THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Committee Item
INFORMATION

Engineering, Operations, and Technology Committee

4/13/2026 Committee Meeting

6b

Subject

Hazard Mitigation Plan Update

Executive Summary

Metropolitan is developing a Local Hazard Mitigation Plan (LHMP) to assess the risks to critical infrastructure and operations posed by natural hazards. The LHMP includes risk assessments for dam failure, drought, earthquakes, extreme heat, floods, landslides, wildfires, and wind. Completion of an LHMP is required to be eligible for receipt of federal grants awarded under the Disaster Mitigation Act. Potential grant awards can be used to offset implementation costs for projects or programs designed to mitigate natural hazards affecting Metropolitan's operations.

The California Office of Emergency Services (CalOES) has completed its review of the draft LHMP and forwarded it to the Federal Emergency Management Agency (FEMA) for its review. Staff will return to the Board following FEMA's conditional approval for formal adoption of the LHMP. See **Attachment 1** for a public review draft of the LHMP.

Fiscal Impact

None

Applicable Policy

Operating Policy A-06: Emergency Management and Business Continuity

Operating Policy A-07: Authority to Evacuate Metropolitan Facilities

Operating Policy E-01: Security and Protection of Infrastructure

Related Board Action(s)/Future Action(s)

Metropolitan Local Hazard Mitigation Plan Adoption

Details and Background

Background

Historically, Metropolitan has assessed its system's risk from various hazards and has identified and implemented programs and projects to mitigate those risks. These mitigation efforts have been funded through Metropolitan's Capital Investment Plan and O&M budget. The federal Disaster Mitigation Act of 2000 requires state and local governments to have a completed hazard mitigation plan to be eligible to receive specific federal grants for natural disaster mitigation. Metropolitan staff has developed an LHMP, which will make Metropolitan eligible for previously inaccessible federal hazard mitigation grant funds. These funds can be used to offset the costs of implementing projects or programs to mitigate the effects of various natural hazards, such as earthquakes, wildfires, or drought.

Metropolitan's LHMP was developed by a planning team composed of Metropolitan staff from Engineering Services, External Affairs, Emergency Management, Finance, Legal, Operations, and Security, as well as professional consultants. The plan development also considered input from stakeholders representing interests within Metropolitan's service area, including member agencies and operational area emergency managers. The plan was released for public review and comment on January 6, 2026. Following completion of the public review period, staff submitted the draft LHMP (**Attachment 1**) for review by the CalOES and FEMA. CalOES has completed its review and forwarded their findings to FEMA. The plan is available on Metropolitan's website. Staff will return to the Board to adopt the LHMP following FEMA's conditional approval. Formal adoption of the LHMP is required to receive final approval from FEMA and become eligible for the hazard mitigation grants.

Local Hazard Mitigation Plan

Metropolitan's LHMP consists of three parts:

- Part 1 describes the concept of hazard mitigation, the process used to develop the hazard mitigation plan, significant hazard-related characteristics of Metropolitan, and relevant laws, ordinances, programs, and capabilities.
- Part 2 provides a detailed risk assessment of the specific hazards of concern to Metropolitan. The assessment of each hazard describes the history, location, frequency, and severity of the hazard, Metropolitan's vulnerability to the hazard, actions currently taken to mitigate the risk, and the losses that could result from occurrences of the hazard.
- Part 3 defines Metropolitan's goals and objectives for hazard mitigation, recommends actions to mitigate hazard risks, and outlines a strategy for implementing those actions. This part also includes information on plan adoption and the strategy for plan maintenance and updates.

Hazards of Concern and Risk Assessment

The Hazard Mitigation Plan assesses the potential risks posed by natural hazards to Metropolitan's buildings, infrastructure, and equipment. Natural hazards considered in the plan include dam failure, drought, earthquake, extreme heat, flood, landslide, wildfire, and wind. A general profile of each hazard as it may affect Metropolitan was developed. An assessment of each hazard determined the number of Metropolitan assets it could affect and the potential damage it could cause. The effects of climate change were also considered within each hazard assessment.

Mitigation Planning

Metropolitan's planning team established goals and objectives to reduce long-term vulnerabilities to the identified hazards. The goals and objectives listed below were chosen to encompass Metropolitan's responsibilities as a regional water agency and its commitment to its member agencies.

Goals:

- Protect life and property.
- Increase public awareness of risk and loss of water service.
- Protect Metropolitan's community lifelines.
- Facilitate partnerships with member agencies and coordinate implementation of mitigation actions.
- Maintain continuity of essential water services.
- Enhance resilience, sustainability, and reliability.

Objectives:

- Implement activities that assist in protecting lives by making infrastructure, community lifelines, and other properties more resistant to natural hazards.
- Assess the vulnerability of key resources and critical infrastructure.
- Mitigate vulnerable infrastructure to reduce/minimize future hazards and disasters.
- Raise awareness and communicate risk to Metropolitan's stakeholders.
- Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions.
- Diversify Metropolitan's water supply portfolio.
- Increase the flexibility of Metropolitan's water supply and distribution system.
- Leverage grant funding and low-interest loan programs for hazard mitigation capital projects.
- Establish procedures and programs to ensure mitigation projects are prioritized for community lifelines, services, and infrastructure.

To support the goals and objectives, staff identified 34 mitigation actions to address the risks posed by the natural hazards assessed within the LHMP. In compiling these actions, staff considered projects listed in Metropolitan's Capital Investment Plan (CIP), potential future projects not currently in the CIP, ongoing programs such as water-efficiency programs, and various recurring plan updates, including the Integrated Resources Plan, Seismic Resilience Report, and Dam Emergency Action Plans. To be eligible for FEMA hazard mitigation grant funding, a project or program must be listed in the LHMP.

Plan Updates

Regular plan updates will be performed by Metropolitan staff. Staff intends to develop a biennial progress report that will include plan status updates and action-tracking. FEMA requires a comprehensive update to the plan every five years to remain eligible for benefits awarded under the Disaster Mitigation Act. Staff may also consider updating the plan after a major disaster that significantly impacts Metropolitan. Continuing public involvement will be achieved by providing the public access to the implementation of this plan through the Hazard Mitigation Plan webpage.

Timing and Urgency

Staff will return to the Board following FEMA's conditional approval for formal adoption of the LHMP. Once Metropolitan adopts the LMHP, Metropolitan will be eligible for federal hazard mitigation grants.

Mai Hattar 3/24/2026
Mai M. Hattar *Date*
Chief Engineer
Engineering Services

Shivaji Deshmukh 3/24/2026
Shivaji Deshmukh *Date*
General Manager

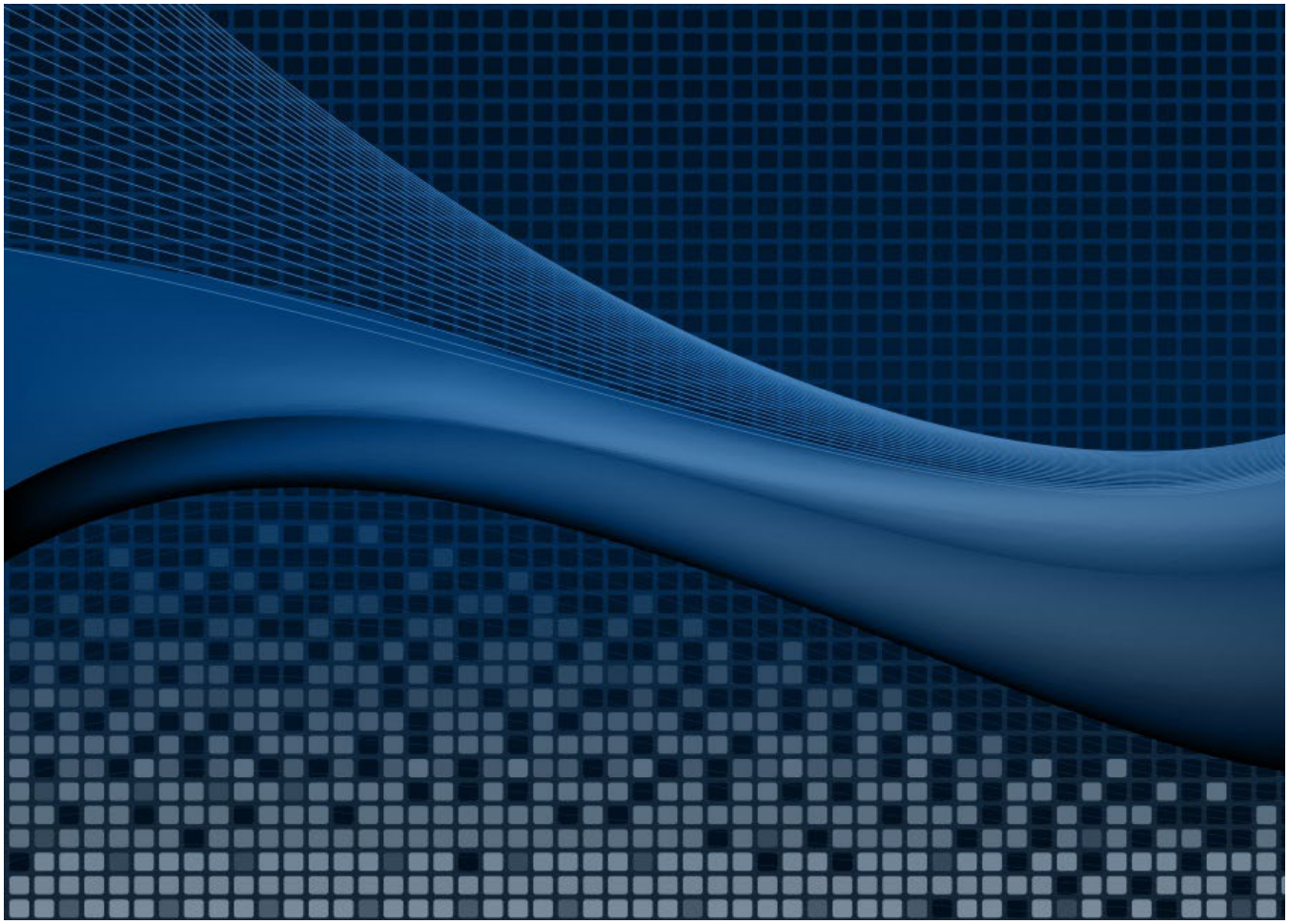
Attachment 1 – Local Hazard Mitigation Plan – Public Review Draft

Ref# es12709915

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Local Hazard Mitigation Plan

Public Review Draft



January 2026

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ABBREVIATIONS

Abbreviation	Definition
%g	Percent acceleration force of gravity
44 CFR	Code of Federal Regulations, Title 44
AWIA	America's Water Infrastructure Act of 2018
AVEK	Antelope Valley-East Kern Water Agency
BRIC	Building Resilient Infrastructure & Communities grant program
CAISO	California Independent System Operator
Cal OES	California Governor's Office of Emergency Services
CAMP4W	Climate Adaptation Master Plan for Water
CDBG	Community Development Block Grant
CFR	Code of Federal Regulations
CIP	Capital Investment Plan
CRA	Colorado River Aqueduct
CWA	Clean Water Act
MWD Act	The Metropolitan Water District Act
DMA	Disaster Mitigation Act
DPW	Department of Public Works
DSOD	California Division of Safety of Dams
DWP	Department of Water & Power
DWR	California Department of Water Resources
EAP	Emergency Action Plan
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
ESA	Endangered Species Act
FEMA	Federal Emergency Management Administration
FERC	Federal Energy Regulatory Commission
FHSZ	Fire Hazard Severity Zone
GIS	Geographic Information System
HMA	Hazard Mitigation Assistance
Metropolitan	The Metropolitan Water District of Southern California
mgd	million gallons per day
mph	miles per hour
MW	megawatt
NEHRP	National Earthquake Hazards Reduction Program
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service
PFAs	polyfluoroalkyl substances
PGA	peak ground acceleration
PSPS	public safety power shutoff
RCFCWCD	Riverside County Flood Control and Water Conservation District
RQE	Risk Quantification and Engineering
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SWP	State Water Project
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
VCWPD	Ventura County Watershed Protection District

EXECUTIVE SUMMARY

The Metropolitan Water District of Southern California (Metropolitan) is a public agency and regional water wholesaler. Its 26 member public agencies serve approximately 19 million people in portions of six counties in Southern California. Metropolitan's mission is to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way. Metropolitan's ability to continue to provide reliable water supplies is critical to the area's ability to recover from a hazard event. To address this need, Metropolitan has prepared this hazard mitigation plan to assess its ability to prepare for and mitigate hazards that could impact Metropolitan. The Metropolitan Water District Local Hazard Mitigation Plan provides a planning framework for natural hazards that are most likely to impact Metropolitan.

The hazard mitigation plan strives to reduce risk for assets that are vital for Metropolitan's continuity of operations following hazard events. The plan's goals and recommendations lay the groundwork for implementing local mitigation activities. The contents of the plan comply with requirements of the federal Disaster Mitigation Act of 2000, under which communities with approved hazard mitigation plans are eligible for various hazard mitigation funding programs provided by the Federal Emergency Management Agency (FEMA).

The plan was prepared by a Planning Committee of Metropolitan staff and professional consultants, with input from stakeholders representing interests within Metropolitan's service area. Input for the plan was solicited focused stakeholder meetings (member agencies and operational area emergency managers), a survey for county operational areas, and public outreach.

METROPOLITAN DESCRIPTION

The Metropolitan Water District of Southern California was created in 1928 under authority of the Metropolitan Water District Act (California Statutes 1927, Chapter 429, reenacted in 1969 as Chapter 209, as amended). The primary purpose of Metropolitan is to provide its members with a reliable, supplemental wholesale water supply service for domestic and municipal uses. To do so, Metropolitan imports water from the Colorado River through its Colorado River Aqueduct and from Northern California through the California's State Water Project. Metropolitan is authorized to develop, store, and distribute water for domestic and municipal purposes and other beneficial uses if excess water is available, and may provide, generate, and deliver electric power within or outside its service area for the purpose of developing, storing, and distributing water. Metropolitan is also expressly authorized to promote and implement conservation programs. Metropolitan helps its member agencies develop increased water conservation, recycling, storage, and other local resource programs.

Metropolitan provides wholesale water service to its 26 member agencies, which include 14 cities, 11 municipal water districts, and one county water authority. The service area covers approximately 5,200 square miles in varied terrain ranging from sea level to over 5,000 feet above sea level.

