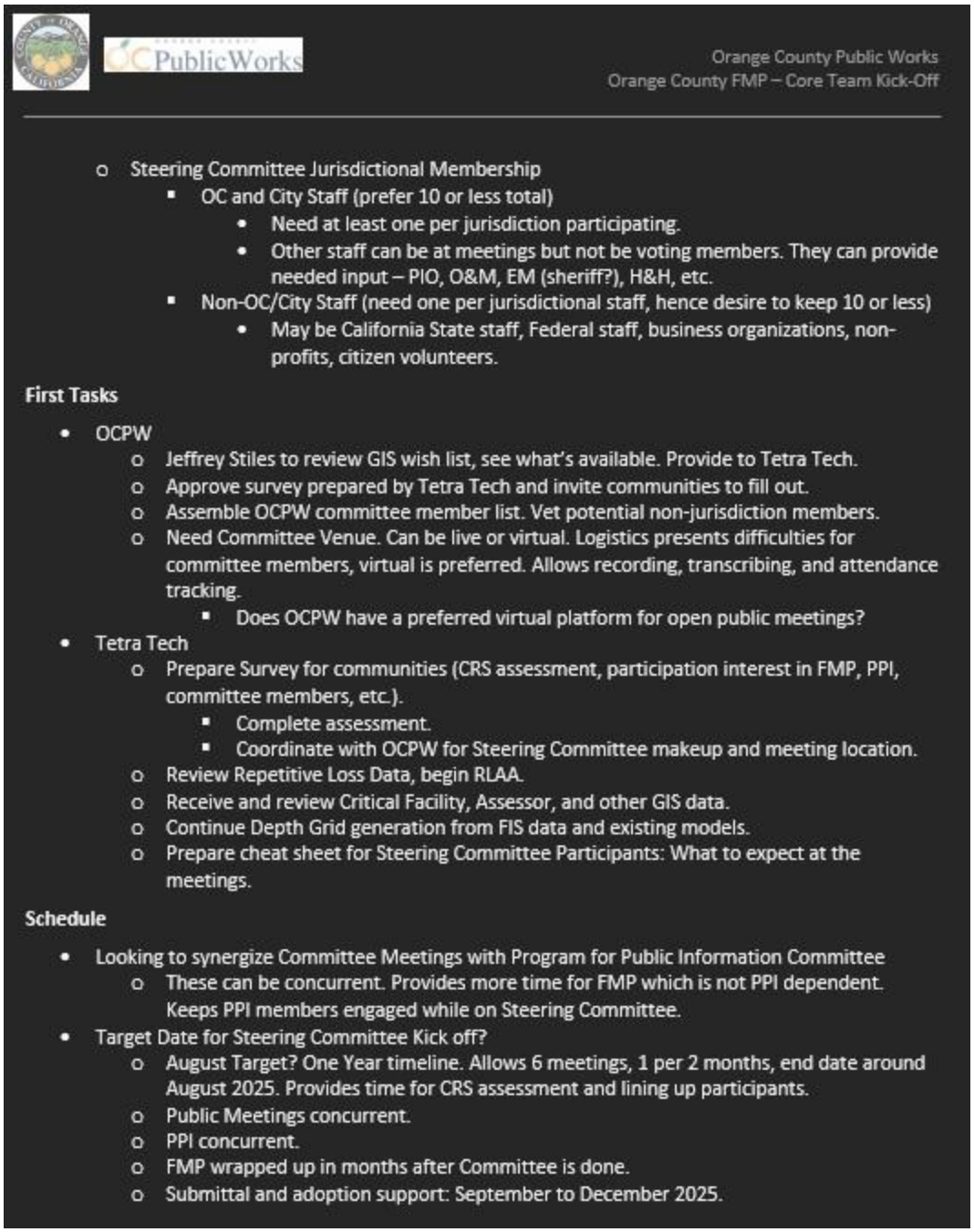
**The Core Planning Team Members at Kick Off**

| | | | |
|---|---|---|---|
| 1 | Tho Tran | OCPW | Giatho.Tran@ocpw.ocgov.com |
| 2 | Joyce Drysdale | OCPW | Joyce.Drysdale@ocpw.ocgov.com |
| 3 | Steve Parker | Tetra Tech | Steve.Parker@tetratech.com |
| 4 | Melissa Mitchell | Tetra Tech | Melissa.Mitchell@tetratech.com |
| 5 | Emma Kilkelly | Tetra Tech | Emma.Kilkelly@tetratech.com |

**Welcome and Introductions**

**Agenda Items**

- Who else to include on these Team Meetings?
- Comprehensive Floodplain Management Plan Overview
  - Original Two-Part Effort. Normally a single effort.
    - Phase 1: Groundwork for Phase 2
      - Programmatic Review and CRS Report
      - Acquire and Format Data
      - RLAA Analysis
      - Determine Steering Committee Makeup for Phase 2
    - Phase 2: Develop FMP
      - FMP: 10 Steps. RLA: 5 Steps. PPI: Steps?
      - Specifically covers Unincorporated OC, all willing OC CRS participating communities, entire Westminster Watershed, Santa Ana River right of way, and Santiago Creek.
      - The Steering Committee provides input and community feedback.
      - Public Meetings
      - Develop Plan
- Phase 1 Standing: Ended at end of contract deadline.
  - Draft Programmatic Review and CRS Report
    - City Codes or Regs specific to flood
    - Querying communities for contacts and participation
  - Repetitive Loss Data acquired by OCPW from FEMA
  - OCPW squared away acquisition of Housing Stock/Assessor Data
  - Some depth grid formatting/preparation.
- Phase 2 Direction
  - Prepare Community Survey to streamline re-launch of effort:
    - Finalizing Review and CRS Report
    - Community FMP participation interest and long-term commitment
      - Steering Committee
      - Program for Public Information
      - Regular 5-year updates
  - Data Acquisition for HAZUS
    - Countywide Critical Facilities
    - Countywide Assessor and Parcel Database (reviewing)



Orange County Public Works
Orange County FMP – Core Team Kick-Off

- Steering Committee Jurisdictional Membership
  - OC and City Staff (prefer 10 or less total)
    - Need at least one per jurisdiction participating.
    - Other staff can be at meetings but not be voting members. They can provide needed input – PIO, O&M, EM (sheriff?), H&H, etc.
  - Non-OC/City Staff (need one per jurisdictional staff, hence desire to keep 10 or less)
    - May be California State staff, Federal staff, business organizations, non-profits, citizen volunteers.

**First Tasks**

- OCPW
  - Jeffrey Stiles to review GIS wish list, see what's available. Provide to Tetra Tech.
  - Approve survey prepared by Tetra Tech and invite communities to fill out.
  - Assemble OCPW committee member list. Vet potential non-jurisdiction members.
  - Need Committee Venue. Can be live or virtual. Logistics presents difficulties for committee members, virtual is preferred. Allows recording, transcribing, and attendance tracking.
    - Does OCPW have a preferred virtual platform for open public meetings?
- Tetra Tech
  - Prepare Survey for communities (CRS assessment, participation interest in FMP, PPI, committee members, etc.).
    - Complete assessment.
    - Coordinate with OCPW for Steering Committee makeup and meeting location.
  - Review Repetitive Loss Data, begin RLAA.
  - Receive and review Critical Facility, Assessor, and other GIS data.
  - Continue Depth Grid generation from FIS data and existing models.
  - Prepare cheat sheet for Steering Committee Participants: What to expect at the meetings.

**Schedule**

- Looking to synergize Committee Meetings with Program for Public Information Committee
  - These can be concurrent. Provides more time for FMP which is not PPI dependent. Keeps PPI members engaged while on Steering Committee.
- Target Date for Steering Committee Kick off?
  - August Target? One Year timeline. Allows 6 meetings, 1 per 2 months, end date around August 2025. Provides time for CRS assessment and lining up participants.
  - Public Meetings concurrent.
  - PPI concurrent.
  - FMP wrapped up in months after Committee is done.
  - Submittal and adoption support: September to December 2025.

# MEETING NO. 2—AGENDA

## ORANGE COUNTY FLOODPLAIN MANAGEMENT PLAN (FMP) Q&A MEETING

**Wednesday, August 14, 2024**

1. **Introductions**
2. **Project Scope and Review**
3. **Project Schedule**
4. **Hazard Assessment**
5. **Vulnerability Assessment**
6. **Next Steps**

## Presentation Notes

OC FMP/RLAA Information and Q&A Meeting – 8/14/2024

| Questions | |
|---|---|
| | - Christopher Pena: What type of title of person are you looking for to participate in the FMP?<br>  o Melissa M.: For CRS purposes, Building department/code enforcement, engineering department, land use planning department, public works, city manager, emergency management/floodplain management, and more.<br>- Joyce Drysdale: Alternate versus representative contact?<br>  o Melissa M.: For CRS purposes, two participants from your community should be participating for CRS credit. Although one will be an alternative contact, it is important for both to be at the meetings and participating.<br>- Tran Giatho: How much time and effort for those participating in the FMP?<br>  o Emma K.: Safe to assume anywhere between 3-5 meetings an hour long. For worksheets, you should not have to spend more than an hour. Please utilize Grace and myself (planners) as resources to help complete these worksheets.<br>- Christopher Pena: Will the plan be a community plan? Or one huge plan?<br>  o Melissa m.: There will be one plan with annexes for separate communities.<br>- William Grigsby: What are the CRS credits?<br>  o Melissa M.: an additional 5 % discount for every 500 points received. This participation could represent half to a full pocket of credit resulting in more flood insurance discounts.<br>- Is CFM a requirement for CRS?<br>  o Melissa M.: Not a requirement but will result in up to 25 points.<br>- Tran Giatho: Is there a benefit for non-CRS communities to participate?<br>  o Melissa M.: Pro's of a FMP is the five year window, which is roll over credit for CRS communities. More manageable due to the roll over window. We should be aiming for an additional 5% discount for the communities based on the level of participation from the communities. |

| | | | |
|---|---|---|---|
| FMP Steering Committee Meeting | | | |
| | | | |
| August 14th, 2024 - ATTENDANCE LOG | | | |
| Name | Attendance | Response | |
| Kilkelly | Emma <EMMA.KILKELLY@tetratech.com> | Accepted | |
| Drysdale | Joyce <Joyce.Drysdale@ocpw.ocgov.com> | Accepted | |
| Tyler | James <James.Tyler@ocpw.ocgov.com> | Tentative | |
| Altenburg | Grace <GRACE.ALTENBURG@tetratech.com> | Didn't respond | |
| Parker | Steve <Steve.Parker@tetratech.com> | Didn't respond | |
| Tran | Giatho <Giatho.Tran@ocpw.ocgov.com> | Didn't respond | |
| | | | |
| | | | |
| | | | |

# MEETING NO. 3

## ORANGE COUNTY FLOODPLAIN MANAGEMENT PLAN (FMP) KICKOFF MEETING / PUBLIC INFORMATION MEETING

**WEDNESDAY, OCTOBER 23, 2024**

1. **Welcome & Introductions**
    a. **Orange County & Tetra Tech**
2. **Plan Overview**
    a. **What Is Floodplain Management?**
    b. **Why is Orange County Public Works leading this effort?**
    c. **How is the County developing the plan?**
    d. **Who participates?**
    e. **When will it take place?**
3. **Steering Committee Responsibilities**

**Orange County, CA – FMP**
**Steering Committee KO | Minutes**

| | |
|---|---|
| **Purpose of Meeting:** | Steering Committee Kick-Off |
| **Location of Meeting:** | **Virtual via Microsoft Teams** |
| **Date of Meeting:** | October 23, 2024 at 9:30 a.m. – 10:30 a.m. CST |

**Attendees:**

- Bill Caiazzo - Realtor (HomeSmart Evergreen Realty, Huntington Beach)
- Andrew Brown, OC San
- John McCarthy, Q3 Consulting
- Melissa Kubischta, City of Newport Beach
- Debbie Leahy, Red Cross
- Matt Lewis, Irvine Homeowner
- Salomon Miranda, CA DWR
- Nadia Cook, Conservation Administrator, City of Laguna Woods
- Kevin O'Toole - Orange County Water District
- Hugo Pineda, OC Operations & Maintenance, OC Public Works
- Shannon Widor, OC Public Works
- Giatho Tran, OC Public Works
- JT Yean, OCPW Planning
- Steve Parker, Project Manager, Tetra Tech
- Chris Shyy, City of San Juan Capistrano
- Eva-Marie Martin, UC Irvine
- Joyce Drysdale, OC Public Works
- Grace Altenburg, CRS Planner, Tetra Tech
- Emma Kilkelly, Lead Planner, Tetra Tech
- Adrian Siew, OC San
- Justin Fenton, OC San
- Alex Tardy, National Weather Service

**Agenda Summary:**

- Welcome & Introductions
  - Orange County & Tetra Tech
- Plan Overview
  - What Is Floodplain Management?
  - Why is Orange County Public Works leading this effort?
  - How is the County developing the plan?
  - Who participates?
  - When will it take place?
- Steering Committee Responsibilities
  - Oversee the planning process
  - Review, update, and provide input
  - Guide stakeholder involvement
  - Conduct public outreach
  - Actively participate!
- Project Organization
  - Planning process overview
- Schedule
  - Project timeline
  - Next steps
- Questions

| Item No. | Description | Action item(s): |
|---|---|---|
| 1 | What is a floodplain management plan?<br>- *A community-wide plan that provides an overall strategy of programs, projects, and measures that will reduce the adverse impacts of flooding on the community and help meet other community needs (i.e., educate property owners and build public support for flood mitigation activities).*<br>Why is the County Public Works Department leading this effort?<br>- Multi-jurisdictional process streamlines decisions and pools resources<br>  o I.e., funds, staff time, meeting locations, media resources, and technical expertise<br>- Aim to reduce each participating jurisdiction's level of effort to remain or become eligible for CRS benefits<br>How is the County developing the plan? | - Introduction<br>- Plan Overview |

TETRA TECH 1

**Orange County, CA – FMP**
**Steering Committee KO | Minutes**

| | | |
|---|---|---|
| | - Will follow the CRS-outlined 10-Step Planning Process to maximize potential points<br>1. Organize<br>2. Involve the Public<br>3. Coordinate<br>4. Assess the Hazard<br>5. Assess the Problem<br>6. Set Goals<br>7. Review Possible Activities<br>8. Draft an Action Plan<br>9. Adopt the Plan<br>10. Implement, Evaluate, Revise<br>- The plan will be scored by ISO/CRS specialist on each of the above 10 CRS Steps. A full checklist for the 10 CRS Steps can be found on the CRS Coordinator's Manual: 510_fmp_checklist_9-2013_508ok.pdf (crsresources.org)<br>- Plan will include the East Garden Grove Wintersburg Channel Watershed, Santa Ana River, Santiago Creek, and flood hazards for participating communities.<br>- Plan will aim for additional CRS points through a Repetitive Loss Area Analysis and Program for Public Information.<br>Who participates?<br>- Public: Participate in public meetings and activities (i.e., questionnaires); comment on draft work products.<br>- Stakeholders: Provide feedback on critical work products and plan process; provide data/information for assessments.<br>- Steering Committee: Provide feedback/advise on all work products; decide on key elements of plan process and document.<br>- Internal Project Team: Execute work; finalize decisions.<br>When will it take place?<br>- Follow FEMA guidance for local mitigation plans, including the allowed time for public review/comment<br>- County to submit draft plan for a courtesy review by ISO during this time frame | |
| **2** | Steering Committee Roles and Responsibilities<br>- Guide the planning process.<br>- Actively participate<br>- Review and update information<br>- Support public outreach efforts.<br>Planning process overview<br>Phase 1: Organize the resources<br>Phase 2: Risk Assessment<br>Phase 3: Outreach strategy<br>Phase 4: Capabilities<br>Phase 5: Mitigation strategy<br>Phase 6: Planning maintenance<br>Phase 7: Prepare the FMP<br>Phase 8: Plan adoption<br>- It is important to note that the above planning phases are not to be confused with the 10 CRS Steps for FMP credit. The 8 planning phases are for developing the plan, while the 10 CRS steps are credit criteria requirements that will be graded by ISO/CRS Specialists.<br>Phase 1: Organize the resources<br>- Data collection and inventory assets | - Steering Committee Responsibilities<br>- Project Organization<br>- Schedule |