Metropolitan is governed by a 38-member Board of Directors. Metropolitan's General Manager administers day-to-day operations in accordance with policies and procedures established by the Board of Directors. Metropolitan employs a full-time staff of 1,965 employees. The Board of Directors will adopt this plan once approval pending adoption has been granted by FEMA.

The Hazard Mitigation Plan assesses the potential risk that natural hazards pose to the buildings, infrastructure and equipment that make up the assets owned by Metropolitan. Table ES-1-1 summarizes Metropolitan's primary assets and their value as of 2021. These values are estimates based on replacement costs and do not quantify the service benefits provided by these assets.

Table ES-1-1. The Metropolitan Water District Assets

Asset	Estimated 2021 Replacement Cost
Colorado River Aqueduct System	
Aqueduct	$5,317,333,152
Pump Plants (5)	1,497,230,598
Reservoirs (4)	$60,205,576
Electrical Facilities	$650,645,599
Other	$82,255,267
Total	***$7,607,670,192***
Conveyance, Treatment and Distribution Facilities	
Water Treatment Plants (5, Including Reservoirs)	$5,311,138,548
Reservoirs – Raw (7)	$3,850,117,209
Reservoirs – Finished (3)	$226,642,833
Hydroelectric Plants (12)	$355,690,352
Pump Plants (3)	$69,226,317
Pressure Control Structures (26)	$308,646,600
Total	***$10,121,461,859***
Pipelines	
Conveyance and Distribution System (830 miles of pipeline)	$9,122,286,538
	$9,122,286,538
Building Facilities	
Headquarters	$230,337,632
La Verne	$201,747,367
Eagle Rock	$15,733,961
Other Facilities	$69,071,080
Total	***$516,890,040***
Other Assets	
Other Assets	$188,482,162
Total	***$188,482,162***
Total Replacement Value for All Metropolitan Assets	**$27,556,790,969**

HAZARDS OF CONCERN

Metropolitan chose to include only natural hazards in this hazard mitigation plan. The Planning Committee considered the full range of natural hazards that could impact Metropolitan and selected the following as those that present the greatest concern:

- Dam failure
- Drought
- Earthquake
- Extreme heat
- Flood
- Landslide
- Wildfire
- Wind

RISK ASSESSMENT

Risk assessments in the hazard mitigation plan describe the risks that each identified hazard of concern poses to Metropolitan's assets. For each hazard, a general profile of the hazard as it may affect Metropolitan was developed. An assessment of each hazard determined the number of Metropolitan community lifelines (critical assets) that the hazard could affect (this is called "exposure") and the potential damage that could result (this is called "vulnerability"). As defined by FEMA, a community lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security; these include the most fundamental services in the community that, when stabilized, enable all other aspects of society to function (FEMA n.d.). Individual sites of lifelines are referred to as "assets" and categorized by the service they provide throughout this plan.

Although many Metropolitan facilities have exposure to most or all of the identified hazards of concern, information needed to estimate quantifiable damage to facilities was available only for the earthquake hazard. Two separate analyses were performed to assess potential seismic impacts on Metropolitan assets: one for pipelines (previously completed, in 2020) and one for above-ground assets.

The 2020 study estimated the number of repairs that would be required for Metropolitan's underground pipeline system due to earthquake shaking, fault displacement, and liquefaction (ABS Consulting 2020). The analysis considered 12 scenario earthquake events in proximity to Metropolitan pipelines. Information from this study was used to estimate time to return facilities to service for the 12 earthquake scenarios. Metropolitan staff from Engineering Planning, Engineering Pipeline Design, Construction Management, Operations Conveyance and Distribution, Construction Services Unit, and Manufacturing Services Unit collaborated over a series of meetings to develop the recovery timeframes based on staff experience within their respective fields. The study considered Metropolitan's emergency response program, the type of repair given the pipeline material and size, Metropolitan's fabrication and coating shops capabilities, in-house construction capabilities, and potential for utilizing outside resources (third-party contractors and existing mutual aid agreements) for fabrication and construction. Table ES-1-2 summarizes the total number of repairs projected for each event modeled and the estimated time required to complete the repairs.

Table ES-1-2. Earthquake Scenario Estimate of Repairs and Recovery Timeframe

Earthquake Scenario	Estimated Number of Breaks	Estimated Number of Leaks	Time to Complete Repairs
Peralta Hills – M6.42	3	2	8 to10 days
Puente Hills – M6.55	3	2	8 to10 days
Mission Hills – M6.82	4	3	9 to 12 days
Cucamonga/San Jose – M6.73	5	2	9 to 12 days
San Gabriel – M6.89	6	4	9 to 12 days
Northridge Hills – M6.99	11	6	2 to 3 weeks
Whittier Elsinore – M7.11	12	9	2 to 3 weeks
Elsinore (Glen Canyon/Julian) – M7.27	12	9	2 to 3 weeks
San Jacinto – M7.66	14	8	3 to 4 weeks
Newport-Inglewood – M7.11	17	7	3 to 4 weeks
Compton – M7.8	27	21	6 to 8 weeks
San Andreas – M7.8	30	12	6 to 8 weeks

The analysis of seismic impacts on above-ground assets, conducted as part of this hazard mitigation plan, considered 12 earthquake scenarios developed by the U.S. Geological Survey that are comparable to those used for the pipeline seismic assessment. Table ES-1-3 summarizes loss estimates for the earthquake scenarios evaluated.

Table ES-1-3. Estimated Damage to Metropolitan Facilities from 12 Earthquake Scenarios

Earthquake Scenario	Loss Value	Loss as % of Total Facilities Replacement Cost Value
Compton M7.45	$981,937,318	12.7%
Cucamonga M6.88	$466,681,304	6.0%
Elsinore M7.62	$332,685,417	4.3%
Mission Hills M6.52	$474,931,208	6.1%
Newport/Inglewood Alternative 1 M7.2	$252,483,148	3.3%
Northridge Hills M7.01	$538,626,195	7.0%
Peralta Hills M6.55	$423,415,004	5.5%
Puente Hills/Santa Fe Springs M6.61	$184,602,034	2.4%
San Gabriel M7.23	$437,899,129	5.7%
San Jacinto M7.7	$203,427,061	2.6%
Southern San Andreas M7.8	$480,346,838	6.2%
Whittier Alternative 2 M7.0	$542,305,988	7.0%

Note: Estimated losses were determined by FEMA's Hazus software, which evaluates damage to each individual asset based on the general type of facility it is. Specifics about actual Metropolitan assets, such as rehabilitations Metropolitan has performed to improve seismic resilience, are not accounted for in the model. The resulting estimates are relative values suitable for planning comparisons.

MITIGATION

Based on the risk assessment, the Planning Committee identified 34 actions (Table ES-1-4) Metropolitan should take to mitigate the loss potential associated with the hazards of concern. These actions were chosen from a range of alternatives, using the following goals and objectives for guidance:

- Goals:
  1. Protect life and property
  2. Increase public awareness of risk and loss of water service
  3. Protect Metropolitan's community lifelines
  4. Facilitate partnerships with member agencies and coordinate implementation of mitigation actions
  5. Maintain continuity of essential water services
  6. Enhance resilience, sustainability and reliability

- Objectives:
  1. Implement activities that assist in protecting lives by making infrastructure, community lifelines, and other properties more resistant to natural hazards
  2. Assess vulnerability of key resources and critical infrastructure
  3. Mitigate vulnerable infrastructure to reduce/minimize future hazards and disasters
  4. Raise awareness and communicate risk to Metropolitan's stakeholders
  5. Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions
  6. Diversify Metropolitan's water supply portfolio
  7. Increase flexibility of Metropolitan's water supply and distribution system
  8. Leverage grant funding and low interest loan programs for hazard mitigation capital projects
  9. Establish procedures and programs to ensure mitigation projects are prioritized for community lifelines, services, and infrastructure

Table ES-1-4 lists the recommended hazard mitigation actions that make up the action plan. It indicates priorities for each action in terms of implementing the action, pursuing grant funding for the action, and overall. These priorities are based on estimated benefits and costs of each action, how many objectives the action can accomplish, the availability of existing funding, and the action's eligibility for grant programs.

Table ES-1-4. Recommended Hazard Mitigation Actions

Number	Action	Implementation Priority	Grant Pursuit Priority	Overall Priority
MWD-01-2024	Complete East Orange County Feeder No. 2 Seismic Retrofit	Low	Low	Low
MWD-02-2024	Construct Burbank Pump Station for Delivery to Connection B5A	Medium	High	High
MWD-03-2024	Construct Hayfield Groundwater Storage and Extraction	Low	Low	Low
MWD-04-2024	Implement San Gabriel Tower and Spillway Improvements	Low	Low	Low
MWD-05-2024	Complete Diemer Treatment Plant Slope Stabilization and Drainage Improvements Project	Medium	High	High
MWD-06-2024	Implement Sepulveda Canyon Control Facility Water Storage Tanks Seismic Upgrades	Low	Low	Low
MWD-07-2024	Complete Colorado River Aqueduct Erosion Protection Project	Medium	High	High
MWD-08-2024	Install Inland Feeder to San Bernardino Valley Municipal Water District Foothill Pump Station Intertie	Medium	High	High
MWD-09-2024	Implement Weymouth Treatment Plant Administration and Control Buildings Seismic Upgrades	Medium	High	High
MWD-10-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 5	Low	Low	Low
MWD-11-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 4	Low	Low	Low
MWD-12-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 3	Low	Low	Low
MWD-13-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 2	Low	Low	Low
MWD-14-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 1	Low	Low	Low
MWD-15-2024	Implement Perris Control Facility Bypass & Pressure Control Structure Upgrades	Low	Low	Low
MWD-16-2024	Implement Weymouth Treatment Plant Finished Water Reservoir Rehabilitation	Low	Medium	High
MWD-17-2024	Implement La Verne Water Quality Laboratory and Field Engineering Building Seismic Upgrades and Building Improvements	Low	Medium	High
MWD-18-2024	Implement Lake Mathews Forebay Pressure Control Structure and Bypass Improvements	Low	Medium	High
MWD-19-2024	Construct Inglewood Lateral Improvements	Low	Low	Low
MWD-20-2024	Construct Sepulveda Feeder Pump Station Phase 2	Low	Low	Low
MWD-21-2024	Implement Pure Water Southern California program for advanced water treatment, new conveyance, potable reuse	Low	Low	Medium
MWD-22-2024	Complete Colorado River Aqueduct Ancillary Erosion and Drainage Control Project	Low	Low	Low
MWD-23-2024	Install Diemer Treatment Plant Fire Hydrants	Low	Low	High
MWD-24-2024	Implement Sepulveda Canyon Control Facility Reliability Improvements	Low	Low	Low
MWD-25-2024	Construct Sepulveda Feeder Pump Station Phase 1	Low	Low	High
MWD-26-2024	Update Integrated Water Resources Plan Needs Assessment	High	Low	High
MWD-27-2024	Update Business Continuity Plan	High	Low	High

Number	Action	Implementation Priority	Grant Pursuit Priority	Overall Priority
MWD-28-2024	Update Risk and Resilience Assessment/Emergency Response Plan as part of America's Water Infrastructure Act	Low	Low	High
MWD-29-2024	Update Information Technology Disaster Recovery Plans	Low	Low	High
MWD-30-2024	Update Metropolitan Regional Water System Flexibility Study	Low	Low	High
MWD-31-2024	Update Seismic Resilience Report	Low	Low	High
MWD-32-2024	Update Dam Emergency Action Plans	Low	Low	High
MWD-33-2024	Provide public outreach and education for socially vulnerable communities to improve water literacy and advocacy capabilities	Low	Low	High
MWD-34-2024	Provide targeted water efficiency programs for socially vulnerable communities	Low	Low	High

Part 1. Background and Methods

1. INTRODUCTION

1.1 OVERVIEW

Hazard mitigation encompasses any sustained action taken to reduce or eliminate long-term risks to human life and property. For The Metropolitan Water District of Southern California (Metropolitan), this expands to consideration of its ability to continue to provide water to its 26 public member agencies through natural disasters, ranging from earthquake, wildfire, and dam failure to drought and climate change. Through hazard mitigation planning, Metropolitan can identify and implement long- and short-term actions—consistent with its authorities—before, during, and after disasters to achieve these goals. Hazard mitigation activities include planning efforts and studies; policies; programs; infrastructure and supply improvement projects; demand management; and other actions to reduce current and future vulnerabilities.

The federal Disaster Mitigation Act of 2000 (DMA) emphasizes planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR). The DMA promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.2 A PLAN FOR THE METROPOLITAN WATER DISTRICT

As a regional wholesale water agency, Metropolitan has comprehensive plans to fulfill its mission of providing its 5,200-square-mile service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way. These plans address the key services Metropolitan provides:

- Importing water through the California State Water Project (SWP) and Colorado River Aqueduct (CRA)
- Treating, storing and delivering treated and untreated water
- Generating hydroelectric power
- Maintaining a resilient water infrastructure system
- Protecting water quality
- Providing infrastructure security
- Managing demand

These planning efforts are collaborative and iterative, conducted with Metropolitan's 26 public member agencies as well as state and federal agencies, regional planning agencies, counties and cities, power and wastewater utilities, emergency coordinators, environmental and community-based organizations, and the general public. The

history of regional planning for resiliency provided the foundation for preparation of The Metropolitan Water District of Southern California Local Hazard Mitigation Plan, Metropolitan's first formal plan to meet the requirements of the DMA. The plan promotes sound policy and actions to protect Metropolitan's community lifelines from the impacts of natural hazards and strengthens Metropolitan's ability to continue providing water service should a disaster occur. It identifies resources, information, and strategies for reducing risk from a wide range of natural hazards: dam failure, drought, earthquake, extreme heat, flood, landslide, wildfire, and wind. Through the involvement of stakeholders, the plan's goals and recommendations also lay the groundwork for identifying local mitigation activities and developing partnerships.

Importantly, the hazard mitigation plan complements Metropolitan's other planning efforts for water resources, drought and conservation, infrastructure security, capital improvements, system flexibility, seismic resilience, climate adaptation, energy sustainability, emergency preparation and response, business continuity, and more. These plans work together to align priorities, avoid policy conflicts, and build a comprehensive body of data and technical analyses.

1.3 PLAN ORGANIZATION

The Metropolitan Water District of Southern California Local Hazard Mitigation Plan consists of three parts:

- Part 1 describes the concept of hazard mitigation, the process used to develop this hazard mitigation plan, significant hazard-related characteristics of Metropolitan, and relevant laws, ordinances, programs and capabilities.
- Part 2 provides a detailed risk assessment of the specific hazards of concern to Metropolitan. The assessment of each hazard describes the history, location, frequency and severity of the hazard, Metropolitan's vulnerability to the hazard, actions currently taken to mitigate the risk, and the losses that could result from occurrences of the hazard.
- Part 3 defines Metropolitan's goals and objectives for hazard mitigation, recommended actions to mitigate hazard risks, and a strategy for implementing the recommended actions. This part also includes information on plan adoption and the strategy for plan maintenance and updates.

2. THE PLANNING PROCESS

In 2021, Metropolitan initiated preparation of this hazard mitigation plan to address the mandates in the DMA. Metropolitan was awarded a planning grant funded by the Federal Emergency Management Agency (FEMA) to develop the plan. Metropolitan contracted with Tetra Tech through a procurement process to assist in the facilitation of the planning process. The Tetra Tech project manager assumed the role of the lead planner, reporting directly to Metropolitan's designated project manager.

2.1 PLANNING COMMITTEE

A Planning Committee (shown in Table 2-1) led the planning effort, with key personnel spanning Metropolitan's organizational structure. The Planning Committee was supported by Tetra Tech and its subconsultant Circlepoint.

Table 2-1. Planning Committee

Name	Title	Department or Agency
Metropolitan Water District Staff		
Greg de Lamare, PE	Project Manager (retired)	Engineering/Project Management
Ernie Ariza, PE	Project Manager / Manager-Engineering Facility Planning Team	Engineering/Project Management
Albert Rodriguez, PE	Principal Engineer	Engineering
Ian Whyte, MSPA	Emergency Management Program Manager	Office of Safety, Security, and Protection-Emergency Management
Carolyn Schaffer	Group Manager	External Affairs
Catherine Stites	Principal Deputy General Counsel	Legal
Jill Frater, MBCP, MBCI	Business Continuity Program Manager	Finance
David Cole, CPP, EMT	Security Team Manager	Security
Austen Nelson	Associate Engineer	Engineering
Rosa Lau	Engineer	Engineering
Consultants		
Bart Spencer	Project Lead Planner; Project Manager (2023 - 2024)	Tetra Tech
Rob Flaner	Project Manager (Aug 2021 – July 2023)	Tetra Tech
Jake Poland	Associate Planner (Dec 2022 – April 2024)	Tetra Tech
Megan Brotherton	Associate Planner (Aug 2021 – July 2023)	Tetra Tech
Kami Spahn	Risk Assessment Lead (2023 - 2024)	Tetra Tech
Carol Bauman	Risk Assessment Lead (Aug 2021 – July 2023)	Tetra Tech
Susan Harden	Principal (Aug 2021 – Aug 2023)	Circlepoint
Stacey Miller	Senior Project Manager (Aug 2021 – Aug 2023)	Circlepoint

The Planning Committee met more than 30 times during the course of the planning process. With input from executive management, the Committee established the plan goals and objectives, defined the planning area, and ensured engagement of member agencies, interested parties, and the public. The Planning Committee guided development of the plan through approval by FEMA and the California Governor's Office of Emergency Services (Cal OES) and adoption by Metropolitan's Board. Subject matter experts from throughout Metropolitan

developed risk assessments and assisted with recommendations for mitigation actions and implementation strategies. Metropolitan's Planning Committee members will continue to be involved in implementation.

2.2 PLANNING AREA

The planning area boundaries affect the risk assessment and the selection of mitigation actions for this hazard mitigation plan. Consistent with Metropolitan's other regional plans, the planning area for this hazard mitigation plan is defined as Metropolitan's 5,200-square-mile service area across six Southern California counties—Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura. This area is served by Metropolitan's 26 member agencies (see Figure 2-1) that serve residents, businesses, industry, and agriculture in 152 cities and 89 unincorporated communities:

- Calleguas Municipal Water District
- Central Basin Municipal Water District
- City of Anaheim
- City of Beverly Hills
- City of Burbank
- City of Compton
- City of Fullerton
- City of Glendale
- City of Long Beach
- City of Los Angeles
- City of Pasadena
- City of San Fernando
- City of San Marino
- City of Santa Ana
- City of Santa Monica
- City of Torrance
- Eastern Municipal Water District
- Foothill Municipal Water District
- Inland Empire Utilities Agency
- Las Virgenes Municipal Water District
- Municipal Water District of Orange County
- San Diego County Water Authority
- Three Valleys Municipal Water District
- Upper San Gabriel Valley Municipal Water District
- West Basin Municipal Water District
- Western Municipal Water District of Riverside County

The planning area also includes the facilities and rights-of-way associated with Metropolitan's Colorado River Aqueduct and other Metropolitan-owned facilities that may be located outside the service area, but within the six counties, to facilitate delivery of imported water from the Colorado River and Northern California (see Figure 2-2).

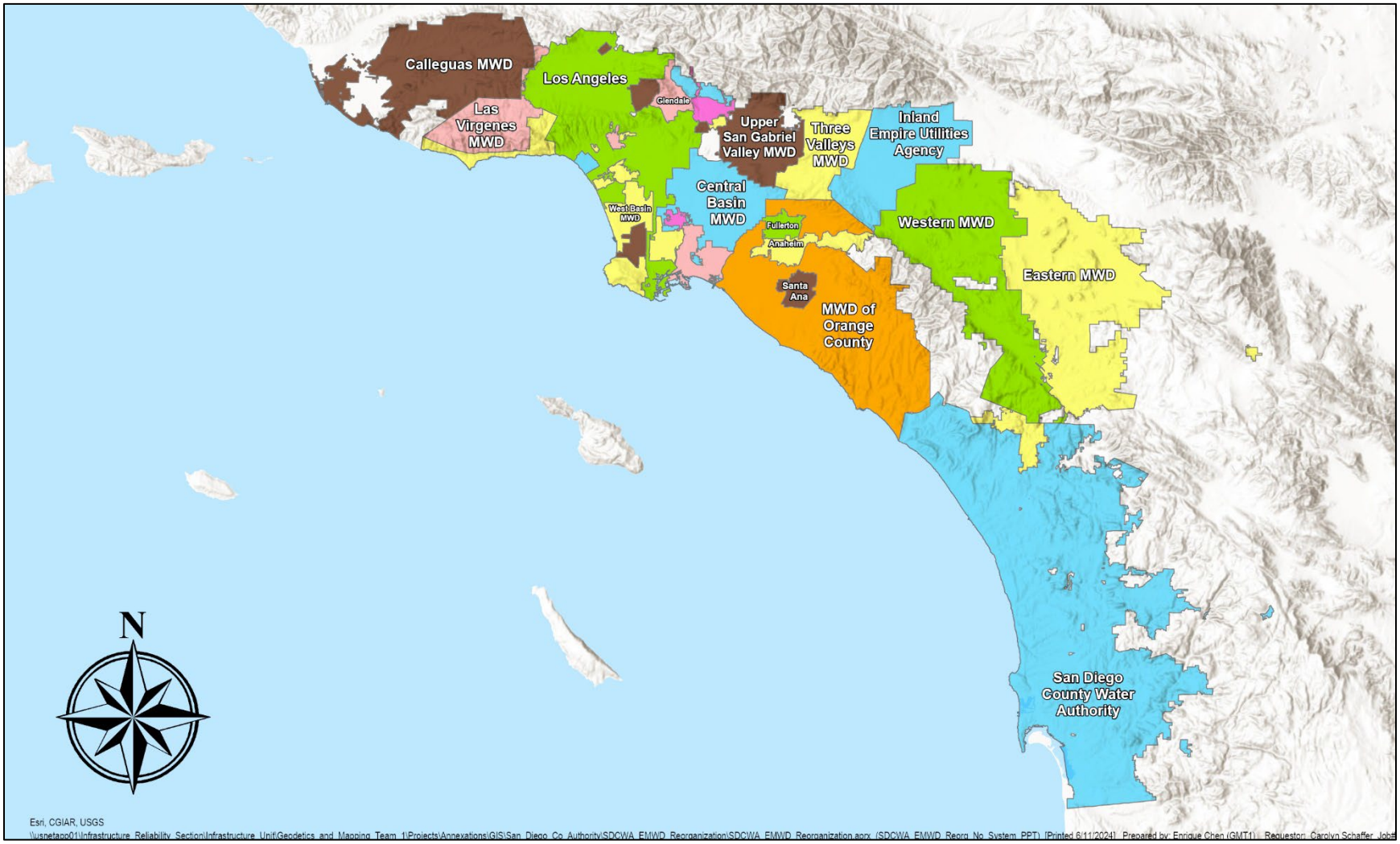


Figure 2-1. Metropolitan Water District Member Agencies and Service Area

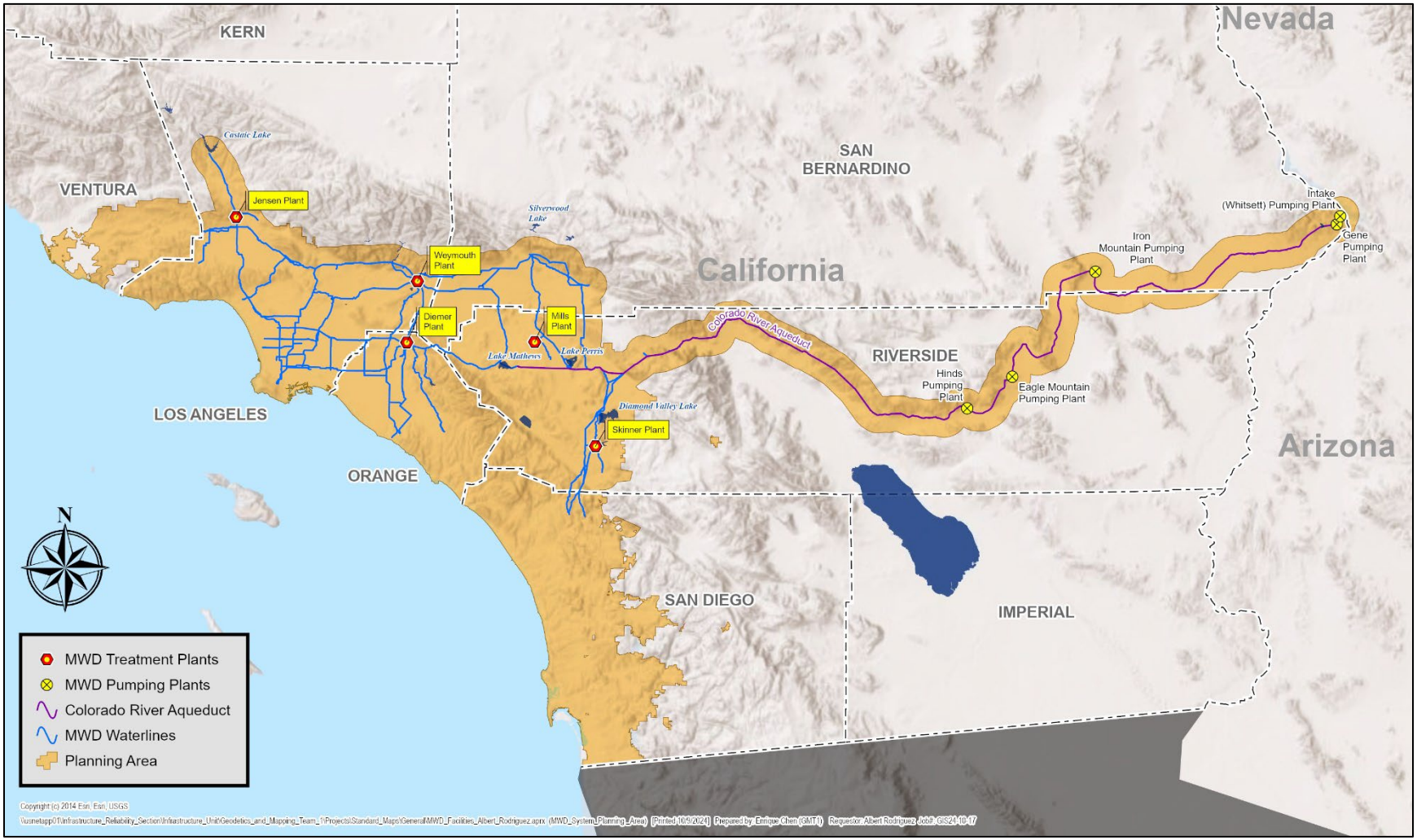


Figure 2-2. Metropolitan Water District Hazard Mitigation Planning Area

2.3 COORDINATION WITH OTHER AGENCIES

During plan development, Metropolitan's member agencies and emergency management officials from the six operational areas within the planning area were invited to contribute by sharing local knowledge about vulnerability to natural hazards and by suggesting potential mitigation actions. An operational area is the designation of each county in California for coordinating emergency activities under the Standardized Emergency Management System. In addition to the member agencies, the following agencies were invited to participate:

- Los Angeles County Office of Emergency Management
- Orange County Emergency Management Division
- Riverside County Emergency Management Department
- San Bernardino County Office of Emergency Services
- San Diego County Office of Emergency Services
- Ventura County Office of Emergency Services

These agencies supported the effort by attending a kickoff meeting and providing input on issues. They were also provided an opportunity to comment on the draft plan.

Additional coordination was conducted with the following organizations specific to certain hazards as part of Metropolitan's ongoing work with them related to water and power supply and public safety:

- Southern California Edison
- California Department of Water Resources
- U.S. Bureau of Reclamation
- California Department of Water Resources Division of Safety of Dams
- California Governor's Office of Emergency Services (Cal OES)
- FEMA Region 9

2.4 REVIEW OF EXISTING PLANS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports, and technical information (44 CFR, Section 201.6(b)(3)). Metropolitan has prepared comprehensive plans, studies, and reports to support its core services and to prepare the region for the future. The key plans shown in Table 2-2 are further discussed in Chapter 4. They have been incorporated into the risk analysis in Part 2 and in the hazard mitigation actions and implementation strategy in Part 3. Numerous technical studies and reports that support the analysis in these plans also have been incorporated into this hazard mitigation plan.