TETRA TECH 2

**Orange County, CA – FMP**
**Steering Committee KO | Minutes**

| | | |
|---|---|---|
| | - Update critical facility/community lifeline inventory<br>  o Critical Facilities provide essential services to the community, especially before, during, and after a flood event.<br>  o Community Lifelines provide services that allow continuity of operations of critical business and government functions, and crucial to health and safety of residents.<br>Phase 2: Risk Assessment<br>- Review flood hazards in the County<br>- Develop flood hazard profile and focus on the different types or sources of flooding<br>- Complete risk assessment<br>- Review risk assessment results with Steering Committee<br>- Assets:<br>  o Population<br>  o Building Stock<br>  o Critical Facility<br>  o Community Lifelines<br>  o Economy<br>  o Future Development<br>- Flood Hazard:<br>  o Location<br>  o Extent<br>  o Previous Occurrence<br>  o Future Probability<br>  o Climate Change<br>- Risk: Where the flood hazard and assets overlap.<br>Phase 3: Public outreach strategy<br>- Public Outreach Toolkit<br>  o Social media templates and posts<br>  o Press release templates<br>  o Printable materials<br>- Surveys<br>  o Stakeholders<br>  o Neighboring communities<br>  o Public<br>- County Website<br>Phase 4: Capabilities and integration<br>- Review existing capabilities and identify how each reduces flood risk and if it incorporates elements of the FMP<br>- Describe current and future integration process for the County and each jurisdiction<br>  o Regulatory: Current ordinances that integrate mitigation (e.g., local flood damage prevention ordinance, stormwater management, wetlands protection, etc.).<br>  o Operational and administrative: County/community boards/departments that integrate mitigation in their current processes and how.<br>  o Funding: Funding sources at the local level that may be used to fund mitigation projects.<br>  o Education/Outreach: Current action the County/community is taking to integrate mitigation in their outreach and notifications to residents.<br>  o Adaptive capacity: Review the County and municipalities' adaptive capacity to deal with the potential impacts of climate change.<br>Phase 5: Mitigation strategy | |

TETRA TECH 3

| | | |
|---|---|---|
| | - Review previous flood mitigation actions<br>- Review and update goals/objectives<br>- Problem statements and potential solutions<br>  ○ What specific actions will be taken to reduce flood risk?<br>- Develop an action plan<br>  ○ How will the actions be prioritized and implemented?<br>Phase 6: Plan maintenance<br>- Develop a game plan for maintaining the 2024 FMP How often will you meet to discuss progress on the FMP?<br>  ○ How will the County and jurisdictions integrate the FMP?<br>  ○ How will you monitor progress on the 2024 flood mitigation actions?<br>Phase 7: Prepare the FMP update<br>- Volume I: Table of contents; Executive summary; Introduction; Planning process; County profile; Risk Assessment; Capability assessment; Mitigation strategies; Plan maintenance; Acronyms and abbreviations; Glossary; References.<br>- Appendices: Sample adoption resolution; Participation matrix; Meeting documentation; Public/Stakeholder outreach; Risk Assessment information; Mitigation strategy support documentation; Plan maintenance tools; Critical facilities.<br>- Volume II: Planning team; Jurisdictional annexes.<br>Phase 8: Adopt the plan<br>- Once FEMA approves the FMP, the County and each jurisdiction will need to adopt the plan<br>- Begin plan implementation and integration<br><br>Program for Public Information (PPI)<br>- The County is also developing a Program for Public Information (PPI) to educate/inform the public about flood risk and safety measures.<br>- PPI includes a committee comprised of local government and non-government members.<br>  ○ The committee works together to develop and share info to help reduce flood damage and improve public safety. This helps the County and CRS communities earn CRS points.<br>- Local government examples: government officials; floodplain management office.<br>- Non-government examples: community stakeholders; business owners; nonprofits education institutes.<br>  ○ We are still working to confirm non-government participants from each community. | |
| **3** | Giatho T.: What are expectations for meetings?<br>Emma K.: Expectations should be one meeting per month. There will also be a number of public meetings but these are optional for the Steering Committee. In terms of time that is related to providing information via worksheets and one-one phone calls, maybe 2-4 hours a month (including meeting obligation). The goal is for us to be as efficient with your time and efforts as possible.<br><br>Joyce D.: there are a couple individuals who have not put their name and agency in the chat, please put your name in the chat.<br><br>Melissa K.: What is the timeline for adoption and what does adoption look like for local agencies? | - Questions<br>- Comments<br>- Chat |

Orange County, CA – FMP
Steering Committee KO | Minutes

| | | |
|---|---|---|
| | Emma K.: Tetra Tech will be working behind the scenes through November and December. Starting January of 2025 is when we will pick up again with meetings. The goal is to have a draft plan by next spring/summer. Most work will be happening in the first 6-7 months of 2025. In terms of adoption for local jurisdictions, that will be dependent upon the jurisdictional structure. The CRS community will get points by finalizing the plan. To finalize the jurisdiction's legislative body must pass a resolution to formally adopt this plan. | |

# MEETING NO. 4—AGENDA

## ORANGE COUNTY FLOODPLAIN MANAGEMENT PLAN (FMP)

## GOAL SETTING AND OBJECTIVES MEETING

**Wednesday, January 29, 2025**

1. **Welcome & Introductions**
2. **Goals & Objectives**
    a. **Purpose**
    b. **Review draft statements**
3. **Feedback session**
    a. **Distribute survey link for additional feedback**
4. **Schedule**
    a. **Project timeline**
5. **Next steps**

# GOALS & OBJECTIVES MEETING: FLOODPLAIN MANAGEMENT PLAN AND PROGRAM FOR PUBLIC INFORMATION

MEETING MINUTES

| | |
|---|---|
| **Purpose of Meeting:** | Goals & Objectives Setting |
| **Location of Meeting:** | Virtual (Microsoft Teams) |
| **Date of Meeting:** | January 29, 2025, 12 pm |

**Attendees:**

Alex Tardy, National Weather Service
Bill Caiazzo, Real Estate Agent, Huntington Beach
Andrew Brown, OC Sanitation District
Jennifer Carey, Huntington Beach
Joanna Cortez, Huntington Beach
Joyce Drysdale, OC Public Works
David Gibson, Newport Beach, Fire Department PIO / CERT Representative
Hazel McIntosh, Mission Viejo
Jannine Wilmoth, CERT Representative
Jason Kwak, Santa Ana Building Safety Manager
Jeff McIver, Yorba Linda, Building Official
John McCarthy, Q3 Consulting
Justin Inducil, San Juan Capistrano
Melissa Kubischta, Newport Beach, Principal Engineer
Debbie Leahy, Red Cross of Orange County
Linda Fontes, Irvine
Matt Jenkins, Fountain Valley
Matt Lewis, Citizen, CERT Graduate
Salomon Miranda, DWR Floodplain Management
Nadia Cook, Laguna Woods, Senior Engineer
Nardy Khan, San Juan Capistrano
Kevin O'Toole, Water Supply
Denice Paxton, Public Information
Hugo Pineda, OC Operations & Maintenance
Nina Quimsing, OC Public Works
Regina Hu, Yorba Linda, Engineer
Robert Schick, Mission Viejo
Stan Ng, Irvine
Steve Sherwood, Manager of Engineering
Tonee Thai, Newport Beach Building Official
Giatho Tran, OC Public Works
James Tyler, OC Public Works
Shannon Widor, Public Information
William Grigsby, Anaheim Principal Engineer
Eva Martin, UC Irvine, PhD Student
Grace Altenburg, Tetra Tech
Emma Kilkelly, Tetra Tech
Melissa Mitchell, Tetra Tech
Steve Parker, Tetra Tech
Lynn Welch, Tetra Tech

**Agenda Summary:** The purpose of this meeting was to review the draft goals and objectives to the FMP Steering Committee and PPI Committee, gather feedback on revisions and priorities for Orange County, and discuss how to submit written comments on the draft statements using the online survey.

| Item No. | Description | Action item(s): |
|---|---|---|
| 1 | **Welcome & Introductions**<br>• Attendees wrote their name and organization in the chat. | - |
| 2 | **Goals & Objectives**<br>• Refresher: What is a floodplain management plan?<br>• The CRS Priority Topics are messages to be developed and implemented by the PPI, which include the following:<br>○ Know your flood hazard.<br>○ Insure your property against your flood hazard.<br>○ Protect people from the hazard.<br>○ Protect your property from the hazard.<br>○ Build responsibly.<br>○ Protect natural floodplain functions.<br>○ General preparedness. | **FMP Steering Committee/ PPI Committee**<br>• Provide feedback via survey: https://www.surveymonkey.com/r/OCfmpGO |

TETRA TECH

| | | |
|---|---|---|
| | • Goals and objectives guide the development of the floodplain management plan and PPI. It also helps identify what types of mitigation strategies are best suited for the planning area.<br>• Review draft statements and request feedback.<br>  ○ Goal 1. Protect Life and Property from the flood hazards through planning, preparing, and mitigating.<br>  ▪ Objective 1.a: Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards.<br>  ▪ Objective 1.b: Reduce losses and repetitive damage for chronic hazard events, while promoting insurance coverage for catastrophic hazards.<br>  ▪ Objective 1.c: Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards.<br>  ▪ Objective 1.d: Discourage new development in the flood hazard area, that if development does occur, ensure that it is done in a way that minimizes flood risk.<br>  ○ Goal 2. Enhance community resilience through Public Awareness opportunities such as outreach programs to provide resources to the public on flood risks, resilience strategies, and safety measures.<br>  ▪ Objective 2.a: Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards.<br>  ▪ Objective 2.b: Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities.<br>  ▪ Objective 2.c: Utilize the best available data and technologies to improve understanding of potential impacts and location of flood hazards.<br>  ○ Goal 3. Protect Natural Systems from flooding impacts through sustainable watershed planning and coordinated resource management practices across public and private sectors.<br>  ▪ Objective 3.a: Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment.<br>  ▪ Objective 3.b: Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.<br>  ▪ Objective 3.c: Provide the highest degree of flood hazard protection by prioritizing prevention and when practical, consider natural systems that enhance floodplain functions.<br>  ▪ Objective 3.d: Consider climate change implications in planning for and mitigating flood or inundation hazards.<br>  ○ Goal 4. Encourage, expand, and strengthen the Partnerships and Implementation of flood mitigation strategies between government agencies, private sector businesses, and non-profit organizations before, during, and after flood events.<br>  ▪ Objective 4.a: Strengthen communication and coordinate participation among and within public agencies, residents, | |

| | | |
|---|---|---|
| | non-profit organizations, business, and industry to gain a vested interest in implementation.<br>▪ Objective 4.b: Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities.<br>▪ Objective 4.c: Provide flood protection by maintaining and enhancing flood control systems.<br>○ Goal 5. Enhance Emergency Services planning to include flood hazard event planning impacts on populations and property.<br>▪ Objective 5.a: Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure.<br>▪ Objective 5.b: Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry.<br>▪ Objective 5.c: Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures. | |
| 3 | **Schedule**<br>• The project is currently focusing on Phase 3 (Outreach Strategy) and Phase 4 (Capabilities); in the upcoming months, there will be PPI meetings and more information gathering to support Phase 5 (Mitigation Strategy). | - |
| 4 | **Questions**<br>• Does this have any correlation to our Storm Manual and other related EAPs?<br>○ These are exactly the plans and objectives we want to make sure align with the FMP goals.<br>• Related to goal 5 and emergencies, if there is a large-scale flood that especially impacts multiple jurisdictions, the County's Emergency Management Division should have procedures documented for public information and coordination with agencies. OC Sheriff's Dept would be a good partner to talk with as this plan develops.<br>• For Goal 3, maybe include OC Environmental Resources too?<br>• Will the plans consider stormwater as a potential local water supply resource? | |
| 5 | Next Steps<br>• Stay tuned for finalized goals and objectives.<br>• The PPI Committee will be meeting in the next month to review potential projects and initiatives. | - |

# MEETING NO. 5—AGENDA

Orange County Floodplain Management Plan (FMP)
MITIGATION ACTION WORKSHOP AND RISK ASSESSMENT REVIEW MEETING

**Wednesday, April 30, 2025**

1. **Welcome & Introductions**
    a. **Orange County & Tetra Tech**
2. **Project Status**
    a. **CRS 10-Steps for FMP Planning**
    b. **Plan Development Status**
3. **Risk Assessment Overview**
    a. **What is risk?**
    b. **Purpose of risk assessment**
    c. **What was assessed?**
4. **Flood Mitigation Strategies**
    a. **Identify Flood Mitigation Actions**
    b. **Develop & Identify New Actions (Workshop)**
5. **Next Steps**
    a. **Project timeline**
    b. **Wrap up discussion**
6. **Questions**

# ORANGE COUNTY (CA) FMP 2025 – RISK ASSESSMENT & MITIGATION ACTION WORKSHOP

## MEETING MINUTES

| | |
|---|---|
| **Purpose of Meeting:** | Review FMP Risk Assessment & Discuss Community Mitigation Actions Development |
| **Location of Meeting:** | Virtual (Microsoft Teams) |
| **Date of Meeting:** | April 30, 2025 – 3:00 PM CST |

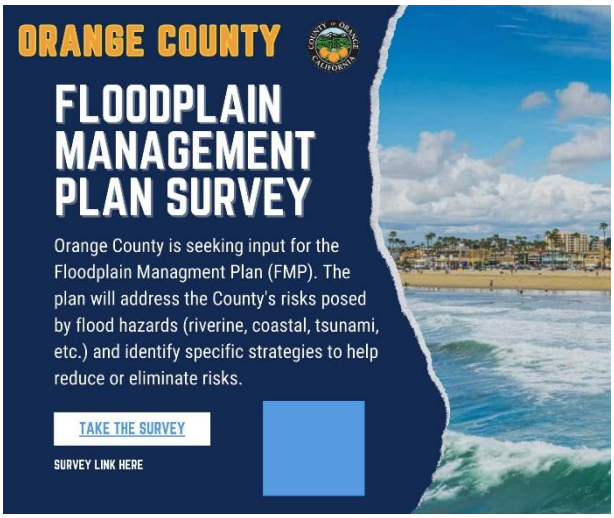
**Attendees:**
Joyce Drysdale (JD), Floodplain Mngt., Orange Co. Public Works
Giatho Tran (GT), Floodplain Mngt., Orange Co. Public Works
Keith Linker (KL), Principal Civil Engineer – Ci. of Anaheim
Charles Guiam (CG), Planning Services, Ci. of Anaheim
Melissa Kubischta (MK), City Engineer, Ci. of Newport Beach
Tonee Thai (TT), Dep. Community Development Director / Chief Bldg. Official – Ci. of Newport Beach
Shawn Mousavi (SM), Sr. Civil Engineer, Ci. San Juan Capistrano
Justin Inducil (JI), Asst. Engineer, Ci. of San Juan Capistrano
Nadia Cook (NC), Regulatory Programs Analyst, Ci. of Laguna Woods
[ TETRA TECH: Mellissa Mitchell (MM); Kevin Gambrill (KG); Steve Parker (SP); Lynn Welch (LW) ]