Table 2-2. Metropolitan Plans

Infrastructure Focused
Capital Investment Plan (2024, updated biennially)
Strategic Asset Management Plan (ongoing)
Integrated Area Study (2007)
Water Resource Focused
Integrated Water Resources Plan Regional Needs Assessment (2022)
Urban Water Management Plan (2020)
Water Shortage Contingency Plan (2021), including Water Surplus and Drought Management Plan, Water Supply Allocation Plan
Climate Adaption Focused
Climate Action Plan (2022)
Energy Sustainability Plan (2020)
Climate Adaptation Master Plan for Water (2024)
Emergency Preparedness and Response Focused
Risk Resilience and Assessment Report (2019)
Seismic Resilience Report (2020)
Business Continuity Plans for Metropolitan Water District (updated annually)
Emergency Response Plan (2019)
Dam Emergency Action Plans
Crisis Communications Plan (2023)
Safety and Regulatory Services Plans for multiple facilities including: • California Environmental Reporting System (CERS) Submittal • Confined Space Inventory • Diver Safety Manual • DOT/Transportation Security Plan • Emergency Action Plans (non-dam facilities and offices) • Metropolitan Water District Chemical Response Plan • Fire Prevention Plan • Fire Management Plans • HazMat / Waste Training Plan • Hazardous Waste Contingency Plan • Hazardous Waste Minimization Plan • Underground Storage Tank Leak Alarm Response Plan • Risk Management Plans and California Accident Prevention Plans • Rule 461 Operations and Maintenance Manual • Spill Prevention Control and Countermeasure Plans

During preparation of this plan, Metropolitan also reviewed local hazard mitigation plans for its member agencies, cities, counties, and other special districts within the planning area.

2.5 PUBLIC INVOLVEMENT

Broad public participation in the planning process helps ensure that diverse points of view about the planning area's needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)). Given Metropolitan's role as a regional water planner and wholesale water provider, the Planning Committee approached public involvement to meet the needs and interests of different constituencies.

A public involvement strategy was prepared to provide access to different phases of the plan's development. In the early stages of plan development, this strategy was influenced by the COVID-19 global pandemic, which limited Metropolitan's capabilities for in-person engagement. Early public engagement for this plan used online

meetings, web and social media, and integration with other coordination and planning processes. With the return of more in-person opportunities, a hybrid approach was used for review of the draft plan, including in-person and online meetings and presentations, web and social media.

2.5.1 Defining the "Public"

Metropolitan's main focus is reliable wholesale water supply. Metropolitan does not have direct retail customers and does not have land use authority. Therefore, Metropolitan's role in mitigating impacts from natural hazards that can impact its service area is different from that of local municipal governments. Continuity of water supply operations is the principal focus of Metropolitan's mitigation strategy in this plan. Metropolitan's water supply, delivery, and other services are provided to and on behalf of its 26 public member agencies. For planning and public engagement purposes, the "public" for this plan has been defined as:

- Metropolitan member agencies
- Emergency managers for the six operational areas within Metropolitan's service area
- General public

The member agencies listed in Section 2.2 and operational area emergency organizations listed in Section 2.3 were the principal targets for public engagement in the development of this plan as they are directly affected by continuity of wholesale water service and plan for natural hazard risks within their jurisdictions. They are most knowledgeable about the services Metropolitan provides and the natural hazard risks that could impact wholesale water service and the regional water infrastructure. Other local hazard mitigation plans address the provision of retail water service and mitigation actions appropriate for cities and communities served by Metropolitan's member agencies.

The general public includes residents, businesses, elected officials, other utilities, cities and counties, environmental organizations, community-based organizations, tribal organizations, academia, and any other parties interested in water service in Southern California.

2.5.2 Outreach Activities

Appendix A provides a schedule of meetings, workshops and presentations conducted to provide input into preparation and review of the draft plan. The outreach and engagement approach tailored to the three constituencies is described in the following section.

Member Agencies

Metropolitan coordinates extensively with its member agencies at the director, general manager, and staff levels. Metropolitan's Board of Directors consists of 38 members who represent the member agencies. Policy discussions, program updates, financial decisions and Board actions occur at monthly Board meetings, which are open to the public via live streaming and in person attendance. Monthly meetings are held with member agency general managers, and workshops are held regularly with member agency staff on key issues and planning efforts. Metropolitan informed the Board and the member agency managers about the development of this plan. Workshops were held with member agency staff to seek their input during plan development. Member agencies were provided the opportunity to review the draft plan prior to the submittal to CalOES and FEMA. A list of the meetings and participants is available in Appendix A.

Other coordination efforts throughout the planning period focused on specific hazards such as drought, climate change, earthquake, and the COVID-19 pandemic. These efforts informed the development of the risk assessment for these hazards as well as implementation strategies. Extensive meetings were held regarding drought and demand management due to a water shortage emergency in areas dependent on the California State Water Project and deteriorating conditions on the Colorado River. Although conditions improved, the drought emergency launched a regional collaborative planning effort to identify drought mitigation strategies for water supply and infrastructure that would prepare the region for the next drought. Some of the projects are in various stages of design and construction, while others are being studied or pending Board direction for further action. Another major effort was preparation of the Climate Adaptation Master Plan for Water, a comprehensive plan that provides a roadmap to guide future capital investments and Metropolitan's business model as the region confronts a new climate reality in the years and decades ahead. All of the member agencies participate in these focused planning efforts.

County Emergency Organizations

Metropolitan maintains cooperative relationships with operational area emergency management organizations to ensure there is an effective coordinated response when situations occur. During development of the plan, Metropolitan held two workshops with the emergency coordinators for the six operational areas within its service area. A survey was also conducted to obtain additional information regarding county planning efforts and natural hazards, and to gauge knowledge of the regional water system. Coordination efforts throughout the planning period focused on specific hazards such as dam safety and wildfire. The operational area representatives were provided the opportunity to review the draft plan prior to its submittal to CalOES and FEMA. A list of the meetings and participants is available in Appendix A.

General Public

At the beginning of the planning process, a hazard mitigation web page was created to provide information for the general public (https://www.mwdh2o.com/how-we-plan/; see Figure 2-3).

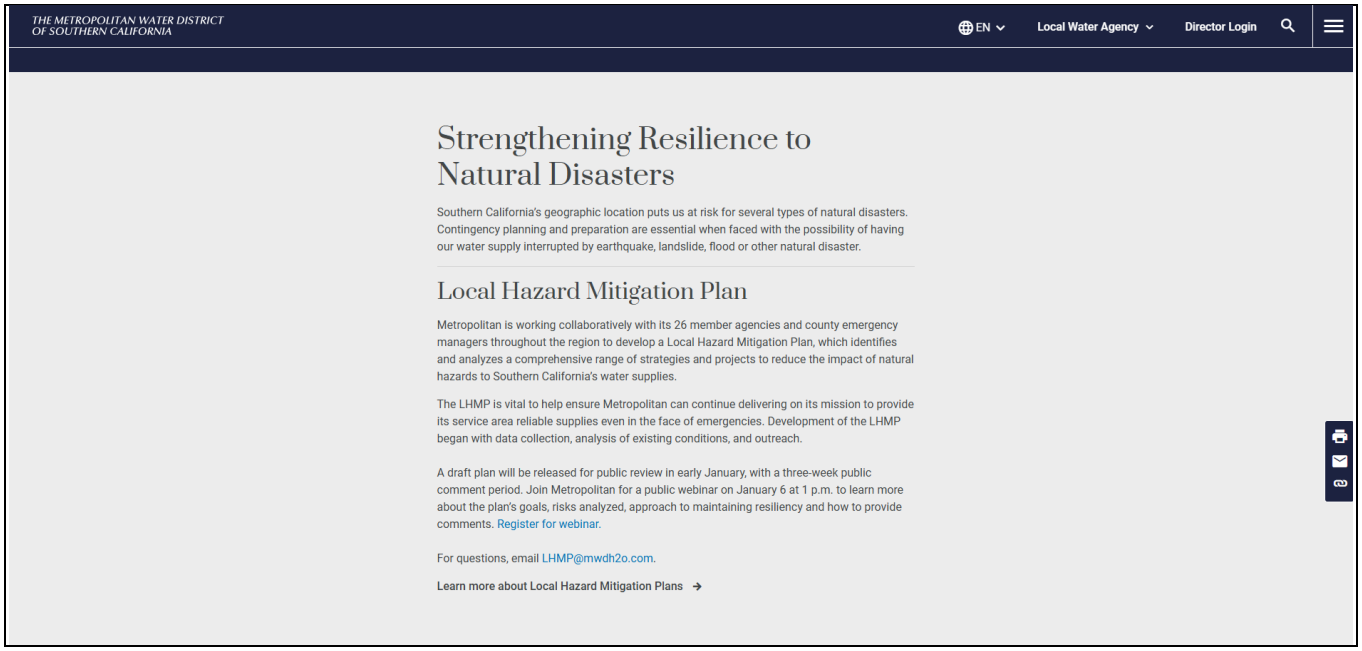


Figure 2-3. Metropolitan's Hazard Mitigation Plan Web Page

The planning process and web page were announced through Metropolitan's e-news. The e-news reaches over 15,000 subscribers throughout Metropolitan's service area and beyond. Metropolitan has provided additional opportunities for the public to provide input on certain hazards, such as drought and demand management and climate adaptation. Approaches included online listening sessions, online and in-person meetings, and working with community organizations to reach more broadly into communities, particularly socially vulnerable communities. Table 2-3 describes the opportunities provided to different interests to be involved in the planning process.

Table 2-3. Opportunities Provided to the Public to Be Involved in the Planning Process

Type of Interest	Target for Outreach within Planning Area	Method
Local and regional agencies involved in hazard mitigation activities	County and city public works departments, emergency management, GIS departments	Notice of draft plan mailed to representatives; online meeting to present draft plan
Agencies with authority to regulate development	County and city zoning, planning community and economic development departments; building officials, planning commissions; other elected officials	Notice of draft plan mailed to representatives; online meeting to present draft plan
Neighboring communities	Special districts and local governments adjacent to Metropolitan's service area that provide water service	Notice of draft plan mailed to representatives; online meeting to present draft plan
Businesses, academia, other private organizations	Business organizations, sustainability institutes at universities, Southern California Edison, SoCal Gas, San Diego Gas & Electric	Notice of draft plan mailed to representatives; online meeting to present draft plan
Community-based organizations	Organizations that support underserved communities and socially vulnerable populations	Direct outreach and engagement; presentation on draft plan

The draft plan was shared with the general public through an online meeting and via the web and social media. Each outreach communication and engagement provided an opportunity to ask questions and provide comments. The comments were considered in preparation of the draft plan. A description of the meeting is available in Appendix A.

2.5.3 Review of Draft Plan

The public review draft of this plan was released through the web page on January 6, 2026 to the member agencies, operational area emergency agencies, and the general public. Its availability was announced through direct mail, email, social media and Metropolitan's e-news. The minimum 14-day public comment period was open for 21 days, ending on January 27, 2026. Metropolitan conducted a virtual public workshop on January 6, 2026, with Spanish interpretation available. Metropolitan was available for follow-up meetings upon request.

Public input was received through verbal and written comments at meetings and presentations. In addition, a specific email inbox was created to allow comment through the website or outside of meetings. A summary of comments is included in Appendix A. Comments were considered and incorporated into the plan as appropriate.

2.5.4 Continuing Public Involvement

Metropolitan will continue its ongoing coordination with the member agencies and the operational area emergency coordinators. They will be periodically updated on implementation progress and will be instrumental in future updates regarding risk assessments, priorities, and strategies. Metropolitan plans to keep the web page active after the plan's adoption to keep the public informed about successful mitigation projects and future plan updates. Metropolitan actively participates in business and community organizations and has public affairs staff

assigned to provide outreach to local, state, and federal officials. Major milestones of implementation will be shared as part of ongoing civic engagement activities.

2.6 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 2-4 summarizes milestones in the plan update process.

Table 2-4. Plan Development Chronology/Milestones

Date	Event	Description	Attendance
2021			
9/24	Planning Committee Meeting	• Welcome and introductions • Project overview • Planning Committee make-up and role • Data needs • Oversight Planning Committee • Public engagement strategy	17
10/07	Planning Committee Meeting	• Planning Committee • Public engagement strategies and requirements • Planning process timeline • Hazard analysis update	11
10/21	Planning Committee Meeting	• Mission statement, goals, objectives • Hazard analysis update • Public engagement strategy	15
11/04	Planning Committee Meeting	• Finalize goals and objectives • Confirm hazard list • Hazard analysis update • Communication plan, strategy, and methodology	12
2022			
1/13	Planning Committee Meeting	• Planning process timeline • Capabilities survey • Hazard analysis update • Public engagement strategy	14
2/10	Planning Committee Meeting	• Planning process timeline • Hazard analysis update • Public engagement update	14
2/24	Planning Committee Meeting	• Planning process timeline • Hazard analysis update • Public engagement update	13
3/24	Planning Committee Meeting	• Planning process timeline • Hazard analysis update • Public engagement update	11
4/21	Planning Committee Meeting	• Planning process timeline • Hazard analysis update • Public engagement update	12
4/27	Member Agency Workshop	• Overview of hazard mitigation planning process • Feedback from member agencies	33
5/5	Planning Committee Meeting	• Planning process timeline • Hazard analysis update • Public engagement update	11

Date	Event	Description	Attendance
5/19	Planning Committee Meeting	• Planning process timeline • Hazard analysis update • Public engagement update	10
6/2	Operational Area Emergency Managers Workshop	• Overview of hazard mitigation planning process • Feedback from emergency managers	18
6/2	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
6/30	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
8/25	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
9/8	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	13
10/6	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
11/3	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
11/17	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
12/1	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
2023			
1/19	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
2/2	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9
4/13	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9
5/25	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
6/22	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
7/6	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
7/20	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	8

Date	Event	Description	Attendance
8/31	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9
9/14	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	6
9/28	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9
10/26	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
12/21	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	6
2024			
1/4	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	8
1/18	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	11
2/1	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	8
2/15	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	6
2/29	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9
3/14	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
4/11	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
5/9	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	10
6/6	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	7
6/20	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9
7/18	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	9

Date	Event	Description	Attendance
8/15	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	8
10/24	Planning Committee	• Planning process timeline • Hazard analysis update Public engagement update	7
11/21	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	8
2025		•	
10/23	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	6
11/25	Planning Committee	• Planning process timeline • Hazard analysis update • Public engagement update	6
12/12	Member Agency Manager Meeting	Preview Draft Public Review Report	51
12/15	Emergency Manager Meeting	Preview Draft Public Review Report	8
2026			
1/6	Public Webinar	Preview Draft Public Review Report	TBD
TBD	Approval Pending Adoption	Approval pending adoption received from FEMA Region 9	n/a
TBD	Plan Adopted by Metropolitan	Plan is finalized with the Board's adoption	n/a
TBD	Final Approval	FEMA granted final approval of the adopted plan	n/a

3. THE METROPOLITAN WATER DISTRICT PROFILE

3.1 DISTRICT OVERVIEW

The Metropolitan Water District of Southern California was created in 1928 under authority of the Metropolitan Water District Act (MWD Act; California Statutes 1927, Chapter 429, reenacted in 1969 as Chapter 209, as amended). The mission of Metropolitan, as promulgated by the Board of Directors, is to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way. Metropolitan has 26 member public agencies and its primary purpose is to provide its members with a reliable, supplemental wholesale water supply service for domestic and municipal uses. To do so, Metropolitan imports water from the Colorado River through its Colorado River Aqueduct and from Northern California through California's State Water Project. Metropolitan is authorized to develop, store, and distribute water for domestic and municipal purposes and other beneficial uses if excess water is available, and may provide, generate, and deliver electric power within or outside its service area for the purpose of developing, storing, and distributing water. Metropolitan is also expressly authorized to promote and implement conservation programs. Metropolitan helps its member agencies develop increased water conservation, recycling, storage, and other local resource programs.