**Agenda Summary**:

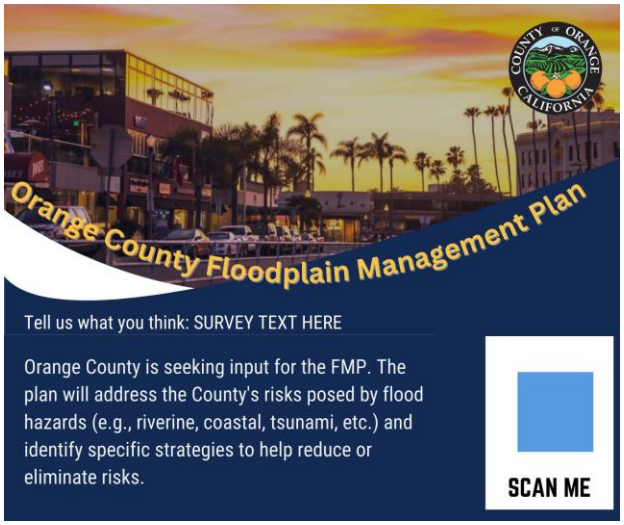
| Item No. | Description | Action item(s) |
|---|---|---|
| 1 | 3:00 PM – Opening Remarks<br>• Attendees submitted their name and organization in the chat window.<br>• General Introduction by Staff (GA)<br>• Staff emphasized that the FMP will be in keeping with the CRS 10-Step Process | - |
| 2 | 3:02 PM – Floodplain Management Plan (FMP) Risk Assessment Progress Report<br>• Staff presented updates to the attendees regarding the FMP, specifically the Risk Assessment.<br>• Staff provided an overview of the key language used in the Risk Assessment, and how elements within the risk assessment differ from each other. | |
| 3 | 3:20 PM – Discussion on Risk Assessment Analysis<br>• Examination of Hazards Assessed<br>• Reviewed the differences between risk (hazard) and vulnerability (potential for loss)<br>• Provided context regarding hazards, ranking impacts, and probability of occurrence vs. potential consequences.<br>• Staff presented a preliminary hazard ranking formula; stating that adjustments would be based on local community input. | - |
| 4 | 3:32 PM – Mitigation Strategy Discussion<br>• Review of Strategies; Staff provided guidance on development of strategies and resulting mitigation actions.<br>• Staff advised communities to consider strategies that reduce flood risk over a longer time horizon.<br>• Provided narratives on risk reduction by examining the life cycle of assets (infrastructure) vs. flood recurrence.<br>• Staff stated that the goal is for the FMPs to contain all 7 CRS activity types and incorporated into an action catalog for communities to use – CRS Step 7, Review Possible Activities.<br>• Staff spoke to elements within a holistic Mitigation Strategy (Plans, Codes, Regulations, Projects, Education) | |
| 5 | 3:40 PM – Development of New Actions<br>• Jurisdictional Annex plans will include actions that may not be in the County level FMP. These 'New Actions' should be actionable and funded.<br>• It is best to have actions that can be completed, or at least commence, within 5 years of FMP adoption. | - |

| | | |
|---|---|---|
| | | |
| 6 | 3:45 PM – Mitigation Actions<br>• Will want to use all 6 CRS Mitigation Action Categories<br>• Staff presented Mitigation Action Worksheet template to attendees with a brief tutorial on how to use for developing actions for their portions of the FMP Anex.<br>• Staff provided a link (QR Code) to a Mitigation Action Survey, intended to assist users with ID mitigation strategies that meet their specific communities' goals and objectives.<br>• Staff discussed needing for communities to schedule Mitigation Action 1-on-1 follow-up meetings with Staff. A matrix of available dates given to attendees. | - |
| 7 | 3:55 PM – Next Steps / Closing Remarks<br>• Staff reminded attendees to complete OP Worksheets, take the Mitigation Action Development survey, and schedule a Mitigation Action 1-on-1 follow up meeting with Staff.<br>• Next month (June 2025) Communities will work with Staff Planners to complete annexes and finalized mitigation actions. | |
| 8 | 4:03 PM – Meeting Ended / Adjourned | |

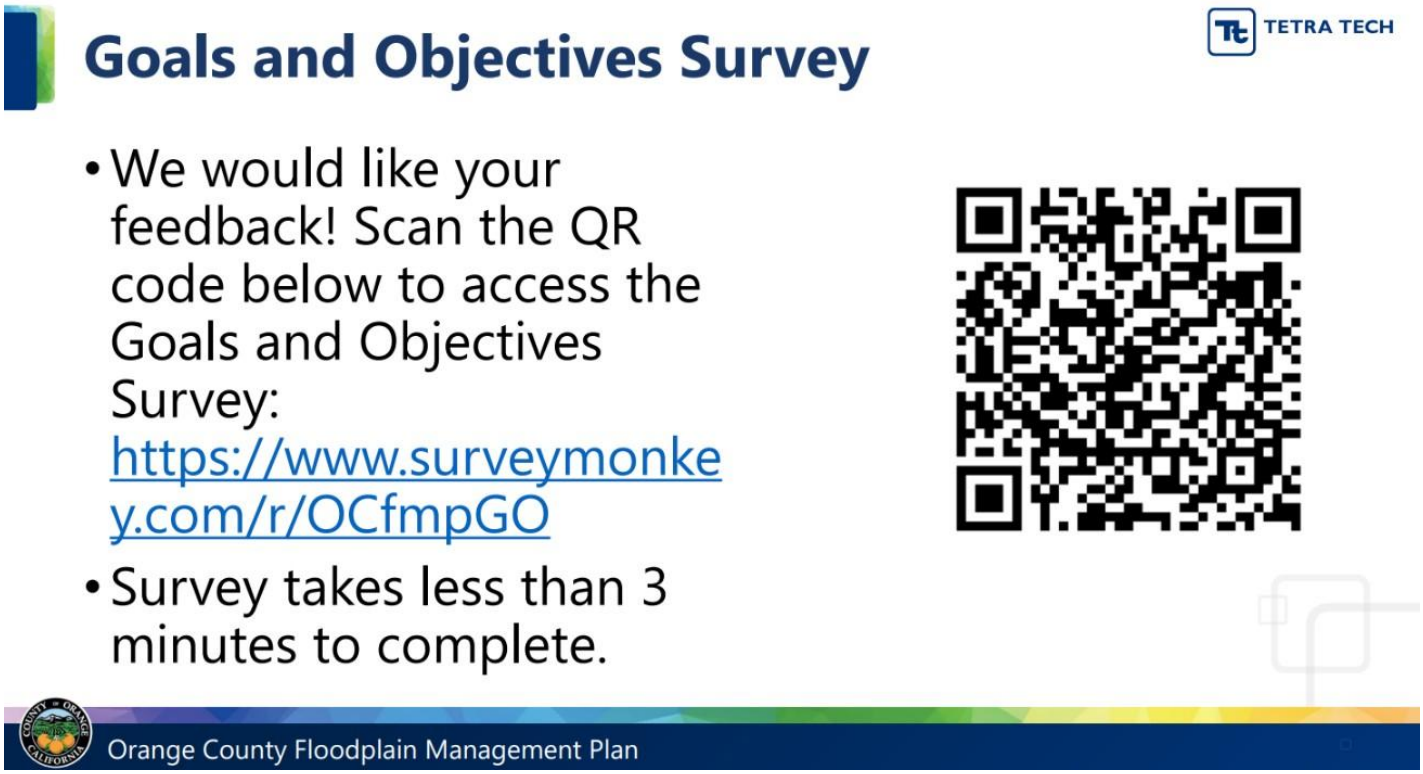
# APPENDIX E. PUBLIC AND STAKEHOLDER OUTREACH DOCUMENTATION


ORANGE COUNTY
FLOODPLAIN MANAGEMENT PLAN SURVEY
Orange County is seeking input for the Floodplain Managment Plan (FMP). The plan will address the County's risks posed by flood hazards (riverine, coastal, tsunami, etc.) and identify specific strategies to help reduce or eliminate risks.
TAKE THE SURVEY
SURVEY LINK HERE


WE NEED YOUR HELP
Orange County is developing a Floodplain Management Plan (FMP) and we want to hear from you.
Tell us what you think the plan should focus on by taking a quick survey:
SURVEY TEXT HERE


Orange County Floodplain Management Plan
Tell us what you think: SURVEY TEXT HERE
Orange County is seeking input for the FMP. The plan will address the County's risks posed by flood hazards (e.g., riverine, coastal, tsunami, etc.) and identify specific strategies to help reduce or eliminate risks.
SCAN ME


ORANGE COUNTY
FLOODPLAIN MANAGEMENT PLAN
ORANGE COUNTY IS WORKING ON DEVELOPING AN FMP TO ADDRESS RISKS TO FLOOD HAZARDS. IF YOU LIVE OR WORK IN THE COUNTY, WE NEED YOUR INPUT ABOUT LOCAL FLOOD HAZARDS.
Take a quick survey to help us with the FMP.
SURVEY TEXT HERE
SCAN ME




*Goals and Objectives Survey; Website and URL from 1/29/2025 Meeting*

## Goals and Objectives Survey for Committee Members—Survey Results

Orange County FMP | Goals and Objectives

### Q1 Contact Information

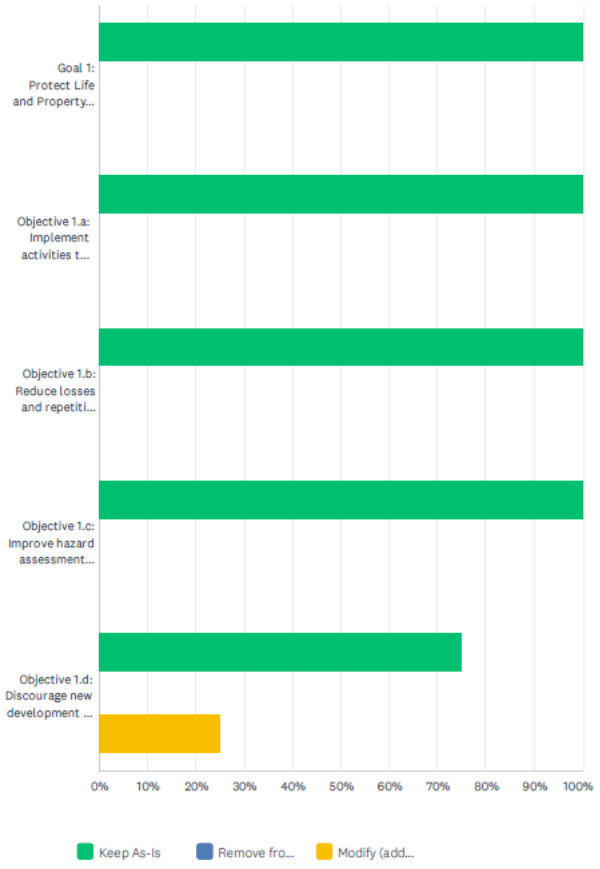
Answered: 5 Skipped: 0

| ANSWER CHOICES | RESPONSES | |
|---|---|---|
| Name | 100.00% | 5 |
| Department/Agency | 100.00% | 5 |
| Address | 0.00% | 0 |
| Address 2 | 0.00% | 0 |
| City/Town | 100.00% | 5 |
| State/Province | 100.00% | 5 |
| ZIP/Postal Code | 0.00% | 0 |
| Country | 0.00% | 0 |
| Email Address | 100.00% | 5 |
| Phone Number | 0.00% | 0 |

Orange County FMP | Goals and Objectives

## Q2 Goal 1 - Protect Life

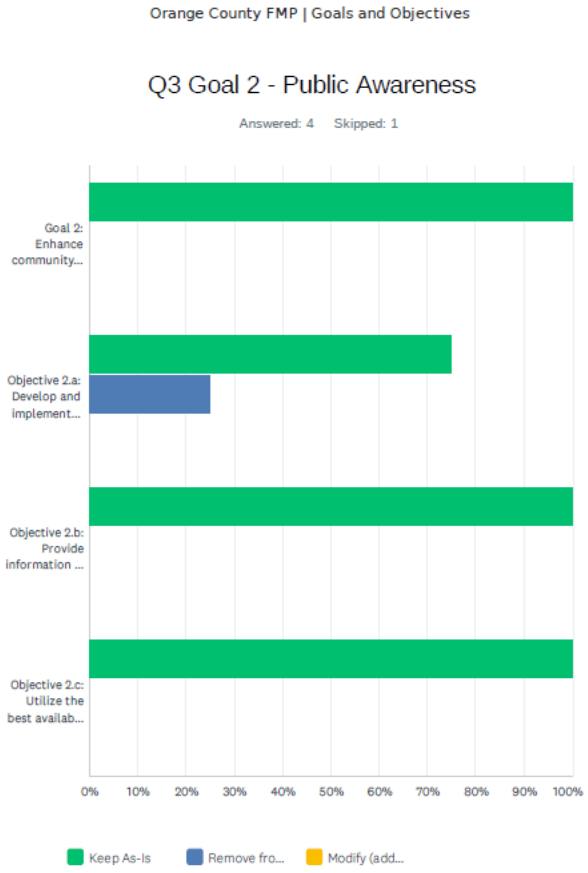
Answered: 4 Skipped: 1




Orange County FMP | Goals and Objectives

| | KEEP AS-IS | REMOVE FROM THE FMP | MODIFY (ADD SUGGESTION BELOW) | TOTAL RESPONDENTS |
|---|---|---|---|---|
| Goal 1: Protect Life and Property from the flood hazards through planning, preparing, and mitigating. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 1.a: Implement activities that assist in protecting lives by making homes, businesses, infrastructure, critical facilities, and other property more resistant to natural hazards. | 100.00% 3 | 0.00% 0 | 0.00% 0 | 3 |
| Objective 1.b: Reduce losses and repetitive damage for chronic hazard events, while promoting insurance coverage for catastrophic hazards. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 1.c: Improve hazard assessment information to make recommendations for discouraging new development and encouraging preventative measures for existing development in areas vulnerable to natural hazards. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 1.d: Discourage new development in the flood hazard area, that if development does occur, ensure that it is done in a way that minimizes flood risk. | 75.00% 3 | 0.00% 0 | 25.00% 1 | 4 |

Orange County FMP | Goals and Objectives



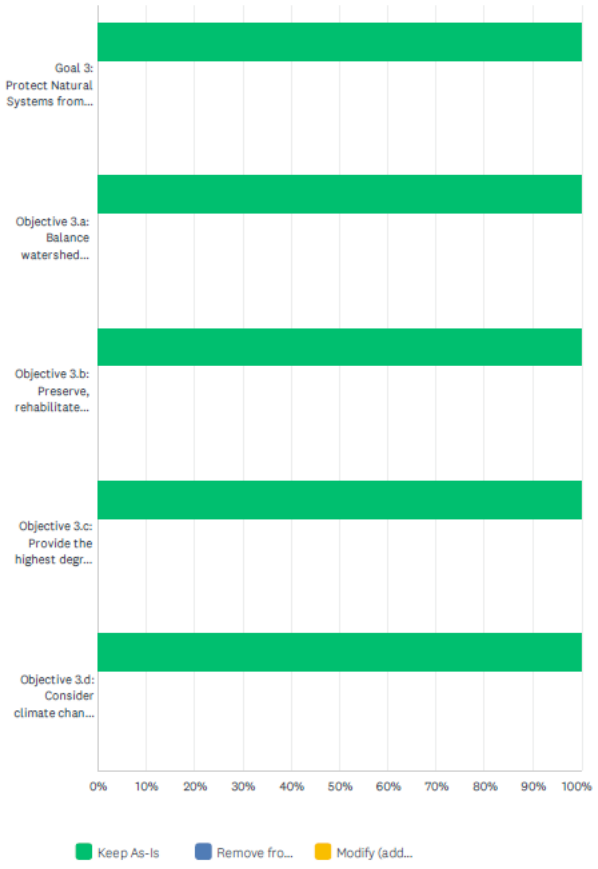

Orange County FMP | Goals and Objectives

| | KEEP AS-IS | REMOVE FROM THE FMP | MODIFY (ADD SUGGESTION BELOW) | TOTAL RESPONDENTS |
|---|---|---|---|---|
| Goal 2: Enhance community resilience through Public Awareness opportunities such as outreach programs to provide resources to the public on flood risks, resilience strategies, and safety measures. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 2.a: Develop and implement education and outreach programs to increase public awareness of the risks associated with natural hazards. | 75.00% 3 | 25.00% 1 | 0.00% 0 | 4 |
| Objective 2.b: Provide information on tools, partnership opportunities, and funding resources to assist in implementing mitigation activities. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 2.c: Utilize the best available data and technologies to improve understanding of potential impacts and location of flood hazards. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |

Orange County FMP | Goals and Objectives

## Q4 Goal 3 - Natural Systems

Answered: 4 Skipped: 1



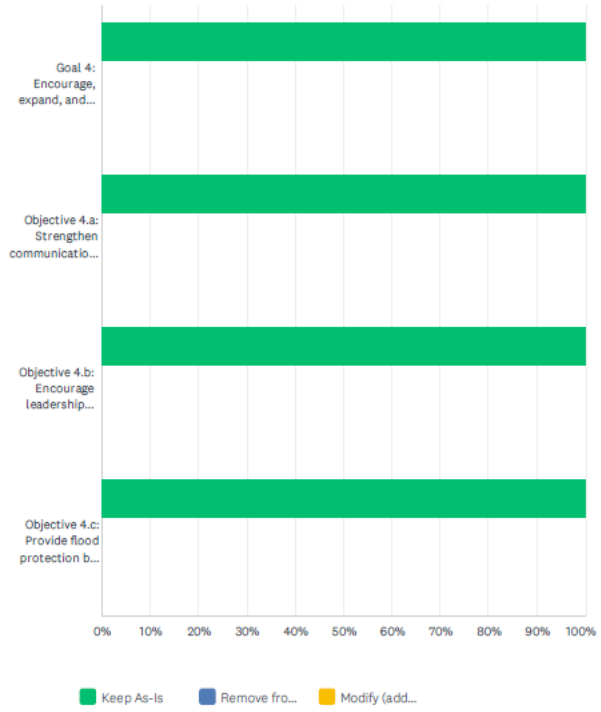

Orange County FMP | Goals and Objectives

| | KEEP AS-IS | REMOVE FROM THE FMP | MODIFY (ADD SUGGESTION BELOW) | TOTAL RESPONDENTS |
|---|---|---|---|---|
| Goal 3: Protect Natural Systems from flooding impacts through sustainable watershed planning and coordinated resource management practices across public and private sectors. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 3.a: Balance watershed planning, natural resource management, and land use planning with natural hazard mitigation to protect life, property, and the environment. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 3.b: Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 3.c: Provide the highest degree of flood hazard protection at lowest cost by working with environmentally friendly natural systems and through prevention as first priority. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 3.d: Consider climate change implications in planning for and mitigation flood or inundation hazards. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |

Orange County FMP | Goals and Objectives

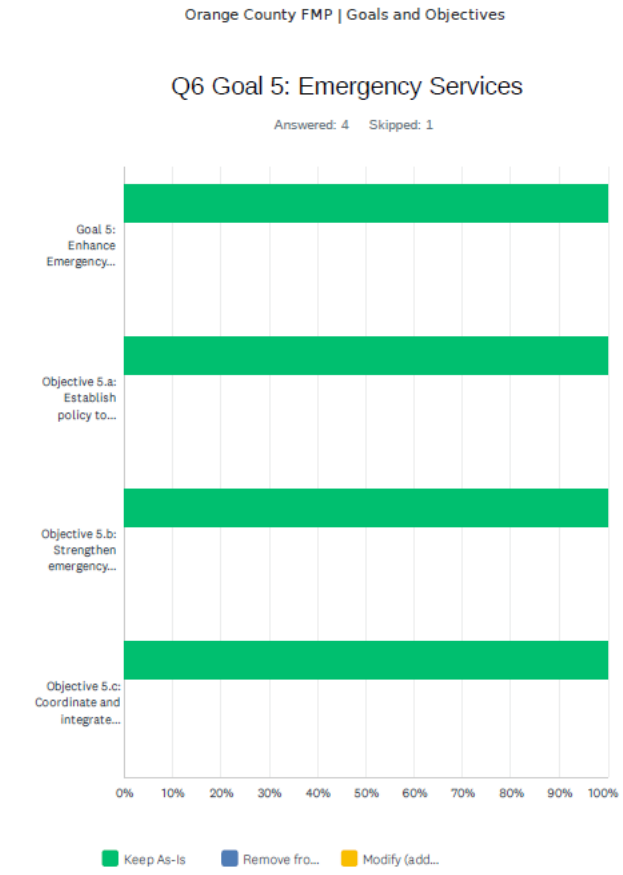
## Q5 Goal 4: Partnerships and Implementation

Answered: 4 Skipped: 1




Orange County FMP | Goals and Objectives

| | KEEP AS-IS | REMOVE FROM THE FMP | MODIFY (ADD SUGGESTION BELOW) | TOTAL RESPONDENTS |
|---|---|---|---|---|
| Goal 4: Encourage, expand, and strengthen the Partnerships and Implementation of flood mitigation strategies between government agencies, private sector businesses, and non-profit organizations before, during, and after flood events. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 4.a: Strengthen communication and coordinate participation among and within public agencies, residents, non-profit organizations, business, and industry to gain a vested interest in implementation. | 100.00% 3 | 0.00% 0 | 0.00% 0 | 3 |
| Objective 4.b: Encourage leadership within public and private sector organizations to prioritize and implement local, county, and regional hazard mitigation activities. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |
| Objective 4.c: Provide flood protection by maintaining and enhancing flood control systems. | 100.00% 4 | 0.00% 0 | 0.00% 0 | 4 |



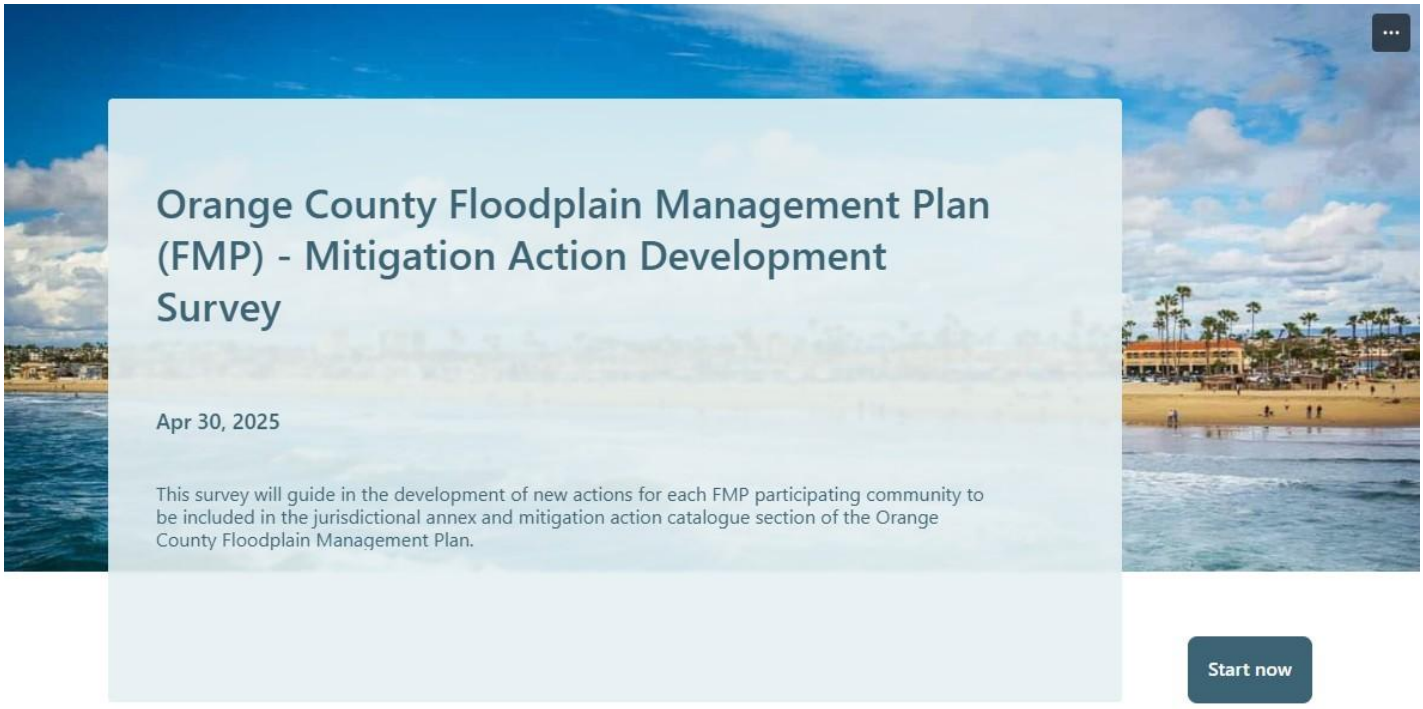

Orange County FMP | Goals and Objectives

| | KEEP AS-IS | REMOVE FROM THE FMP | MODIFY (ADD SUGGESTION BELOW) | TOTAL RESPONDENTS |
|---|---|---|---|---|
| Goal 5: Enhance Emergency Services planning to include flood hazard event planning impacts on populations and property. | 100.00%<br>4 | 0.00%<br>0 | 0.00%<br>0 | 4 |
| Objective 5.a: Establish policy to ensure mitigation projects for critical facilities, services, and infrastructure. | 100.00%<br>4 | 0.00%<br>0 | 0.00%<br>0 | 4 |
| Objective 5.b: Strengthen emergency operations by increasing collaboration and coordination among public agencies, non-profit organizations, business, and industry. | 100.00%<br>4 | 0.00%<br>0 | 0.00%<br>0 | 4 |
| Objective 5.c: Coordinate and integrate natural hazard mitigation activities, where appropriate, with emergency operations plans and procedures. | 100.00%<br>4 | 0.00%<br>0 | 0.00%<br>0 | 4 |

**FMP Participating Jurisdictions**

**Mitigation Action Development Survey:**

*FMP Participating Jurisdictions—Mitigation Action Development Surveys*




Orange County Floodplain Management Plan (FMP) - Mitigation Action Development Survey

**FMP Participating Jurisdictions**

**Mitigation Action Development Survey RESULTS**

View results

| Respondent | | |
|---|---|---|
| 2 | Anonymous | 7267:40 Time to complete |

## Community Participation

Please let us know which community you are filling out this form for along with your name and email so that we may contact you if needed.

1. Community: *

County of Orange (Unincorporated)

2. Name of Respondent: *

Joyce Drysdale

3. Email of Respondent: *

joyce.drysdale@ocpw.ocgov.com

## Strengths, Weaknesses, Obstacles, and Opportunities

We need to look at the following for each hazard of concern:

**Strengths** – what the County and communities do well; things upon which we can capitalize;

**Weaknesses** – what can be done better; what can be strengthened;

**Obstacles** – what stands in the way to implementation to prevent mitigation or response (for example regulatory, geographical, environmental, financial issues); and

**Opportunities** - actions or projects to mitigate issues or improve resilience.

4. Flooding - **Strength and Opportunities**

The County has worked on reducing its largest floodplains and has implemented numerous flood improvement plans through its Capital Improvement Program and has a robust maintenance program with a biannual inspections of flood control infrastructure and addresses targeted maintenance and repair concerns.

5. Flooding - **Weakness and Obstacles**

Flood improvement projects seem to be costing more, while we have a limited amount of funding. The County has a large backlog of flood improvement projects to be completed, but only some may be programmed into our Capital Improvement Projects 7-year Plan. Another obstacle is working with USACE, as they are dependent on what may be variable federal funds. Additionally, infrastructure is aging and some are nearing the end of their expected life cycle.

6. Coastal Flooding - **Strength and Opportunities**

The unincorporated County only has a couple locations where coastal flooding would have impacts - Dana Point Harbor, Emerald Cove area in Laguna Beach, an area near the mouth of the Santa Ana River, a small undeveloped portion of Huntington Beach, and County beaches.

7. Coastal Flooding - **Weakness and Obstacles**

Some of the more frequently suggested options to mitigate this hazard include property acquisition or elevation, either of which would be very costly in the area.

8. Riverine Flooding - **Strength and Opportunities**

The largest regional sources of riverine flooding have been improved by the County. The County has worked on reducing its largest floodplains and the Santa Ana River project is nearing completion. Biannual inspections are performed for every flood facility, along with USACE levee inspections and participation in PL84-99.

9. Riverine Flooding - **Weakness and Obstacles**

Our Capital Improvement Projects 7-year Plan currently has a large backlog of flood improvement projects that has not been programmed yet. Some infrastructure is nearing the end of its expected life cycle. Additionally, some challenges include finding maintenance improvements that will require minor regulatory and environmental permitting.

10. Tsunami - **Strength and Opportunities**

The unincorporated County only has a couple locations where tsunami would have impacts - Dana Point Harbor, Emerald Cove area in Laguna Beach, an area near the mouth of the Santa Ana River, a small undeveloped portion of Huntington Beach, and County beaches.

11. Tsunami - **Weakness and Obstacles**

Many coastal areas are densely populated, so there would be a large impact to residents.

12. Dam Failure - **Strength and Opportunities**

The County has Emergency Action Plans and Inundation Maps for each of the County-owned dams with Extremely High Hazard ratings. There are current plans to replace and raise the spillway to the Prado Dam, which would allow for greater storage capacity.

13. Dam Failure - **Weakness and Obstacles**

The dam with the largest impact to Orange County is Prado Dam, which is located outside of the County and owned and operated by USACE. If this dam were to fail, much of Orange County would be inundated. Due to the significant urbanization of Orange County, this would impact numerous residents.

14. Sea Level Rise - **Strength and Opportunities**

The unincorporated County only has a couple locations where sea level rise would have impacts - Dana Point Harbor, Emerald Cove area in Laguna Beach, an area near the mouth of the Santa Ana River, a small undeveloped portion of Huntington Beach, and County beaches.

15. Sea Level Rise - **Weakness and Obstacles**

A Preliminary Climate Action Plan was released in 2024; however, future implementation of the plan has not been determined.

New Action Development

Below are a set of CRS categories to help guide new action development.