3.1.1 Governance

All powers, privileges and duties vested in or imposed upon Metropolitan are exercised and performed by and through its Board of Directors. The 38-member Board consists of at least one representative from each of the 26 member agencies, with each agency's assessed valuation determining its additional representation and voting rights. The Board includes business, professional, and civic leaders. Directors are appointed by member agencies in accordance with those agencies' processes and the MWD Act. They serve on the Board without compensation from Metropolitan. Board and committee meetings are open to the public and are broadcast on the internet through Metropolitan's website, www.mwdh2o.com. A schedule of Board and committee meetings, as well as current and archived Board materials, are available at the same website.

The Board administers its policies through the Metropolitan Water District Administrative Code, which was adopted by the Board in 1977. The Administrative Code is periodically amended to reflect new policies or changes to existing policies that occur from time to time.

The management of Metropolitan is under the direction of its General Manager, who serves at the discretion of the Board, as do Metropolitan's General Auditor, General Counsel, and Ethics Officer. In addition to the MWD Act and Administrative Code, the General Manager issues Operating Policies to direct staff activities, including emergency management and business continuity.

3.1.2 Water Resources

Metropolitan was established to obtain an allotment of Colorado River water and to construct and operate the 242-mile Colorado River Aqueduct, which runs from an intake at Lake Havasu on the California-Arizona border, to an endpoint at Metropolitan's Lake Mathews reservoir in Riverside County. Deliveries through the aqueduct to member agencies began in 1941. Metropolitan owns and operates an extensive portfolio of capital facilities including the Colorado River Aqueduct and a power transmission system, 16 hydroelectric facilities, nine reservoirs, 830 miles of large-scale pipes, and five water treatment plants.

In 1960, Metropolitan, followed by other public agencies, signed a long-term contract with the California Department of Water Resources (DWR) to participate in the State Water Project (SWP). The SWP, managed and operated by DWR, is the largest state-built, user-financed water supply and transportation project in the country. It serves urban and agricultural agencies from the San Francisco Bay area to Southern California. Its facilities were constructed with several general types of financing, the repayment of which is made by the 29 agencies and districts that participate in the SWP through long-term contracts. These state water contractors also pay for the operations, maintenance, power, and replacement costs of the SWP, as the state water contracts are the basis for all SWP construction and ongoing operations. As the largest of the 29 contractors, Metropolitan is entitled to slightly less than half of all SWP supplies. Water supplies from the SWP are conveyed to Metropolitan via the SWP's 444-mile California Aqueduct, which was made possible pursuant to Metropolitan's state water contract.

Metropolitan uses groundwater banking partnerships and water transfer arrangements to secure additional supplies. It also provides financial incentives to its member agencies for local investments in water management projects and programs (e.g., conservation, water recycling and recovered groundwater). A growing portion of Southern California's water supply comes from such local resources.

3.2 SERVICE AREA

Metropolitan's service area covers the Southern California coastal plain. It extends about 200 miles along the Pacific Ocean from the city of Oxnard on the north to the international boundary with Mexico on the south, and it reaches as far as 70 miles inland from the coast. The total area served is approximately 5,200 square miles, and it includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. As shown in Table 3-1, 14 percent of the land area of the six Southern California counties is within Metropolitan's service area, and 86 percent of the populations of those counties reside within Metropolitan's boundaries.

Table 3-1. July 1, 2020, Area and Population in the Six Counties of Metropolitan's Service Area

	Land Area (Square Miles)			Population (persons)		
County	Total County	In Metropolitan Service Area	Percent in Metropolitan	Total County	In Metropolitan Service Area	Percent in Metropolitan
Los Angeles County	4,061	1,408	35%	10,172,000	9,275,000	91%
Orange County	789	699	89%	3,191,000	3,184,000	100%
Riverside County	7,208	1,057	15%	2,449,000	1,813,000	74%
San Bernardino County	20,052	242	1%	2,184,000	872,000	40%
San Diego County	4,200	1,420	34%	3,352,000	3,261,000	97%
Ventura County	1,845	365	20%	841,000	630,000	75%
Metropolitan's Service Area	**38,155**	**5,191**	**14%**	**22,189,000**	**19,035,000**	**86%**

Sources: (California Department of Finance 2020) (Metropolitan 2021)

3.2.1 Socially Vulnerable Communities

Metropolitan has analyzed demographic data from the 2020 U.S. Census to identify underserved communities within its service area based on the following definition for disadvantaged communities (DAC): Census geographies with an annual median household income that is less than 80 percent of the statewide annual median. Using a statewide median of $91,905, a community with an annual median household income below $73,524 meets this threshold. Figure 3-1 shows disadvantaged communities within Metropolitan's service area.

Using data from the American Community Survey 5-Year Estimates (2018-2022), Metropolitan estimates that 4.7 million people live in a Census tract designated as a disadvantaged community. This is 25.3 percent of the total population in Metropolitan's service area (which totals 18.5 million people using the same data).

3.2.2 Water Service Provided

Metropolitan is a water wholesaler with no retail customers. It provides treated and untreated water directly to its 26 public member agencies, who deliver to their customers a combination of local groundwater, local surface water, recycled water, and imported water acquired from Metropolitan through purchase or exchange. Metropolitan supplies most of the water used within some of its member agencies' service areas. Others obtain varying amounts of water from Metropolitan to supplement local supplies.

Between 2011 and 2020, Metropolitan provided between 40 and 50 percent of the municipal, industrial, and agricultural water used in its service area (Metropolitan 2021). The remaining water supply came from local wells, local surface water, recycling, and the city of Los Angeles' aqueduct from the Owens Valley/Mono Basin east of the Sierra Nevada. Member agencies also implement conservation and other programs that can be considered part of their supplies.

Some member agencies provide retail water service, while others provide water to the local area as wholesalers. Table 3-2 shows Metropolitan's member agencies and the type of service that they provide. As shown in the table, 15 member agencies provide only retail service to customers, nine provide only wholesale service, and two provide a combination of both. Within Metropolitan's service area, approximately 250 retail water suppliers directly serve the population.

To aid in planning future water needs, member agencies advise Metropolitan in July of each year of how much water they anticipate they will need during the next five years. In addition, Metropolitan works with its member agencies to forecast future water demand.

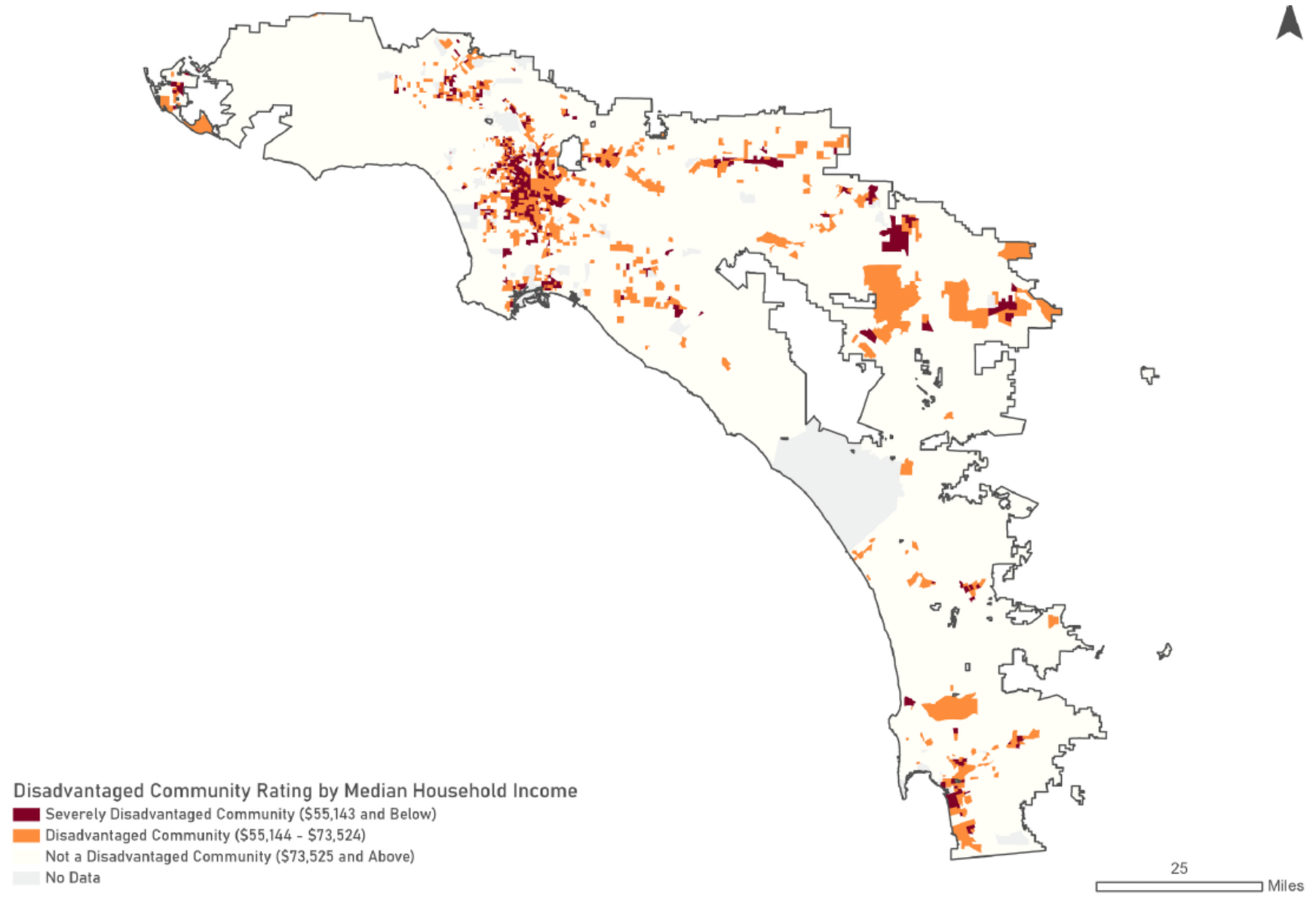


Figure 3-1. Socially Vulnerable Communities Within Metropolitan's Service Area

Table 3-2. Metropolitan's Member Agencies and Type of Water Service Provided

Member Agency	Retail or Wholesale
Los Angeles County	
Beverly Hills, City of	Retail
Burbank, City of	Retail
Central Basin Municipal Water District	Wholesale
Compton, City of	Retail
Foothill Municipal Water District	Wholesale
Glendale, City of	Retail
Las Virgenes Municipal Water District	Retail
Long Beach, City of	Retail
Los Angeles, City of	Retail
Pasadena, City of	Retail
San Fernando, City of	Retail
San Marino, City of	Retail
Santa Monica, City of	Retail
Three Valleys Municipal Water District	Wholesale
Torrance, City of	Retail
Upper San Gabriel Valley Municipal Water District	Wholesale
West Basin Municipal Water District	Wholesale
Orange County	
Anaheim, City of	Retail
Fullerton, City of	Retail
Municipal Water District of Orange County	Wholesale
Santa Ana, City of	Retail
Riverside County	
Eastern Municipal Water District	Retail & Wholesale
Western Municipal Water District	Retail & Wholesale
San Bernardino County	
Inland Empire Utilities Agency	Wholesale
San Diego County	
San Diego County Water Authority	Wholesale
Ventura County	
Calleguas Municipal Water District	Wholesale

3.3 DISTRICT FACILITIES

Metropolitan's capital assets include water infrastructure, land and buildings, participation rights in the SWP and various other water programs, as well as intangible right-to-use leased assets. Metropolitan's water system is primarily gravity-fed, with pump plants, treatment plants and reservoirs strategically located to minimize the need for pumping and associated infrastructure and energy demand. The water system includes the following critical infrastructure and key resources:

Colorado River Aqueduct

- Length: 242 miles from Lake Havasu to Lake Mathews, Riverside
- Capacity: 1.3 million acre-feet annually (1 acre-foot = 325,851 gallons)

- Pumping Plants (east to west): Whitsett Intake (lift 291 feet); Gene (303 feet); Iron Mountain (144 feet); Eagle Mountain (438 feet); Julian Hinds (441 feet); Total lift 1,617 feet
- Siphons: 144, totaling 29 miles
- Tunnels: 29, totaling 92 miles
- Canals: 63 miles
- Conduits and Pipeline: 58 miles
- Power transmission system: 230 kV serving five pumping plants, totaling 320 miles

Water Treatment Plants:

- Joseph Jensen, Granada Hills (capacity 750 million gallons per day (mgd))
- Robert A. Skinner, Winchester (capacity 350 mgd)
- F.E. Weymouth, La Verne (capacity 520 mgd)
- Robert B. Diemer, Yorba Linda (capacity 520 mgd)
- Henry J. Mills, Riverside (capacity 220 mgd)

Reservoirs and Dams:

- Metropolitan owns and operates 20 reservoirs:
  - Diamond Valley Lake, Hemet, capacity 810,000 acre-feet
  - Lake Mathews, Riverside, capacity 182,000 acre-feet
  - Lake Skinner, Winchester, capacity 44,000 acre-feet
  - Copper Basin, Gene, capacity 24,200 acre-feet
  - Gene Wash, Gene, capacity 6,300 acre-feet
  - Live Oak, La Verne, capacity 2,500 acre-feet
  - Garvey, Monterey Park, capacity 1,600 acre-feet
  - Palos Verdes, Rolling Hills, capacity 1,100 acre-feet
  - Orange County, Brea, capacity 212 acre-feet
  - Eight smaller reservoirs at Diemer, Mills, Weymouth and Skinner Water Treatment Plants
  - Three other smaller reservoirs (Diamond Valley Lake Forebay, Goodhart Detention Basin, Cajalco Creek Detention Basin)
- For the 20 reservoirs above, Metropolitan owns 24 dams that meet the jurisdictional dam criteria for regulation by the California Division of Safety of Dams (DSOD). Diamond Valley Lake and Lake Mathews each have three dams.