**Property Protection (PP)** -These actions include public activities to reduce hazard losses or actions that involve (1) modification of existing buildings or structures to protect them from a flood hazard or (2) removal of structures from the flood hazard area.
**Preventative Measures (PR)** - Government, administrative, or regulatory actions, or processes that influence the way land and buildings are developed and built. Examples include planning and zoning, capital improvement plans, etc.
**Public Information (PI)** - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.
**Natural Resource Protection (NPR)** - Actions that minimize flood hazard loss and preserve or restore the functions of natural systems.
**Structural Flood Control Project (SP)** - Actions that involve the construction of structures to reduce the impact of a flood hazard. Such structures include dams, setback levees, floodwalls, retaining walls, and safe rooms.
**Emergency Services (ES)** - Actions that protect people and property during and immediately following a disaster or flood related hazard event. Services include warning systems, emergency response services, and the protection of essential facilities.

Please consider the hazards of concern (**flooding, coastal flood, riverine flood, tsunami, dam failure, and sea level rise**) and list any current or upcoming projects your community is implementing or planning to implement.

**Make sure to create an action that applies to each CRS category and addresses at least one or more than one of the hazards of concern (listed above)**

*Ex. Floodproofing the Fire Department Building- The City has extensive flood issues at the Fire Department Building. The City proposes to floodproof the Fire Department Building by elevating all utilities above flood levels (ac unit, electrical panel, etc.) and installing flood vents to lessen overall flood impacts to the structure. This will ensure continuity of operations for the Fire Department. CRS Category: ES and SP.*

16. Name and short description of new action #1

East Garden Grove-Wintersburg Channel (C05) Bolsa Bay Outlet Flood Control Improvements
Project Limits: Warner Avenue Bridge (d/s)
Project Description: The project consists of improving the flood control facility to convey a 100-year storm

17. What CRS category does action #1 apply to?

- [x] Preventative Measures (PR)
- [x] Property Protection (PP)
- [ ] Public Information (PI)
- [x] Natural Resource Protection (NPR)
- [x] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

18. Name and short description of new action #2

East Garden Grove-Wintersburg Channel (C05)
Project Limits: From Tide Gates to u/s Graham Street
Project Description: The project consists of improving the flood control facility to convey a 100-year storm

19. What CRS category does action #2 apply to?

- [x] Preventative Measures (PR)
- [x] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [x] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

20. Name and short description of new action #3

Santa Ana River Channel Reach 5 Levee Height Correction (E01)
Project Limits: 300 feet d/s SR-22 freeway to 300 feet u/s I-5 Fwy
Project Description: The project consists of correcting the west levee height along E01 from the limits provided
CRS Categories: PR, SP

21. Name and short description of new action #4

Santa Ana-Delhi Channel (F01)
Project Limits: from Bayview Bridge to d/s Mesa Drive
Project Description: The project consists of widening portions of the channel to create additional habitat area, restoring channel slopes to convey a 100-year storm event, and replacing the existing bicycle bridge to allow continued coastal access

22. What CRS category does action #4 apply to?

- [x] Preventative Measures (PR)
- [x] Property Protection (PP)
- [ ] Public Information (PI)
- [x] Natural Resource Protection (NPR)
- [x] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

23. Name and short description of new action #5

East Garden Grove-Wintersburg Channel (C05)
Project Limits: from the confluence with Ocean View Channel (C06) to d/s Woodruff Street
Project Description: The project consists of reconstructing the existing trapezoidal earthen rip rap channel to a concrete rectangular channel, allowing the channel reach to convey a 100-year storm

24. What CRS category does action #5 apply to?

- [x] Preventative Measures (PR)
- [x] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [x] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

25. Name and short description of new action #6

Fullerton Creek Channel (A03)
Project Limits: from d/s of I-5 freeway to d/s of Dale Avenue
Project Description: The project consists of reconstructing the existing trapezoidal concrete lined channel and constructing concrete U-channel to convey a 100-year storm

26. What CRS category does action #6 apply to?

- [x] Preventative Measures (PR)
- [x] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [x] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

27. Do you have a Post Disaster Response Action Plan? *

- (•) Yes
- ( ) No

Thank you for your response!

**If you have questions or further new actions you would like to add, please contact grace.altenburg@tetratech.com.**

View results

Respondent

1 Anonymous

3070:30
Time to complete

## Community Participation

Please let us know which community you are filling out this form for along with your name and email so that we may contact you if needed.

1. Community: *

City of Newport Beach

2. Name of Respondent: *

Melissa Kubischta

3. Email of Respondent: *

mkubischta@newportbeachca.gov

## Strengths, Weaknesses, Obstacles, and Opportunities

We need to look at the following for each hazard of concern:

**Strengths** – what the County and communities do well; things upon which we can capitalize;

**Weaknesses** – what can be done better; what can be strengthened;

**Obstacles** – what stands in the way to implementation to prevent mitigation or response (for example regulatory, geographical, environmental, financial issues); and

**Opportunities** - actions or projects to mitigate issues or improve resilience.

4. Flooding - **Strength and Opportunities**

Newport Beach has a robust training program for plan check staff in the implementation of our Floodplain ordinance and a high turnover of residential inventory in the SFHA that allows us to have redevelopments built in compliance NFIP guidelines and our CRS 6 higher regulatory standards.

5. Flooding - **Weakness and Obstacles**

Very build up coastal and harbor areas with high cash values mean that we cannot reasonably limit development in large portions of the SFHA.

6. Coastal Flooding - **Strength and Opportunities**

The City of Newport Beach has a Coastal Land Use and Implementation Plan (NBMC Title 21). The Coastal Land Use Plan includes recommendations for berms and other temporary barriers and the Public Works department implements berm creation during the off season on City property.

7. Coastal Flooding - **Weakness and Obstacles**

Conflicts between zoning requirements and NFIP/CRS requirements for elevated structures in the VE zones discourage redevelopment of existing nonconforming structures to new standards.

8. Riverine Flooding - **Strength and Opportunities**

The Upper Newport Bay Ecological Reserve (UNBER) is a 752 acre property maintained by California Fish and Game as area to be preserved in a natural condition. The UNBER is in the flood channel for San Diego Creek which is the main tributary of the Newport Bay watershed and provides benefits for flood storage and conveyance.

9. Riverine Flooding - **Weakness and Obstacles**

Ageing and low bulkheads in the harbor in conjunction with regulatory requirements make improvements on the Harbor side difficult. Additionally, existing streets and parks that dead-end into the harbor are points of vulnerability.

10. Tsunami - **Strength and Opportunities**

City of Newport Beach has emergency notification sirens on the peninsula that are regularly maintained and tested.

11. Tsunami - **Weakness and Obstacles**

The majority of citizens in the mapped tsunami inundation zone have only one means of egress from the peninsula in the event of a tsunami warning.

12. Dam Failure - **Strength and Opportunities**

13. Dam Failure - **Weakness and Obstacles**

Citizens are not educated on the presence of reservoirs in the City and those in the inundation zones are largely unaware.

14. Sea Level Rise - **Strength and Opportunities**

The City of Newport Beach had its Local Coastal Program Implementation Plan approved by the California Coastal Commission on September 8, 2016 and went into effect on January 30, 2017. The Implementation Plan (NBMC Title 21) requires the City review development within the coastal zone for potential impacts from coastal hazards, including sea level rise. The City uses best-available science to determine the projected sea level rise range for the proposed project's planning horizon (i.e., life of project/structure) and applies appropriate conditions of approval, such as increasing heights of sea walls or finished floor elevations, to minimize potential impacts from flooding, wave runup, and erosion.

15. Sea Level Rise - **Weakness and Obstacles**

Public perception.

New Action Development

Below are a set of CRS categories to help guide new action development.

**Property Protection (PP)** -These actions include public activities to reduce hazard losses or actions that involve (1) modification of existing buildings or structures to protect them from a flood hazard or (2) removal of structures from the flood hazard area.
**Preventative Measures (PR)** - Government, administrative, or regulatory actions, or processes that influence the way land and buildings are developed and built. Examples include planning and zoning, capital improvement plans, etc.
**Public Information (PI)** - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them.
**Natural Resource Protection (NPR)** - Actions that minimize flood hazard loss and preserve or restore the functions of natural systems.
**Structural Flood Control Project (SP)** - Actions that involve the construction of structures to reduce the impact of a flood hazard. Such structures include dams, setback levees, floodwalls, retaining walls, and safe rooms.
**Emergency Services (ES)** - Actions that protect people and property during and immediately following a disaster or flood related hazard event. Services include warning systems, emergency response services, and the protection of essential facilities.

Please consider the hazards of concern (**flooding, coastal flood, riverine flood, tsunami, dam failure, and sea level rise**) and list any current or upcoming projects your community is implementing or planning to implement.

**Make sure to create an action that applies to each CRS category and addresses at least one or more than one of the hazards of concern (listed above)**

*Ex. Floodproofing the Fire Department Building- The City has extensive flood issues at the Fire Department Building. The City proposes to floodproof the Fire Department Building by elevating all utilities above flood levels (ac unit, electrical panel, etc.) and installing flood vents to lessen overall flood impacts to the structure. This will ensure continuity of operations for the Fire Department. CRS Category: ES and SP.*

16. Name and short description of new action #1

17. What CRS category does action #1 apply to?

- [ ] Preventative Measures (PR)
- [ ] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [ ] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

18. Name and short description of new action #2

19. What CRS category does action #2 apply to?

- [ ] Preventative Measures (PR)
- [ ] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [ ] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

20. Name and short description of new action #3

21. Name and short description of new action #4

22. What CRS category does action #4 apply to?

- [ ] Preventative Measures (PR)
- [ ] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [ ] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

23. Name and short description of new action #5

24. What CRS category does action #5 apply to?

- [ ] Preventative Measures (PR)
- [ ] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [ ] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

25. Name and short description of new action #6

26. What CRS category does action #6 apply to?

- [ ] Preventative Measures (PR)
- [ ] Property Protection (PP)
- [ ] Public Information (PI)
- [ ] Natural Resource Protection (NPR)
- [ ] Structural Flood Control Project (SP)
- [ ] Emergency Services (ES)

27. Do you have a Post Disaster Response Action Plan? *

- ( ) Yes
- (•) No

Thank you for your response!

**If you have questions or further new actions you would like to add, please contact grace.altenburg@tetratech.com.**

**FMP Participating Jurisdictions**

**Mitigation Action 1-on-1 Meetings:**

# ORANGE COUNTY (CA) FMP MITIGATION ACTION '1 ON 1' MTG.

## CITY OF LAGUNA WOODS (CA)

MEETING MINUTES

| | |
|---|---|
| **Purpose of Meeting:** | FMP Risk Assessment & Possible Mitigation Actions |
| **Location of Meeting:** | Virtual (Microsoft Teams) |
| **Date of Meeting:** | 05/16/2025 |

**Attendees:** TETRA TECH: Kevin Gambrill (KG); Grace Altenburg (GA); Lynn Welch (LW); Melissa Mitchell
CITY STAFF: Nadia Cook (NC) – City Conservation Administrator

**Agenda Summary:**

| Time | Description | |
|---|---|---|
| **12:30 PM** | **Welcome & Introductions**<br>Attendees signed into the virtual meeting and were logged. | |
| **12:35 PM** | KG: Description of Annex for Each City; Discussion needed to inform the 'Mitigation Catalog'. Began to discuss 'Adaptive Capacity'. Does the City have the capacity to mitigate, and if so, what does that translate into in terms of resource needs? Discussion with staff and City regarding assigning priority to identified risk (Low-Med-High). | |
| **12:43 PM** | NC: Our flooding is dominated by channelized flooding and specific areas of stormwater overflows.<br>KG: Where exactly?<br>NC: Intersection of El Toro Road and Avenida Sevilla, which is unable to adequately manage runoff during heavy rain events<br>KG: What rivers or waterbodies does the City have to be concerned with in terms of flooding?<br>NC: The main water body in Laguna Woods associated with riverine flooding is Aliso Creek.<br>KG: Does the City know where its high-risk properties are with flooding?<br>NC: The City does not keep a dedicated list of properties damaged by flooding; however, records of permitted work within Special Flood Hazard Areas are maintained through the City's building permit management system.<br>KG: What about substantial damage? Does the City know where those properties / structures are?<br>NC: No substantial damages have been declared for recent flood events in Laguana Woods.<br>KG: Have there been any flood mitigation activities in the City in recent years?<br>NC: No, there have been no recently permitted mitigation activities in Laguna Woods. | |
| **12:50 PM** | KG: Begin Risk Ranking; Flood (SFHA), Tsunami, SLR, Dam Failure = LOW;<br>Flood (SFHA), Coastal Flood and Riverine Flood (Channels) = HIGH | |

| Time | Description | |
|---|---|---|
| 12:55 PM | KG: Given the size and limited budget of the City, what projects has the City prioritized to mitigate flooding?<br>NC: We do need to increase capacity is some of our more aging storm drain infrastructure, especially during heavy rain events.<br><br>KG: Okay, that is definitely something we will include in the Annex / Mitigation Action list. Is that throughout the City?<br>NC: Yes, city wide review and maintenance. Would be staggered over several CIP years though. We would of course concentrate on issues along Aliso Creek.<br><br>KG: Does the City have a post-disaster plan?<br><br>NC: No, we do not. We don't have a dedicated website for public safety and/or hazard mitigation either.<br><br>KG: If this is a relatively easy action, lets include in the Mitigation Strategy? The City will want to include General FEMA guidance on flooding, evacuation maps, local Hazard Mitigation Plans, emergency response guidance.<br><br>NC: Sounds good to us.<br><br>KG: With our time about to end, we can review our notes and send the City the Draft Annex document for your review and feedback. Thank you! | |
| 1:00 PM | Meeting Adjourned / Ended | |

# ORANGE COUNTY (CA) FMP MITIGATION ACTION '1 ON 1' MTG.

## CITY OF NEWPORT BEACH (CA)

MEETING MINUTES

| | |
|---|---|
| **Purpose of Meeting:** | FMP Risk Assessment & Possible Mitigation Actions |
| **Location of Meeting:** | Virtual (Microsoft Teams) |
| **Date of Meeting:** | 05/28/2025 – 11:00 AM (CST) / 9:00 AM (PST) |
| **Attendees:** | Kevin Gambrill (KG); Melissa Kubischta (MK) |
| **Agenda Summary:** | |

| Time | Description |
|---|---|
| **11:00 AM** | **Welcome & Introductions**<br>Attendees signed into the virtual meeting and were logged. |
| **11:05 AM** | KG: Discuss Flood Hazard Risk Ranking (high / med / low)<br>• Flooding & SFHA: Citizen's view SFHA as 'administrative' action; not actual risk? Media / news reports show shallow flooding in AO zone, but citizens don't make that connection.<br>• Riverine Flooding: Most 'visible' problem; harbor into peninsula toward coast.<br>• Coastal Flooding: 250 houses / 'V' zones – and immediately adjacent zone. Est. grade based on flood height – then neighboring dwelling is much higher than adjacent house.<br>• Dam Failure: Generally, the community is unaware of this risk.<br>• Sea Level Rise: Generally, the community is unaware of this risk. The state has selected Newport Beach as one of the States' agreements with the California Coastal Commission.<br>• Tsunami: Generally, the community is unaware of this risk. |
| **11:15 AM** | KG: Open up discussion on possible mitigation actions.<br><br>**Flood & SFHA**: Mitigation Actions are ongoing; redevelopment in the SFHA must meet the City's higher regulatory standard (i.e. 6ft.). Cannot otherwise 'limit' development due to very high property valuations along coast / harbor.<br><br>**Riverine Flooding:** Upper Newport Bay Wildlife Preserve is within the SFHA but cannot disturb this area as it is a State designated ecological wildlife preserve. CRS points are earned since this is considered naturally preserved open space. City will follow-up with Staff on CIP and/or project list from DPW for projects within the SFHA and/or stormwater management projects.<br><br>**Coastal Flooding:** Balboa Island Seawall Extension project elevated height of existing seawall; project combined this with addition of locks that operate during high-tides / large storms. Protection of key areas – i.e. Balboa Blvd.<br>Ongoing Maintenance – DPW implements 'Coastal Land Use and Implementation Plan' recommended action to install berms and similar barriers along coastal areas / areas vulnerable to wave action / erosion.<br><br>FMP Annex. Should discuss high-tides and 'king tides' as specific types of coastal flood risk.<br><br>Proposed 2025-2026 CIP:<br>Balboa Island Drainage Master Plan / Pump Station (p. 22) |

| | | |
|---|---|---|
| | Storm Drain System Repair / Rehabilitation (p. 37)<br><br>Balboa Island Seawall (p. 69)<br>Balboa Island Seawall / Ferry Landing (p. 70)<br><br>Dam Failure: N/A – 4 dams that are the source of flooding for the City (3 within City limits?), but all are maintained by the State or County<br><br>Sea Level Rise:<br>Ongoing Maintenance – Balboa Island Seawall Extension project elevated height of existing seawall; project combined this with addition of locks that operate during high-tides / large storms.<br><br>Balboa Island Seawall (p. 69)<br><br>Balboa Island Seawall / Ferry Landing (p. 70)<br><br>Tsunami:<br>Ongoing Maintenance: Have an existing Tsunami warning system that is tested monthly. | |
| **11:25 PM** | Next Steps: Incorporate possible measures into a 'mitigation catalog' within the City Annex.<br>Where possible, align actions in 'mitigation catalog' with CRS Activities / Credits. | |
| **11:33 AM** | ADJOURN | |

**FLOOD**

Newport Beach has a robust training program for plan check staff in the implementation of our Floodplain ordinance and a high turnover of residential inventory in the SFHA that allows us to have redevelopments built in compliance NFIP guidelines and our CRS 6 higher regulatory standards.

**Obstacles:**

Very built up coastal and harbor areas with high cash values mean that we cannot reasonably limit development in large portions of the SFHA.

**RIVERINE**

The Upper Newport Bay Ecological Reserve (UNBER) is a 752-acre property maintained by California Fish and Game as an area to be preserved in a natural condition. The UNBER is in the flood channel for San Diego Creek which is the main tributary of the Newport Bay watershed and provides benefits for flood storage and conveyance.

**Obstacles:**

Ageing and low bulkheads in the harbor in conjunction with regulatory requirements make improvements on the Harbor side difficult. Additionally, existing streets and parks that dead-end into the harbor are points of vulnerability.

**COASTAL FLOOD**

The City of Newport Beach has a Coastal Land Use and Implementation Plan (NBMC Title 21). The Coastal Land Use Plan includes recommendations for berms and other temporary barriers, and the Public Works department implements berm creation during the off season on City property.

**Obstacles:**

Conflicts between zoning requirements and NFIP/CRS requirements for elevated structures in the VE zones discourage redevelopment of existing nonconforming structures to new standards.

**SEA LEVEL RISE**

The City of Newport Beach had its Local Coastal Program Implementation Plan approved by the California Coastal Commission on September 8, 2016, and went into effect on January 30, 2017. The Implementation Plan (NBMC Title 21) requires the City review development within the coastal zone for potential impacts from coastal hazards, including sea level rise. The City uses the best-available science to determine the projected sea level rise range for the proposed project's planning horizon (i.e., life of project/structure) and applies appropriate conditions of approval, such as increasing heights of sea walls or finished floor elevations, to minimize potential impacts from flooding, wave runup, and erosion.

**Obstacles:** Public perception.

**DAM FAILURE**

**Obstacles:**

Citizens are not educated on the presence of reservoirs in the City and those in the inundation zones are largely unaware.

**TSUNAMI**

The city of Newport Beach has emergency notification sirens on the peninsula that are regularly maintained and tested.

**Obstacles:** The majority of citizens in the mapped tsunami inundation zone have only one means of egress from the peninsula in the event of a tsunami warning.

# ORANGE COUNTY (CA) FMP MITIGATION ACTION '1 ON 1' MTG.

## CITY OF SAN JUAN CAPISTRANO (CA)

MEETING MINUTES

| | |
|---|---|
| **Purpose of Meeting:** | FMP Risk Assessment & Possible Mitigation Actions |
| **Location of Meeting:** | Virtual (Microsoft Teams) |
| **Date of Meeting:** | 05/12/2025 |
| **Attendees:** | TETRA TECH: Kevin Gambrill (KG); Grace Altenburg (GA); Lynn Welch (LV<br>CITY STAFF: Justin Inducil (JI); Natalia Chavez (NC); Shawn Mousavi (SM) |
| **Agenda Summary**: | |

| Time | Description | Action item(s): |
|---|---|---|
| **12:30 PM** | **Welcome & Introductions**<br>Attendees signed into the virtual meeting and were logged. | - |
| **12:35 PM** | GA: Description of Annex for Each City; Discussion needed to inform the 'Mitigation CatLog'. Lead discussion toward 'Adaptive Capacity'. What are the community obstacles and strengths as it relates to their capacity to mitigate. Discussion with staff and City regarding assigning priority to identified risk (Low-Med-High). | - |
| **12:43 PM** | SM: Considering a Storm Drain Master Plan; Remap the boundaries for the city. What Areas actually flood? The last plan was in the mid-1970's<br>GA: What about Riverine Flooding;<br>SM: Not too much of a risk with respect to riverine flooding? Deferring to Natalia? No, not too much. Perhaps City enhances the notification? The city may have an emergency notice system.<br>GA: Coastal Flooding?<br>SM: Regional Coordination needs to be improved with respect to coastal flooding.<br>GA: Great! May want to add increased coordination at the regional level with hazard risks that are lower than others (EX: SLR);<br>SM: SLR Impacts; Perhaps looking at Coastal Ecosystems?<br>SM: Dam Failure; Closest dam is the Trampus Canyon Dam – couple miles away;<br>SM: Tsunami and Coastal Flooding are similar in that they are low risk; more communication maybe? But, for City not a huge risk. | Add Storm Drain Master Plan as possible activity in Mitigation Catalog |
| **12:47 PM** | GA: Begin Risk Ranking; Tsunami, SLR, Coastal Flood, and Dam Failure = LOW;<br>Flood (SFHA), Riverine = MED;<br>KG: Is 'Riverine' risk in City natural or urban / channelized?<br>SM: Will revisit; will perhaps put Riverine at 'MED'. | City examine extent of natural riverine flooding vs. channelization |

| Time | Description | Action Item(s) |
|---|---|---|
| **12:52 PM** | SM: City is pursuing a Storm Drain Project; replacing / retrofitting corrugated pipes. City applied to CTA for Connective Pipe Screens (CPS) grant, this will allow for a full capture for our priority land uses (PLU's).<br>GA: Does the City have a post-disaster response plan?<br>SM: Yes, need to have it sent.<br>GA: Substantial Damage Plan?<br>SM: Need to get back to us.<br>GA: RLAA Started?<br>SM: Sent w/ CRS.<br>NC: Q: Do we need to do a RLAA if we haven't had a RL claim in 10 years?<br>GA: Staff will follow up;<br>LW: Yes, we will look.<br>GA: Once we have the GIS Maps and in the Draft Annex; will have the City review. | |
| **12:58 PM** | Meeting Adjourned / Ended | |

# ORANGE COUNTY (CA) FMP – MITIGATION ACTIONS 1-ON-1

## CITY OF SANTA ANA (CA)

MEETING MINUTES

| | |
|---|---|
| **Purpose of Meeting:** | Santa Ana Annex – Mitigation Actions Discussion Meeting |
| **Location of Meeting:** | Virtual (Microsoft Teams) |
| **Date of Meeting:** | July 11th, 2025 – 1:00 PM CST / 11:00 AM PST |

**Attendees:** Rudy Rosas (RR), City Engineer, Ci. of Santa Ana
Craig Foste (CF), NPDES SWM Coordinator, Ci. of Santa Ana
Steve Rhyner (SR), Police, Ci. of Santa Ana
TETRA TECH: Grace Altenberg (GA); Kevin Gambrill (KG); Lynn Welch (LW) ]

**Agenda Summary**:

| TIME | Description |
|---|---|
| **1:02 PM** | Opening Remarks (GA)<br>• The meeting was convened to discuss the City of Santa Ana's annex for the Orange County Floodplain Management Plan (FMP).<br>• The annex serves as a mini-chapter highlighting the city's capabilities, vulnerabilities, and project needs, with a focus on developing and documenting mitigation actions for flood hazards. |
| **1:06 PM** | Points of Contact and Departmental Responsibilities<br>• Rudy Rosas and Craig Foste were confirmed as the primary and alternate points of contact, respectively, for the annex process. This may be revised if responsibilities shift.<br>• It was acknowledged that responses and data collection would involve multiple departments and staff members, depending on specialization |
| **1:15 PM** | Review of City Plans and Ordinances<br>• RR – Planning & Bldg. Agency – Building Code; Zoning and Land Use; Sub-division; Site Development<br>• GA – What about SWC? RR - That would be Dept. of Public Works, Mr. Craig Foster<br>• GA – Post Disaster Recovery Code? SR – Have a plan, but not a code.<br>• GA – We will have a line-item for plan in annex.<br>• GA – Growth Mngt. Ordinance? RR – Nothing outside the Zoning Code<br>• GA – Environmental Code? CF – Stormwater 18.155 – NPSES<br>• GA – Floodplain Ordinance? RR – Planning and Zoning<br>• GA – Wellhead Protection? RR – Chapter. 39, State Regs., but City complies through DPW.<br>• GA – Emergency Mngt. Ordinance? RS – Police Dept.<br>• RR – Ali Pezeshkpour (Planning & Building Dept) is the City FPA per Santa Code<br>• GA – General Plan (Ali)<br>• GA – CIP? Public Works<br>• GA – Disaster Debris Mngt. Plan? RS – No, but need to add<br>• GA – SWMP? RR – Dept. Public Works – SW Project Master Plan<br>• GA – Open Space Plan? RR – Element w/n General Plan (Ali) + Parks Master Plan (Appropriate Funds is Rec and Parks; Public Works Implements the projects).<br>• GA – Continues to review the plans and projects list in the Table GA; Does City have a Sub. Dam Plan?<br>• LW – Review of Substantial Damage Plan and overview of what it entails. |

| | | |
|---|---|---|
| **1:35** | Begin review of Table 1-3 in the Santa Annex.<br>GA – What agencies Planning and Building Agency is responsible for permits.<br>GA – Does the City have a Floodplain Development Permit?<br>RR – Defer to Planning and Building.<br>GA – Buildable Land Inventory?<br>RR – Defer to City Planning & Building Agency. | |
| **1:38** | GA – Table 1-4; Planning Board? Yes; Planning Commission; ZBA? Yes, Planning Commission. | - |
| **1:50** | GA – Table 'Fiscal Capabilities' Review | |
| **1:52** | GA – Worksheet Review w/ City Staff (A, B, C, etc.); RR – Provides online resource listing major projects and monthly development reports; SR – List of projects from CIP and SW; SR will send to TT Staff; TT Staff to review. | |
| **1:59** | GA – Review of Flood Mit. Action Development Survey; GA to send to City Staff; City Staff should review and answer if possible. | |
| **2:00** | SR – Timetable? GA – Yes, Going to try for Public Review Meeting in August. Want Annex documents reviewed and completed by early August. RR – He will send out forms to other staff . | |
| **2:02** | Meeting Adjourned. | |

# APPENDIX F. PROGRESS REPORT TEMPLATE

## Orange County, California Floodplain Management Plan Annual Progress Report

**Reporting Period:** *(Insert reporting period)*

**Background:** Orange County developed a floodplain management plan (FMP) to reduce its flooding risk by identifying resources, information, and strategies for risk reduction. To prepare the plan, Orange County organized resources, assessed risks from flooding, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from floods. The plan can be viewed on-line at:

*[Insert website]*

**Summary Overview of the Plan's Progress:** The performance period for the FMP became effective on _____, 2025, with the final plan being approved by the County Board of Supervisors. The initial performance period for this plan will be 5 years, with an anticipated update to the plan to occur before _____, 2030.

As of this reporting period, the performance period for this plan is considered to be_____% complete.

The FMP has targeted XX floodplain management actions to be pursued over the 5-yr. performance period.

As of the reporting period, the following overall progress can be reported:

___out of __actions (_%) reported ongoing action toward completion.

___out of __actions (_%) were reported as being complete.

___out of __actions (_____%) reported no action taken.

**Purpose:** The purpose of this report is to provide an annual update on the implementation of the action plan identified in the Orange County FMP. The objective is to ensure that there is a continuing and responsive planning process that will keep the FMP dynamic and responsive to the needs and capabilities of Orange County and stakeholders. This report discusses the following:

- Flood events that have occurred within the last year
- Changes in risk exposure within the planning area
- Mitigation success stories
- Review of the action plan
- Changes in capabilities that could impact plan implementation
- Recommendations for changes/enhancement.

**The FMP Steering Committee:** The Steering Committee, made up of stakeholders within the County, reviewed and approved this progress report at its meeting held on _____, 202_. It was determined through the plan's development process that the Steering Committee would remain in service to oversee maintenance of the plan. At a minimum, the Steering Committee will provide technical review and oversight on the development of the annual progress report. It is anticipated that there will be turnover in the membership annually, which will be documented in the progress reports. For this reporting period, Steering Committee membership is as indicated in Table 1.