Distribution System:

- 830 miles of pipelines and tunnels with over 400 service connections to its member agencies

Hydroelectric Plants:

- 16 hydroelectric plants with a nameplate capacity totaling 131 megawatts

Solar Generation:

- Four solar power generating facilities with a total of 5.5 megawatts of solar generating capacity

The hazard mitigation plan assesses the potential risk that natural hazards pose to critical infrastructure and key resources. The risk assessment in Part 2 provides an inventory of key facilities. The inventory created for this plan includes two parts: an overview count of specific types of assets that Metropolitan owns, and a listing of the estimated replacement value of key assets. All of Metropolitan's key assets are defined for this plan as community lifelines. As defined by FEMA, a community lifeline enables the continuous operation of critical government and business functions and is essential to human health and safety or economic security; these include the most fundamental services in the community that, when stabilized, enable all other aspects of society to function

(FEMA n.d.). Individual sites of lifelines are referred to as "assets" and categorized by the service they provide throughout this plan. Table 3-3 summarizes Metropolitan's community lifelines and their gross value.

Table 3-3. Metropolitan Water District Assets

Asset	Estimated 2021 Replacement Cost
Colorado River Aqueduct System	
Aqueduct	$5,317,333,152
Pump Plants (5)	1,497,230,598
Reservoirs (4)	$60,205,576
Electrical Facilities	$650,645,599
Other	$82,255,267
Total	***$7,607,670,192***
Conveyance, Treatment and Distribution Facilities	
Water Treatment Plants (5, Including Reservoirs)	$5,311,138,548
Reservoirs – Raw (7)	$3,850,117,209
Reservoirs – Finished (3)	$226,642,833
Hydroelectric Plants (12)	$355,690,352
Pump Plants (3)	$69,226,317
Pressure Control Structures (26)	$308,646,600
Total	***$10,121,461,859***
Pipelines	
Conveyance and Distribution System (830 miles of pipeline)	$9,122,286,538
Total	***$9,122,286,538***
Building Facilities	
Headquarters	$230,337,632
La Verne	$201,747,367
Eagle Rock	$15,733,961
Other Facilities	$69,071,080
Total	***$516,890,040***
Other Assets	
Other Assets	$188,482,162
Total	***$188,482,162***
Total Replacement Value for All Metropolitan Assets	**$27,556790,969**

3.4 FINANCIAL SUMMARY

Metropolitan's principal sources of revenue are charges for the sale and availability of water, including water rates and other exchange and wheeling transactions. Other sources of operating revenue include readiness-to-serve charges, capacity charge, and hydroelectric power sales. Other revenues include ad valorem property taxes and investment income. The Board of Directors sets Metropolitan's water rates to recover the cost of providing water service to customers. New rates are set every other year in an open and transparent public process, concurrent with the biennial budget review process. Metropolitan's rates and charges are not subject to regulation or approval by the California Public Utilities Commission or any other state or federal agency.

Metropolitan adopted a biennial budget of $2.413 billion for FY 2024/25 and $2.426 billion for FY 2025/26, with overall rate increases of 8.5 percent per year. This includes $636.5 million in capital investments to address aging infrastructure, respond to drought, and comply with regulatory requirements and 1,965 full-time equivalent positions. Water transactions are estimated to be 1.34 million acre-feet in each fiscal year (Metropolitan 2024).

Affordability for water ratepayers is important for Metropolitan and its member agencies. Aging infrastructure requires greater investment in refurbishment, replacement, and upgrades. Climate change, with increasing aridity and changing hydrology, requires system improvements and expanding demand management programs to maintain reliability. This will impact Metropolitan's rates through debt service and pay-as-you-go, which is funded through current operating revenues. Metropolitan maintains a strong credit rating to control the cost of debt service. Water revenue bond ratings are as follows: Standard & Poor's AAA; Moody's AA1; and Fitch AA+.

The Capital Investment Plan (CIP) communicates the capital priorities of Metropolitan for the current biennial budget through 10 capital programs:

- **Climate Adaptation**—Projects under this program will replace, refurbish, upgrade, or construct new facilities to prepare Metropolitan to adjust to current and projected climate change impacts on its operation and its mission to provide its service area with adequate and reliable supplies of high-quality water in an environmentally and economically responsible way.
- **Colorado River Aqueduct Reliability**—Projects under this program will replace or refurbish facilities and components on the Colorado River Aqueduct system to reliably convey water from the Colorado River to Southern California.
- **Dams & Reservoirs Improvements**—Projects under this program will upgrade or refurbish Metropolitan's dams, reservoirs, and appurtenant facilities to reliably meet water storage needs and regulatory compliance.
- **Distribution System**—Projects under this program will replace or refurbish existing facilities within Metropolitan's distribution system, including pressure control structures, hydroelectric power plants, and pipelines to reliably meet water demands.
- **Drought Mitigation, State Water Project Dependent Areas**—Projects under this program will replace, refurbish, upgrade, or construct new facilities, which are identified to mitigate the vulnerability experienced by specific member agencies that are impacted during shortages on State Water Project supplies.
- **Minor Capital Projects**—This program consists of projects with an estimated cost of less than $400,000 that require rapid response to address unanticipated failures or safety or regulatory compliance concerns, or to take advantage of shutdown opportunities. The projects will be identified after adoption of the budget.
- **Information Technology & Control Systems**—Projects under this program will replace, upgrade, or provide new facilities, software applications, or technology that will enhance cyber security, reliability, flexibility, and capability of information, communication, and control systems.
- **Additional Facilities and Systems—**Projects under this program will refurbish, replace, upgrade, or provide new facilities and systems that support Metropolitan's business and operations.
- **Prestressed Concrete Cylinder Pipe Rehabilitation**—Projects under this program will refurbish or upgrade Metropolitan's prestressed concrete cylinder pipe feeders to maintain reliable water deliveries without unplanned shutdowns.
- **Water Treatment Plants—**Projects under this program will replace or refurbish facilities and components at Metropolitan's five water treatment plants and chlorine unloading facility to continue to reliably meet treated water demands.

Figure 3-2 depicts the capital investment plan for the FY 2024/25 and 2025/26 biennial budget with the funding for each program. Figure 3-3 depicts the planned capital spending profile for the 10-year period from FY 2024/25 through FY 2033/34.

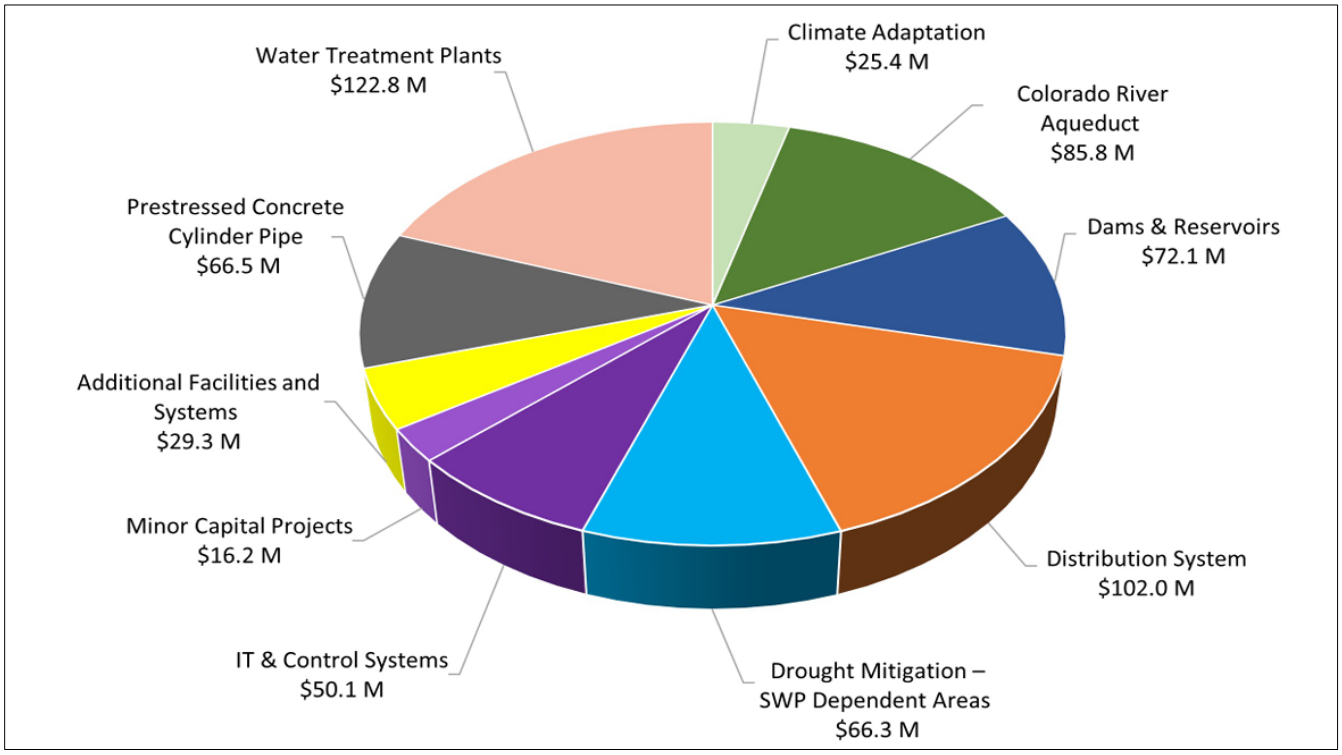


Figure 3-2. Metropolitan Capital Investment Plan Breakdown for FY 2024/25 and FY 2025/26

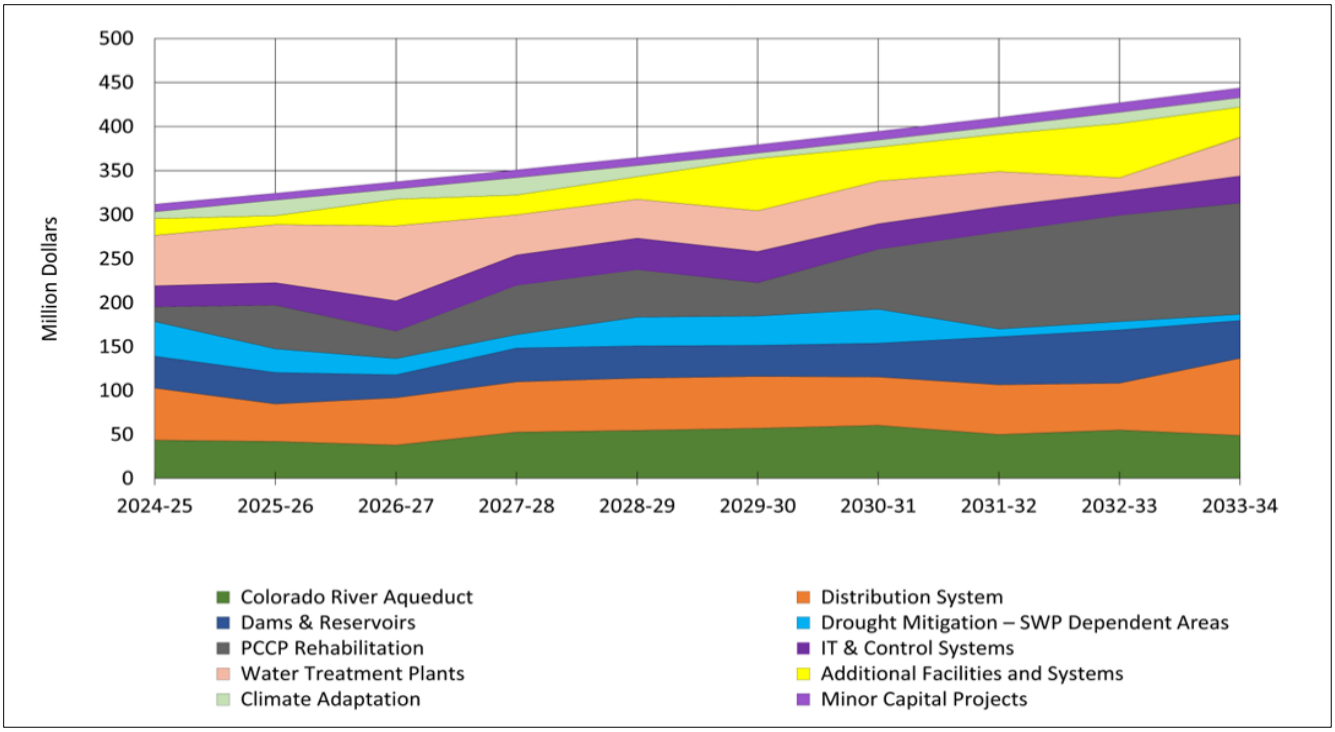


Figure 3-3. CIP 10-Year Window by Program, FY 2024/25 through FY 2033/34

3.5 PHYSICAL CHARACTERISTICS

3.5.1 Geography

Metropolitan's service area covers the Southern California coastal plain. Figure 3-4 and Figure 3-5 show the major geographic features of the service area, including rivers, local mountain ranges and coastal foothills, along with major water infrastructure. The planning area also includes Metropolitan's Colorado River Aqueduct and related facilities. The 242-mile aqueduct begins at the intake on Lake Havasu and crosses 242 miles of desert and mountains. Major earthquake faults cross the service area as shown in Figure 3-6.