**Table 1. Steering Committee Members**

| Name | Organization | Alternate |
|---|---|---|
| ***Orange County Government Representatives*** | | |
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| ***Non-Voting Orange County Government Representatives*** | | |
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| ***Non-Government Representatives*** | | |
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**Flood Events within the County:** During the reporting period, there were XX flood events in the County that had a measurable impact on people or property. A summary of these events is as follows:

**Changes in Risk Exposure in the Planning Area:** *(Insert brief overview of any flood event in the County that changed the probability of occurrence of flooding as presented in the FMP)*

**Mitigation Success Stories:** *(Insert brief overview of mitigation accomplishments during the reporting period)*

**Review of the Action Plan:** Table 2 reviews the action plan, reporting the status of each action. Reviewers of this report should refer to the FMP for more detailed descriptions of each action and the prioritization process. *Address the following in the "status" column of the following table:*

- *Was any element of the action carried out during the reporting period?*
- *If no action was completed, why?*
- *Is the timeline for implementation for the action still appropriate?*
- *If the action was completed, does it need to be changed or removed from the action plan?*

Table 2. Action Plan Matrix

| Action Number | Action | Lead Agency/ Dept. | Timeline | Priority | Status (No progress, in progress, complete, or discontinued) |
|---|---|---|---|---|---|
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**Changes That May Impact Implementation of the Plan:** *(Insert brief overview of any significant changes in the County that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

**Recommendations for Changes or Enhancements:** Based on the review of this report by the Steering Committee, the following recommendations will be noted for future updates or revisions to the plan:

- _____
- _____
- _____
- _____

***Public review notice:*** The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the Orange County Board of Supervisors, to local media outlets, and is posted on the Orange County flood information website. Any questions or comments regarding the contents of this report should be directed to:

NAME/POC, TITLE / AGENCY
Orange County Public Works
County Administration
South
601 N. Ross Street,
Santa Ana, CA
92701
Phone:(714) 667-8800

# APPENDIX G. PLAN ADOPTION RESOLUTION

**Intentionally left blank for adopting resolution.**

RESOLUTION OF THE BOARD OF SUPERVISORS OF

ORANGE COUNTY, CALIFORNIA

DATE

WHEREAS, the Community Rating System (CRS) is a voluntary program for National Flood Insurance Program (NFIP) participating communities and the goals of the CRS are to reduce flood damages, strengthen and support the insurance aspects of the NFIP, and encourage a comprehensive approach to floodplain management; and

WHEREAS, the CRS was developed to provide incentives in the form of premium discounts for communities that go beyond the minimum floodplain management requirements to develop extra measures to provide protection from flooding; and

WHEREAS, pursuant to Resolution No. XXX, the County entered into an agreement with Tetra Tech, Inc., ADDRESS, for a thorough review of the floodplain management program in effect for the County, including a scoring evaluation in accordance with the 2025 Community Rating System (CRS) Manual and 2021 Addendum to the 2017 CRS Coordinator's Manual; and

WHEREAS, the County is an active participant in the CRS program and is presently a Class 5 community, which equates to a 25% reduction in flood insurance premiums for unincorporated County residents; and

WHEREAS, Orange County has developed a Multi-jurisdictional Hazard Mitigation Plan (OCHMP) which allows jurisdictions within the County to satisfy a critical pre-requisite requirement identified in Section 510 (Floodplain Management Planning) of the CRS Coordinator's Manual; and

WHEREAS, A proposal was received by the Orange County Public Works of MONTH, DAY, YEAR from Tetra Tech, Inc., ADDRESS to provide the above services, at a cost of $XXX; and

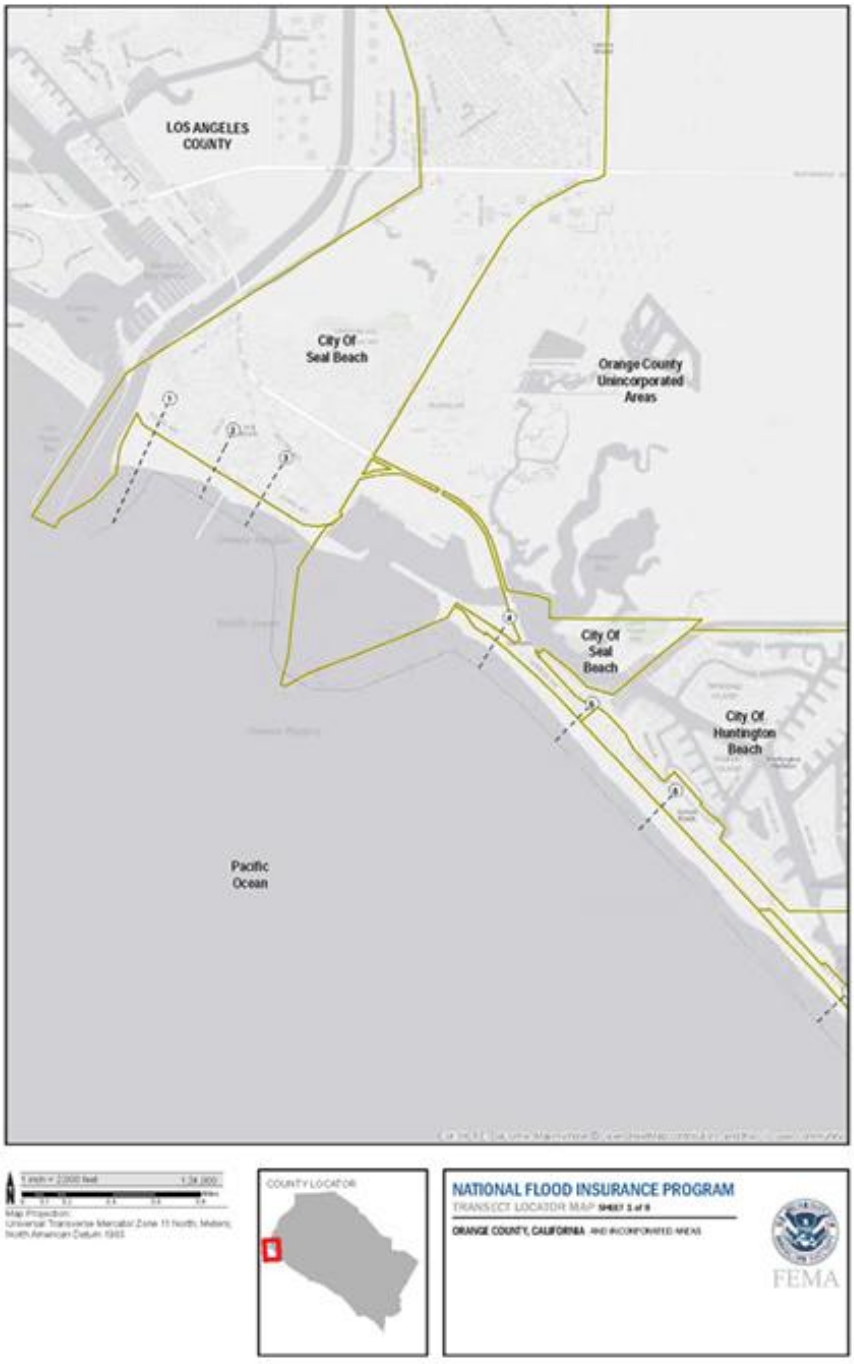
WHEREAS, the Floodplain Management Plan is to be adopted by DATE;

NOW, THEREFORE, be it RESOLVED, by the Orange County Board of Supervisors, California that the TITLE be and hereby is authorized to enter into an agreement with Tetra Tech, Inc., ADDRESS for professional consulting services to assist the County with the CRS Cycle Verification and to develop a Floodplain Management Plan, at a cost of $XXX Funds are available at Account No. XXX (NAME).

NOW, THEREFORE, BE IT RESOLVED that

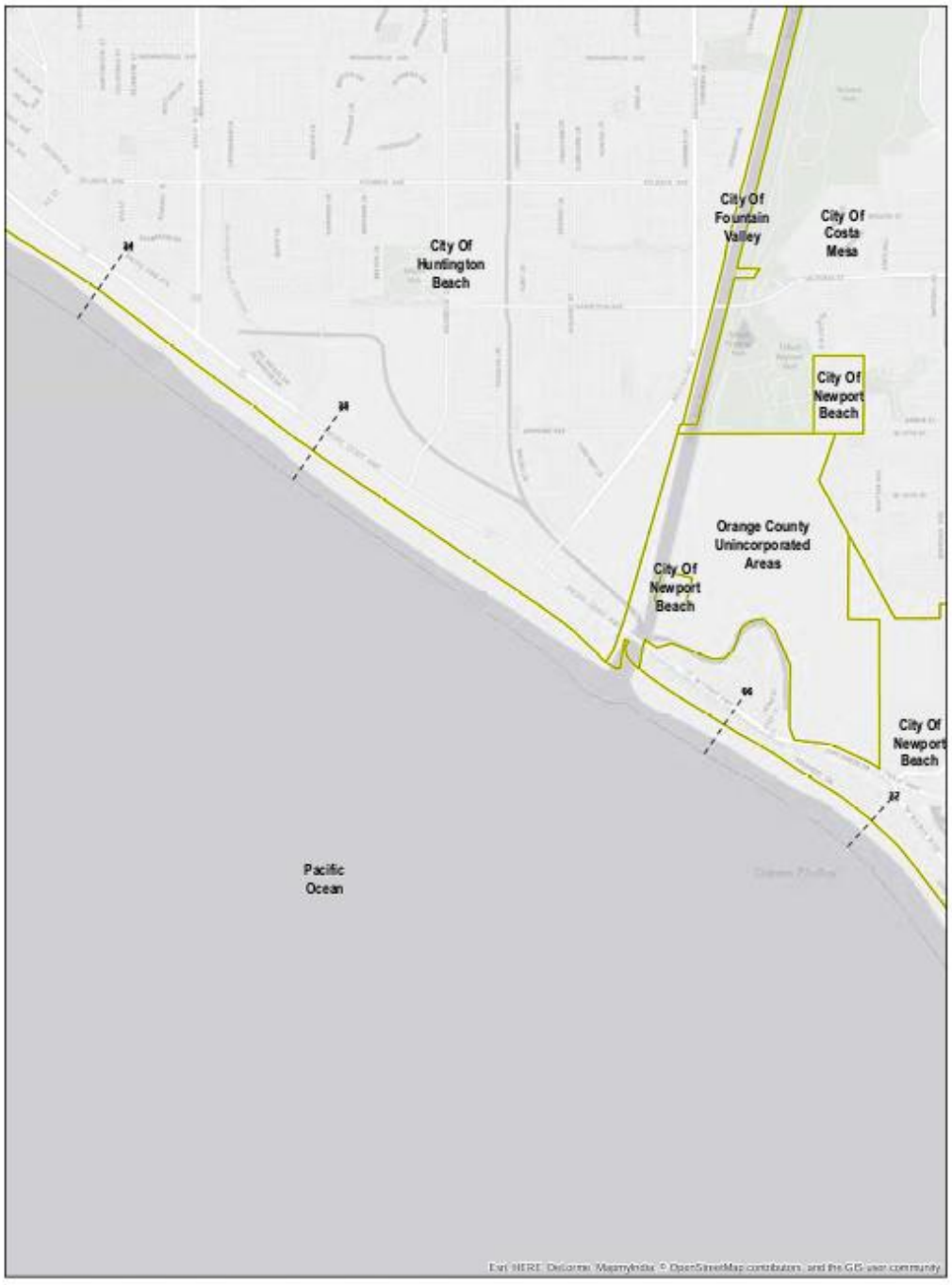
1. The County of Orange Floodplain Management Plan is hereby adopted.
2. The Director of Public Works or designee is authorized, after review and approval by County Counsel, to make minor, non-substantive amendments to the County of Orange Floodplain Management Plan that do not materially alter the intent or scope of the Plan.

# APPENDIX H. ORANGE COUNTY FIS COASTAL TRANSECT DATA MAPS

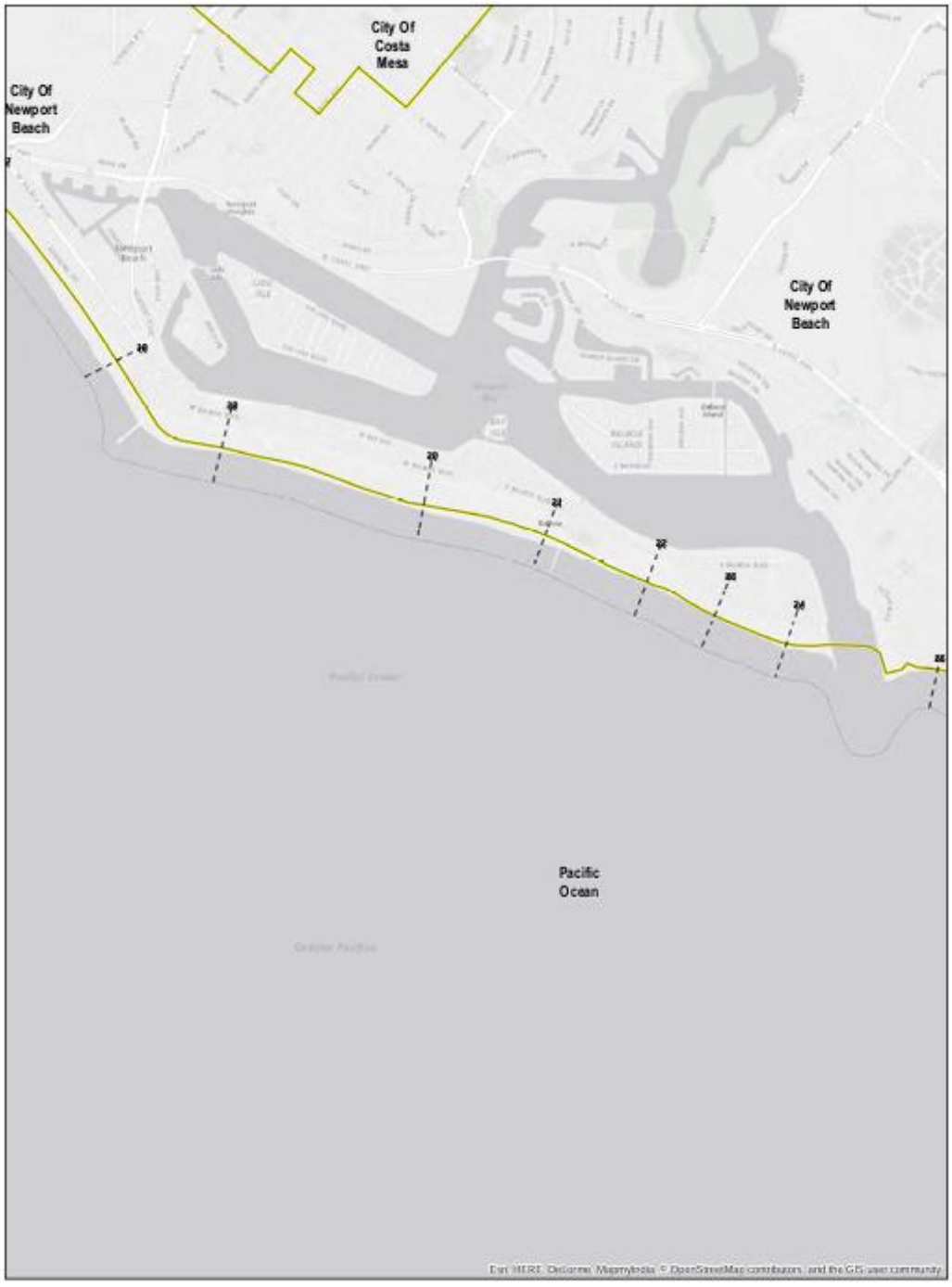



Orange County
Unincorporated
Areas
City Of
Huntington
Beach
Pacific
Ocean
Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community
1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 2 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