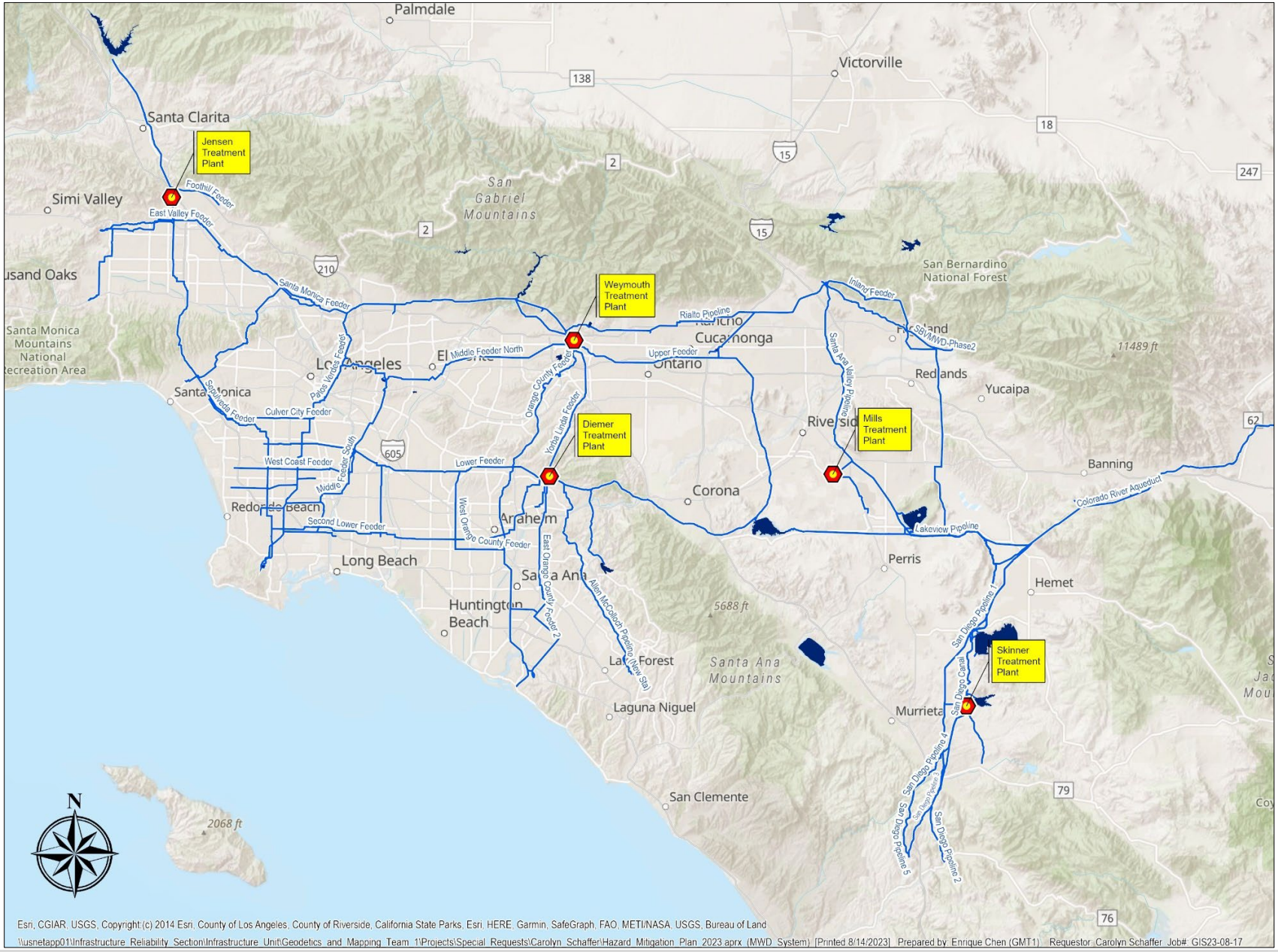


Figure 3-4. Major Geographic Features and Regional Water Infrastructure in Western Portion of Metropolitan Planning Area

Figure 3-5. Major Geographic Features and Regional Water Infrastructure in Eastern Portion of Metropolitan Planning Area

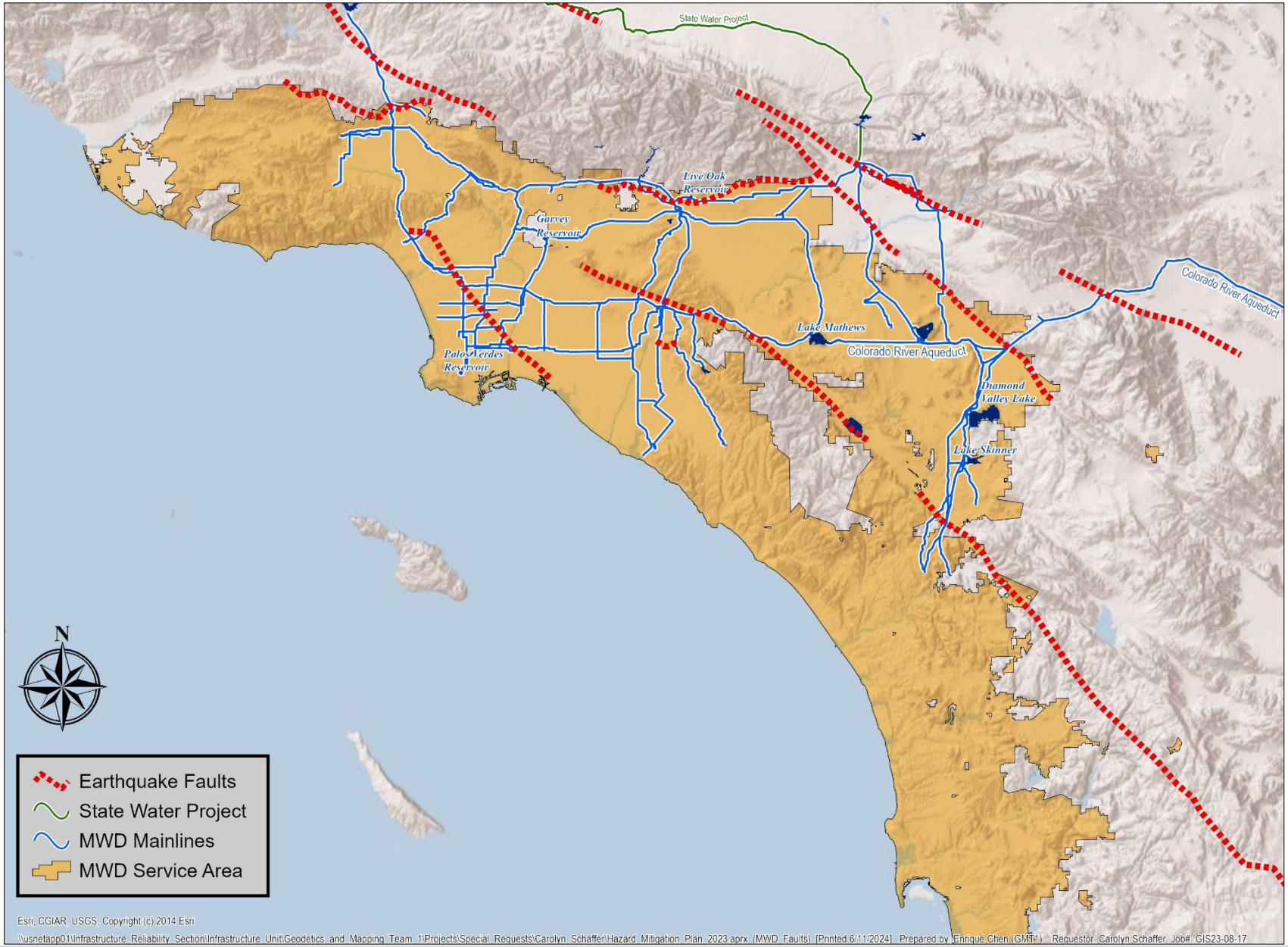


Figure 3-6. Major Earthquake Faults in Metropolitan Service Area

3.5.2 Climate

Historical and Current Climate

Metropolitan's service area encompasses three major climate zones as shown in Figure 3-7. Table 3-4 reports the average temperature and rainfall information for representative locations in three major counties in the service area (Los Angeles, San Diego, and Riverside) for the 30-year period from 1990 to 2019. Evapotranspiration data (expressed as ETo) are reported for the 30-year period of 1985 to 2014.

Hydrologic conditions can have a significant impact on Metropolitan's imported water supply sources and the member agencies' local resources. For Metropolitan's SWP supplies, precipitation in California's northern Sierra Nevada during the fall and winter helps replenish storage levels in Lake Oroville, a key State Water Project facility. The subsequent runoff from the spring snowmelt helps satisfy regulatory requirements in the San Francisco Bay/Sacramento-San Joaquin River Delta, bolstering water supply reliability in the same year. The sources of Metropolitan's Colorado River supplies are primarily the watersheds of the Upper Colorado River Basin in Colorado, Utah, and Wyoming. Although precipitation is primarily observed in the winter and spring, summer storms are common and can affect water supply conditions.

Uncertainties from potential future temperature and precipitation changes also present challenges. Associated areas of concern to California water planners include the following:

- Reduction in Sierra Nevada and Colorado Basin snowpack
- Increased intensity and frequency of extreme weather events
- Shifting runoff patterns to earlier in the year when reservoir storage is more constrained due to flood protection
- Rising sea levels resulting in increased risk of damage from storms, high-tide events, and the erosion of levees and potential cutbacks of deliveries of imported water.
- In the Southern California region, climate change threatens groundwater basins with saltwater intrusion and less natural replenishment.

Climate Change

The United Nations Framework Convention on Climate Change defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (United Nations 1994). The well-established worldwide warming trend of recent decades and its related impacts are caused by increasing concentrations of carbon dioxide and other greenhouse gases in the earth's atmosphere. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. Carbon dioxide is the most commonly known greenhouse gas; however, methane, nitrous oxide and fluorinated gases also contribute to warming. Emissions of these gases come from a variety of sources, such as the combustion of fossil fuels, agricultural production, and changes in land use.

Source: (Metropolitan 2021)

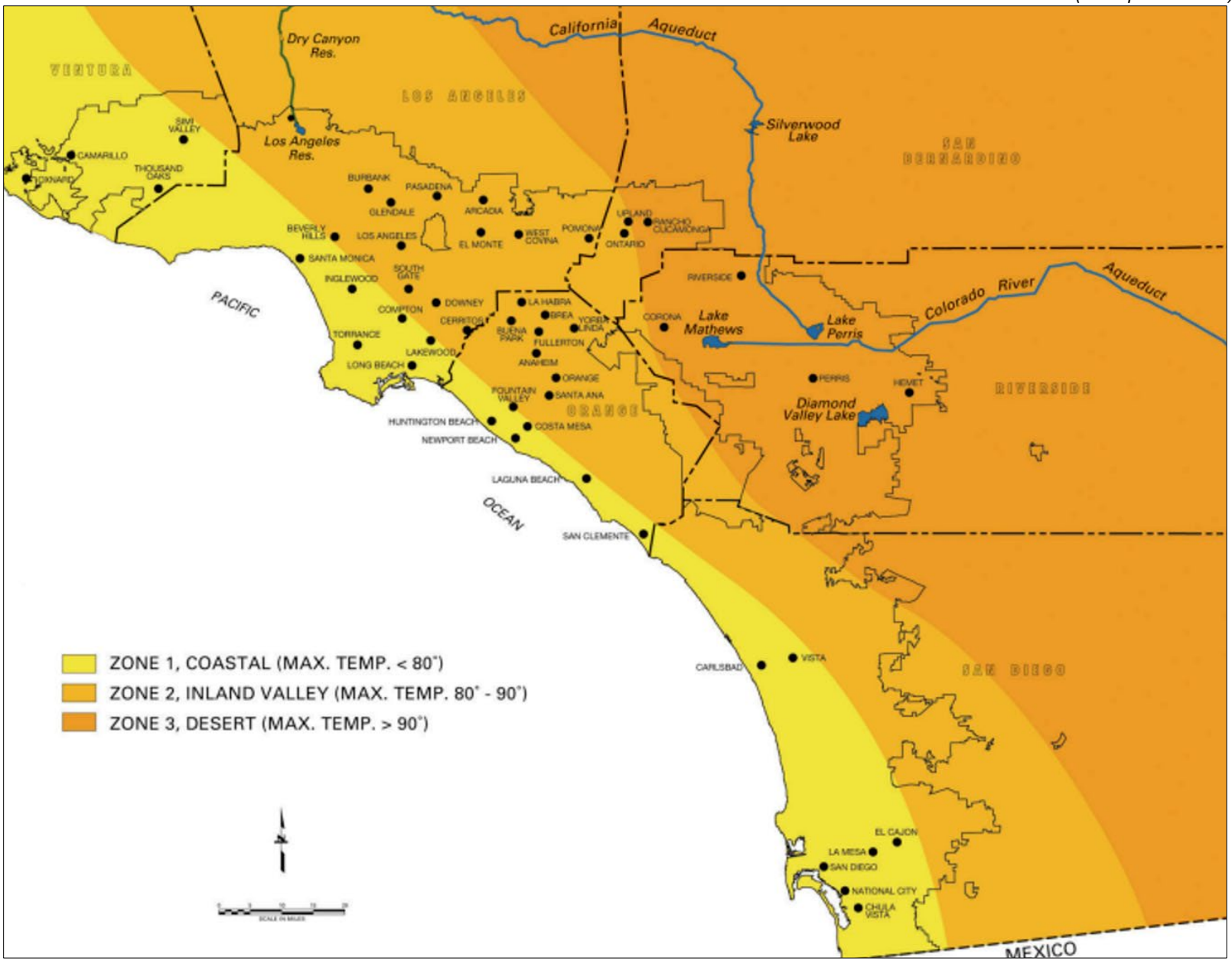


Figure 3-7. Climate Zones in Southern California

Table 3-4. Weather Variables in Three Counties in Metropolitan's Service Area

	Los Angeles County[a]	Riverside County[b]	San Diego County[c]
Average Temperature (ºF, 1990 – 2019)			
January	68.77	68.89	69.76
February	68.54	65.55	70.02
March	70.62	66.45	73.61
April	73.06	68.22	77.79
May	74.34	68.98	80.93
June	78.16	71.18	88.06
July	82.95	74.87	94.21
August	84.61	76.85	95.84
September	83.69	76.64	92.65
October	79.41	74.04	84.52
November	73.77	70.15	76.35
December	67.90	65.42	68.83
Annual	***75.48***	***70.35***	***81.05***
Average Precipitation (inches, 1990 – 2019)			
January	3.32	2.01	2.05
February	3.74	2.48	2.22
March	2.09	1.31	1.40
April	0.61	0.52	0.55
May	0.35	0.23	0.29
June	0.09	0.09	0.07
July	0.02	0.13	0.08
August	0.00	0.13	0.01
September	0.13	0.15	0.12
October	0.58	0.47	0.49
November	0.78	0.66	0.80
December	2.42	1.35	1.67
Annual	***15.20***	***11.16***	***9.85***
Average Evapotranspiration (inches, 1985 – 2014)[d]			
January	2.2	2.1	2.5
February	2.7	2.4	2.9
March	3.7	3.4	4.2
April	4.7	4.6	5.3
May	5.5	5.1	5.9
June	5.8	5.3	6.6
July	6.2	5.7	7.2
August	5.9	5.6	6.9
September	5.0	4.3	5.4
October	3.9	3.6	4.1
November	2.6	2.4	2.9
December	1.9	2.0	2.6
Annual	***50.1***	***46.5***	***56.4***

a. Los Angeles County temperature and precipitation data from USC Station KCQT. Last updated February 18, 2020
b. Riverside County temperature and precipitation data from Riverside Station KNOC. Last updated February 18, 2020
c. San Diego County temperature and precipitation data from San Diego Airport Station KSAN. Last updated February 18, 2020
d. Evapotranspiration data from Model Water Efficient Landscape Ordinance, September 10, 2009; Appendix A—Reference Evapotranspiration Table

Climate change will affect people, property, economy, and ecosystems in a variety of ways. Consequences of climate change are numerous and include increased frequency and severity of droughts, increased flood vulnerability, increased wildfire risk, and increased heat-related illnesses. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of multiple natural hazards.