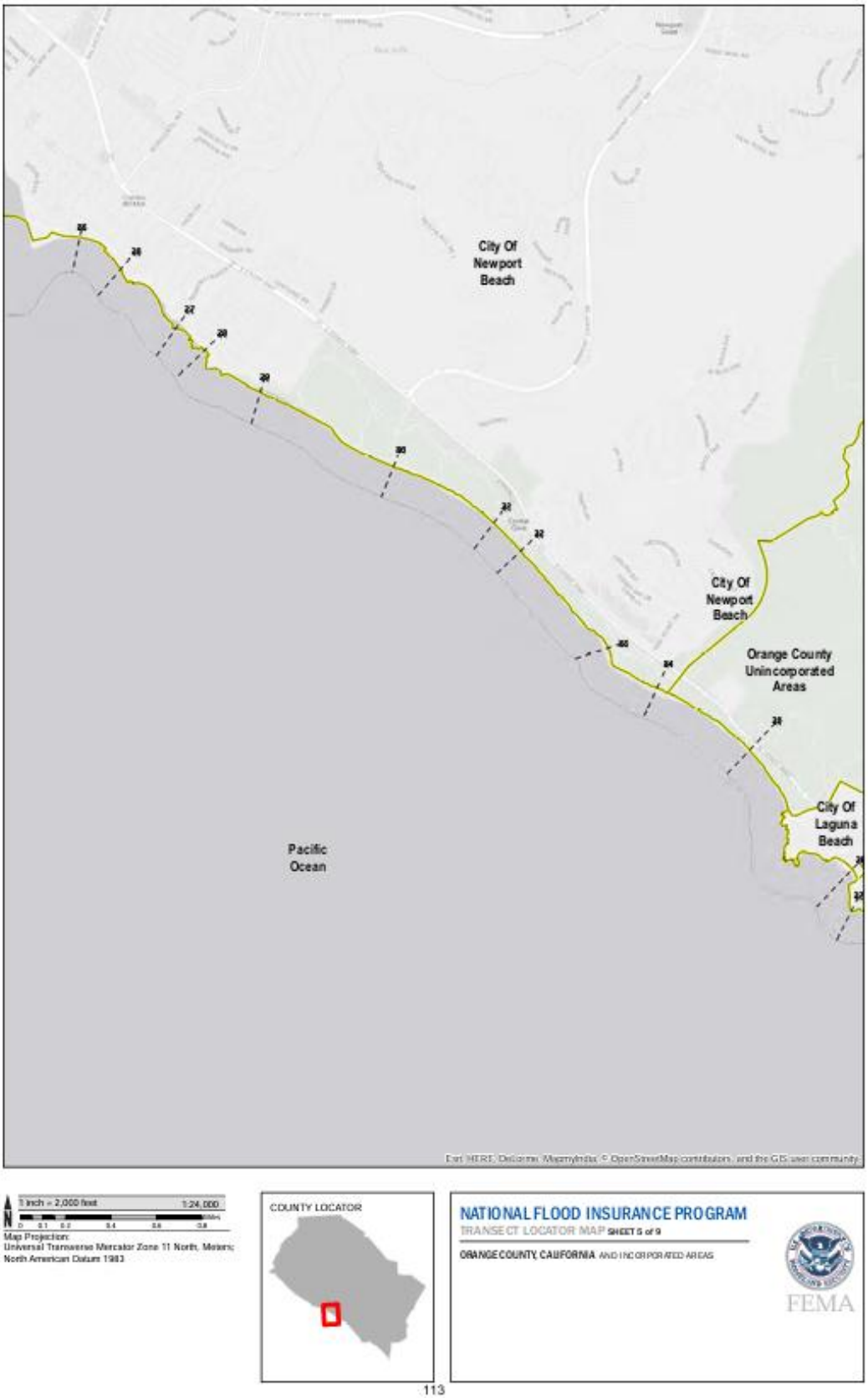
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City Of Huntington Beach
City Of Fountain Valley
City Of Costa Mesa
City Of Newport Beach
Orange County Unincorporated Areas
City Of Newport Beach
City Of Newport Beach
Pacific Ocean
84
84
84
82
1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 3 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

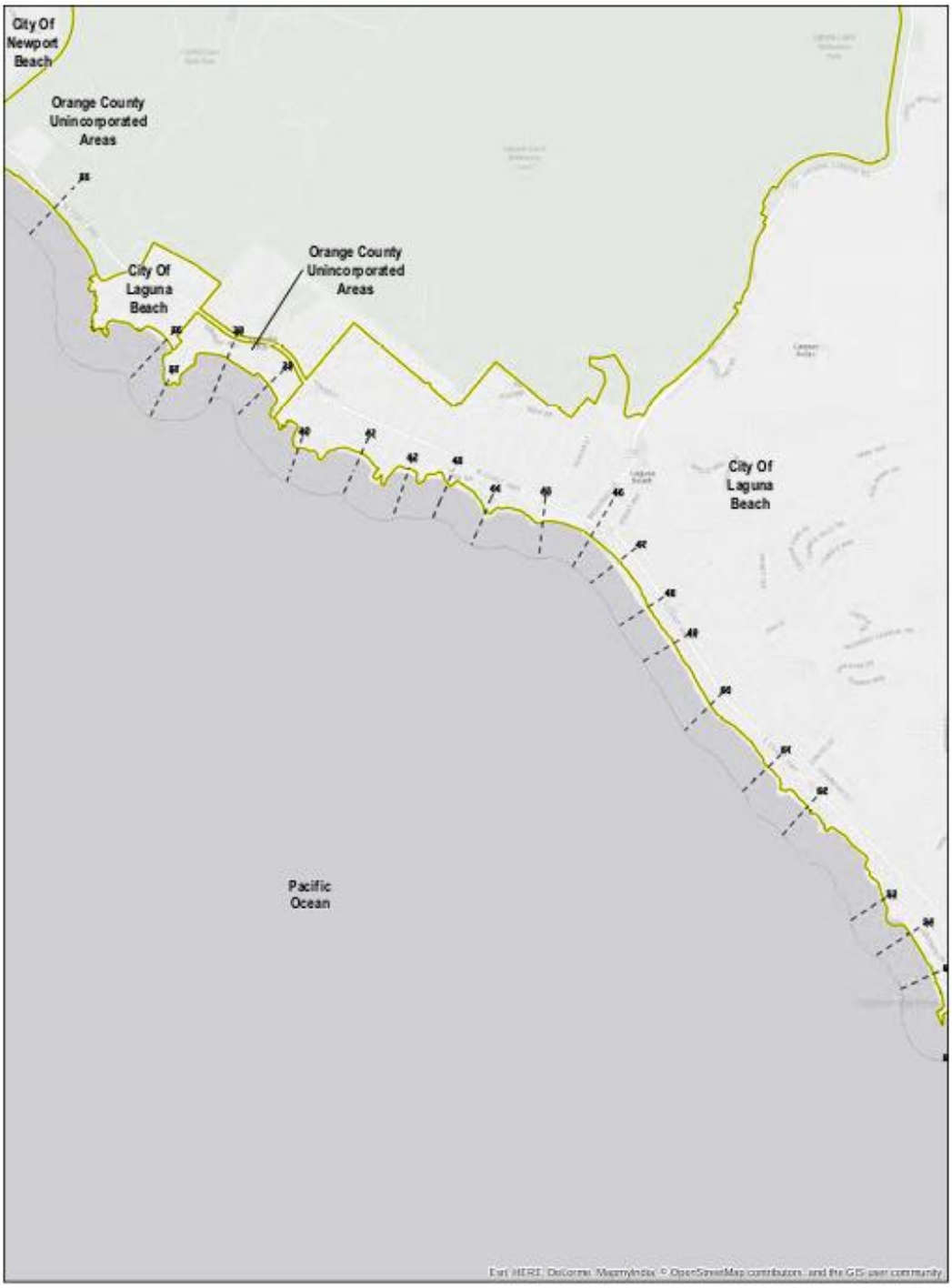
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City Of
Costa
Mesa
City Of
Newport
Beach
City Of
Newport
Beach
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28
Pacific
Ocean
1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 4 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

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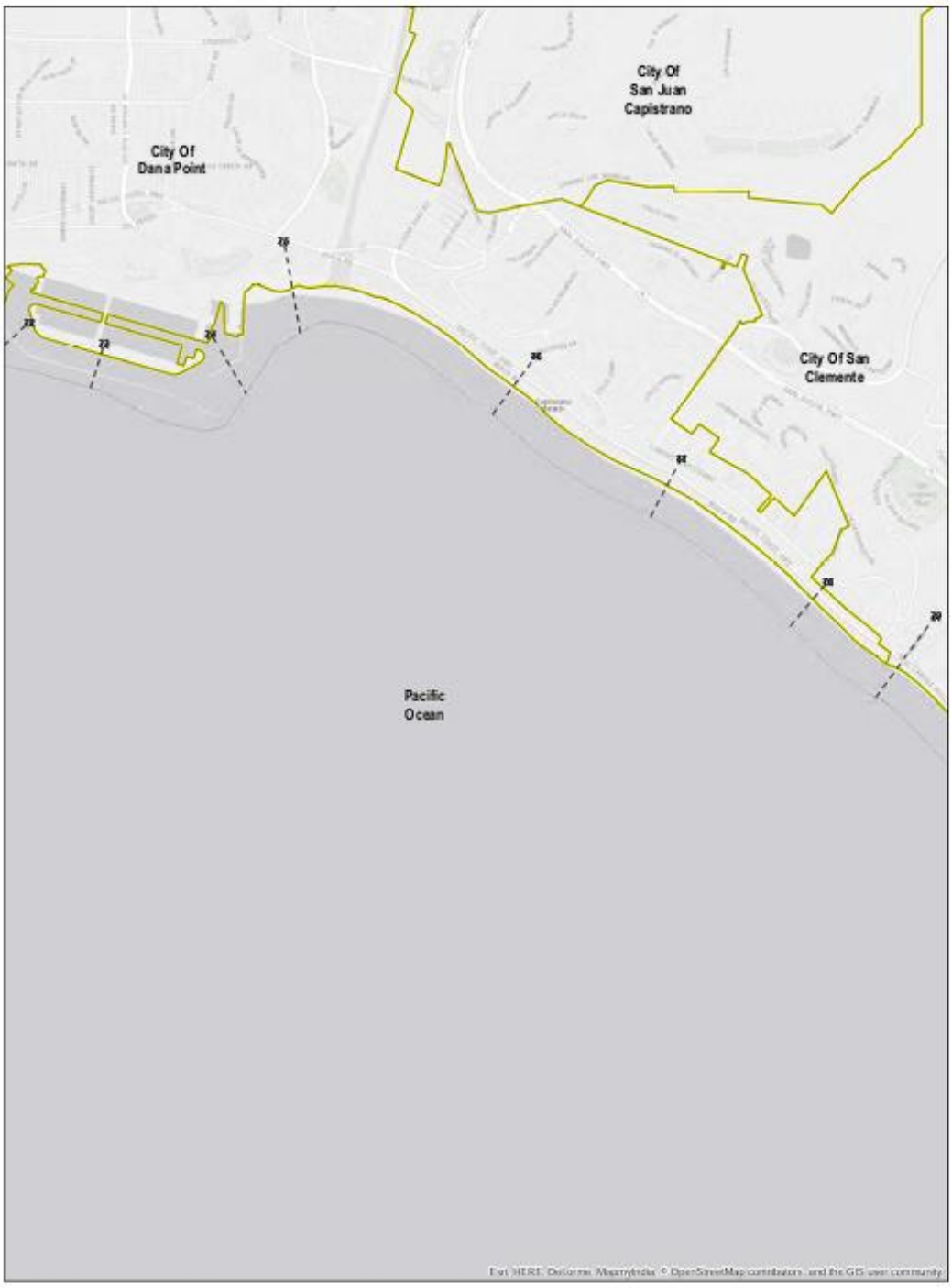

City Of
Newport
Beach
City Of
Newport
Beach
Orange County
Unincorporated
Areas
City Of
Laguna
Beach
Pacific
Ocean
1 inch = 2,000 feet
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Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 5 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

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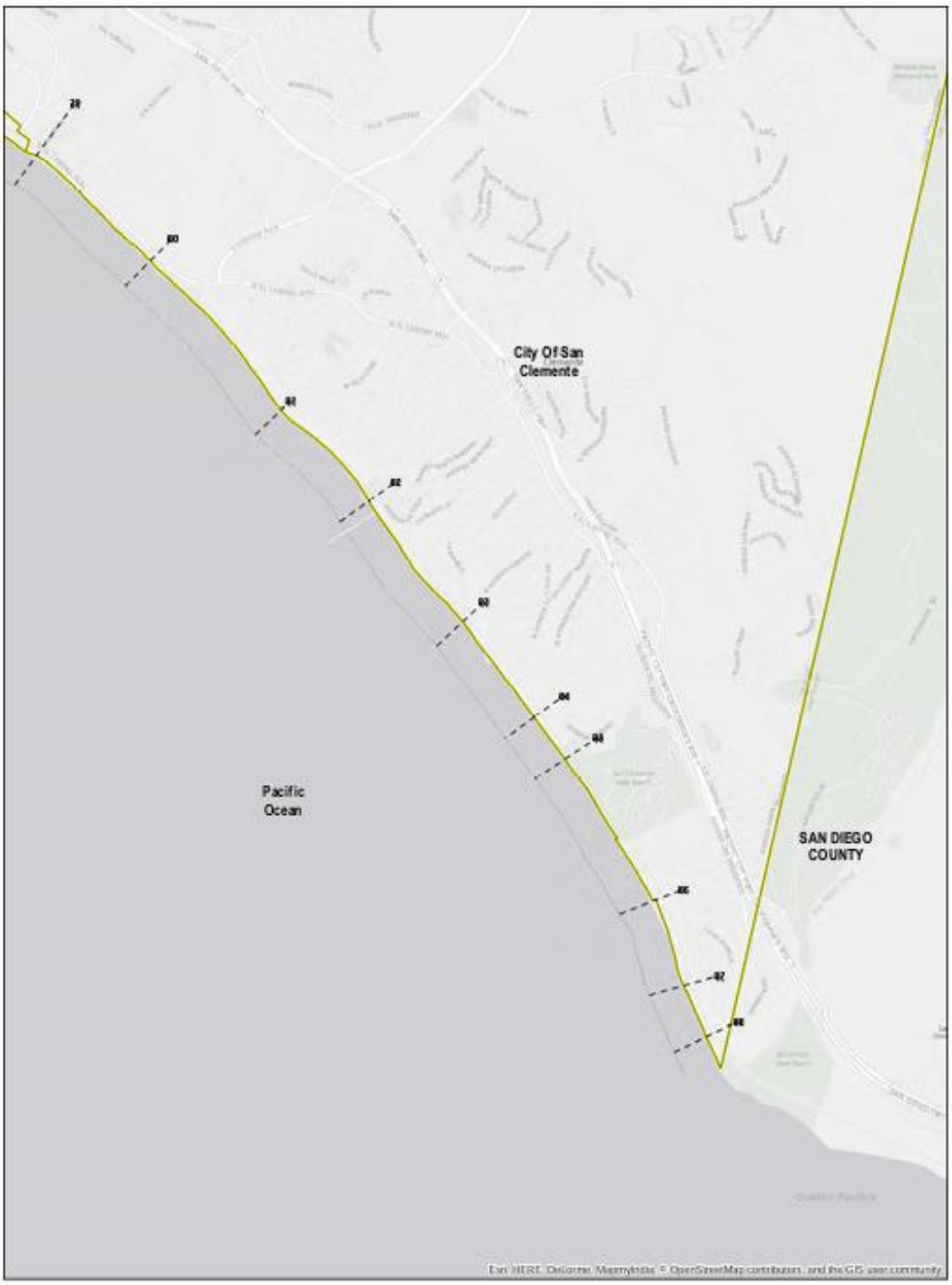

City Of Newport Beach
Orange County Unincorporated Areas
City Of Laguna Beach
Orange County Unincorporated Areas
City Of Laguna Beach
Pacific Ocean
1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 6 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA
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Orange County Unincorporated Areas
City Of Laguna Beach
City Of Laguna Niguel
City Of Dana Point
Pacific Ocean
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1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 7 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

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City Of
San Juan
Capistrano
City Of
Dana Point
City Of San
Clemente
Pacific
Ocean
1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 8 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

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City Of San Clemente
Pacific Ocean
SAN DIEGO COUNTY
1 inch = 2,000 feet
1:24,000
Map Projection:
Universal Transverse Mercator Zone 11 North, Meters;
North American Datum 1983
COUNTY LOCATOR
NATIONAL FLOOD INSURANCE PROGRAM
TRANSECT LOCATOR MAP SHEET 9 of 9
ORANGE COUNTY, CALIFORNIA AND INCORPORATED AREAS
FEMA

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