The Fifth National Climate Assessment Report for the United States indicates that impacts resulting from climate change will continue through the 21st century and beyond. Key findings from the report are summarized in Figure 3-8 through Figure 3-10.

Source: (USGCRP 2023)

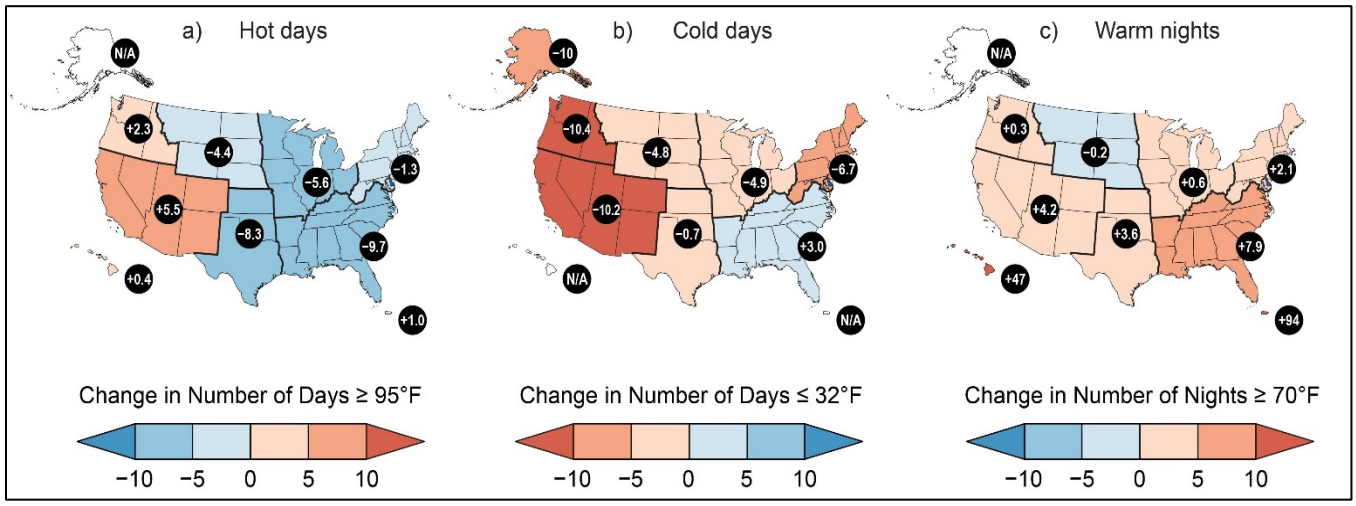


Figure 3-8. Observed Changes in Hot and Cold Extremes

Source: (USGCRP 2023)

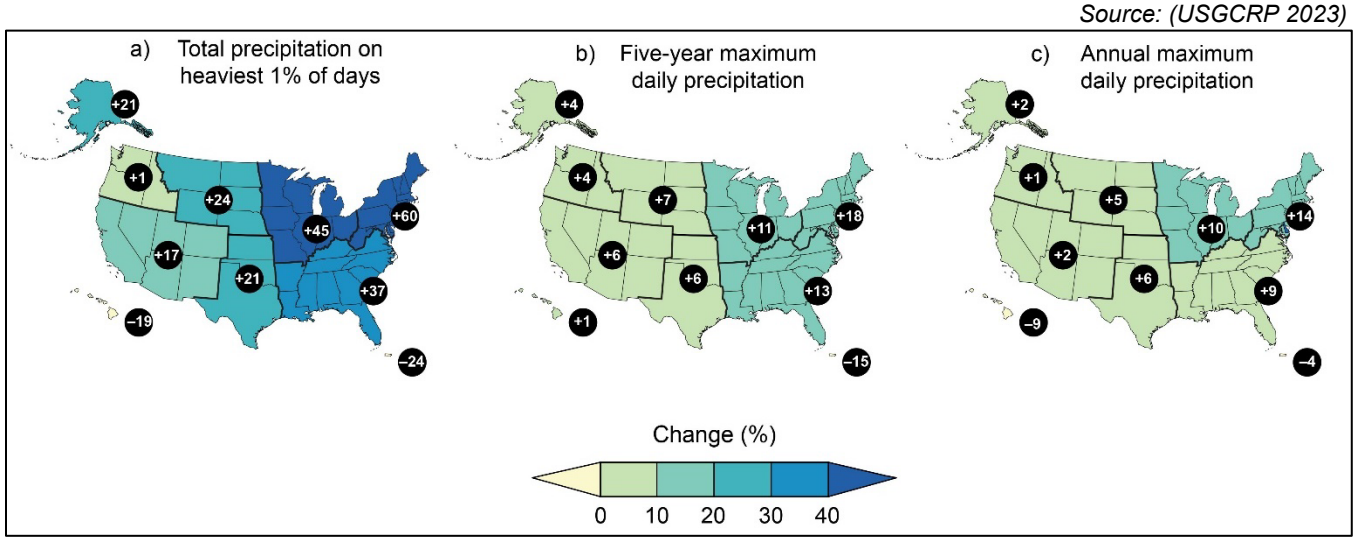


Figure 3-9. Observed Changes in the Frequency and Severity of Heavy Precipitation Events

Source: (USGCRP 2023)

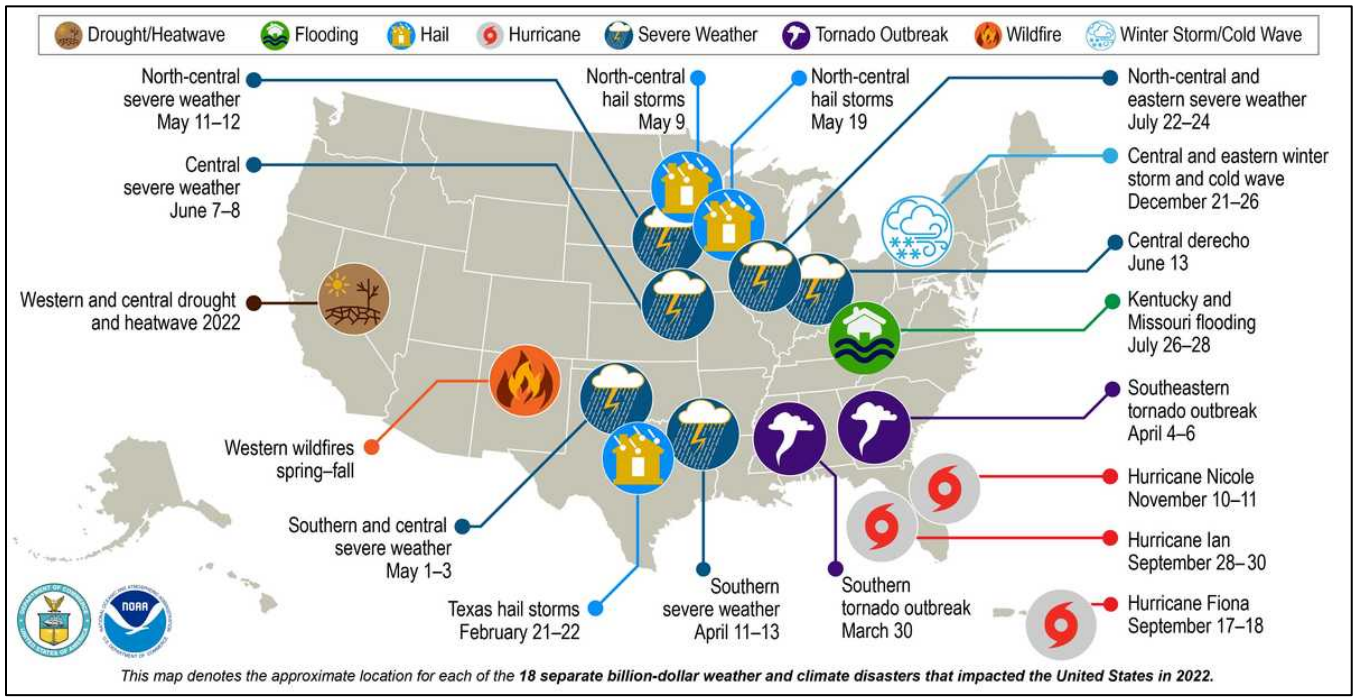


Figure 3-10. Billion-Dollar Weather and Climate Disasters in 2022

The California Climate Adaptation Planning Guide outlines climate change impact concerns for the South Coast climate impact region (Cal OES 2020). Some of these changes are direct or primary climatic changes, such as increased temperature, while others are indirect or secondary impacts, such as air pollution. The climate change impacts likely to affect Metropolitan's planning area are summarized in Table 3-5.

The following sections summarize information developed for the Los Angeles Region by Cal-Adapt, a resource for public information on how climate change might impact local communities over a range of emissions scenarios. Climate change projections depend on estimates of future greenhouse gas emissions, and the uncertainty in these estimates is addressed by assessing multiple scenarios:

- In low-emissions scenarios, greenhouse gas emissions are reduced substantially from current levels.
- In high-emissions scenarios, greenhouse gas emissions generally increase or continue at current levels.

For its planning, Metropolitan has adopted the use of Representative Concentration Pathway (RCP) 8.5, which represents more pronounced climate change. The Cal-Adapt projections for Los Angeles are provided as examples, with similar impacts expected for other parts of Metropolitan's six-county service area.

Temperature

The historical (1981-2010) average temperature for the Los Angeles region was 66.6 ºF. By 2090, the average temperature is expected to increase above this baseline by 3.5 ºF and 6.0 ºF in the low- and high-emissions scenarios, respectively (see Figure 3-11). By 2100, if temperatures rise to the higher warning range, there could be up to 100 more days per year with temperatures above 90 ºF (see Figure 3-12).

Table 3-5. Summary of Climate Change Impacts Likely to Affect the Planning Area

Primary Impact	Secondary Impact	Example Human and Natural System Impacts
Increased Temperature	Heat wave and high carbon emissions	• Increased frequency of illness and death • Increased high alert ozone days, urban heat islands • Increased stress on mechanical systems, such as HVAC systems • Increased stress on electricity supply and demand
Reduced Precipitation	Changed seasonal patterns	• Reduced water supply • Changes to ecosystems, habitat • Precipitation patterns no longer maximize benefit of existing storage infrastructure
	Increased wildfires	• More people, wildlife, land, and structures impacted by fires. • Summer dryness will begin earlier, last longer, and become more intense.
Sea Level Rise	Permanent inundation of previously dry land	• Loss of assets and tax base • Loss of coastal habitat • Saltwater intrusion in groundwater basins
	Larger area impacted by extreme high tide	• More people and structures impacted by storms
	Increased coastal erosion	• Loss of assets and tax base
Reduced Mountain Snowpack	Reduced water supply	• Primary imported sources of water are State Water Project and the Colorado River, both originating in mountain snowpack; change may reduce water supply. • Increased costs for water • Greater dependence on local water supplies

Adapted and expanded from California Adaptation Planning Guide: Planning for Adaptive Communities (Cal OES 2020)

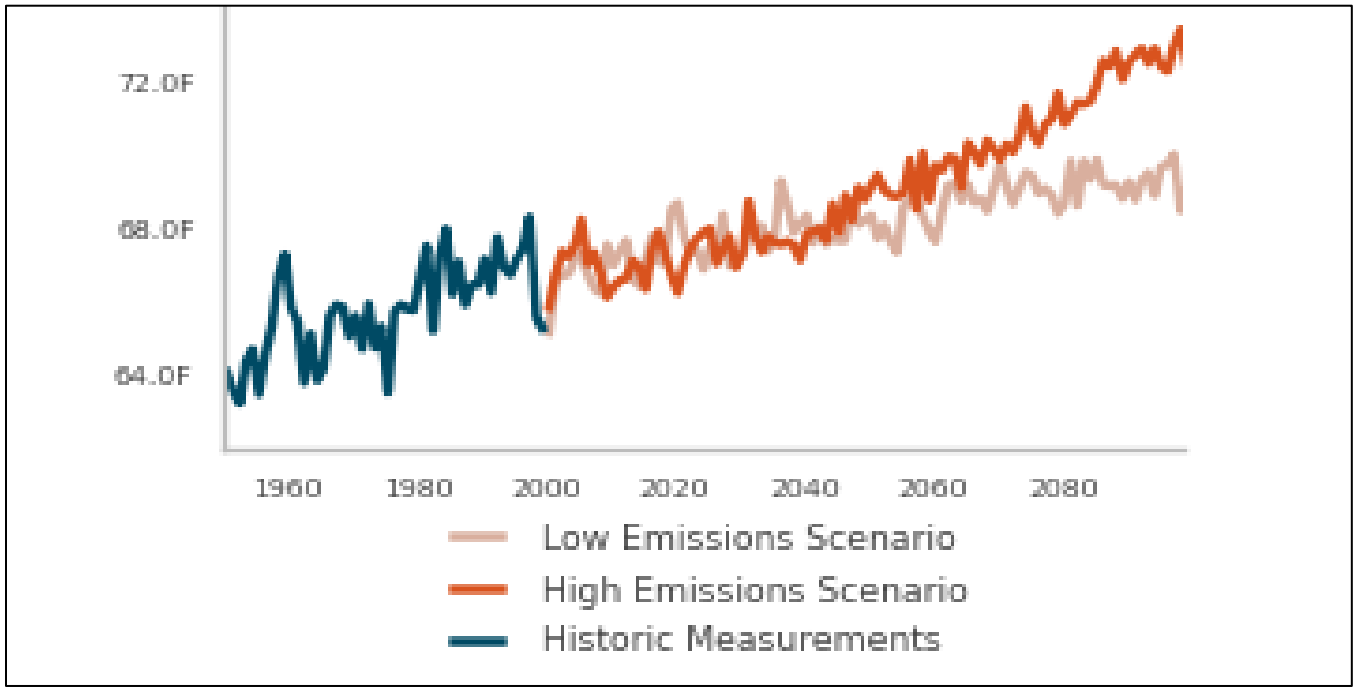


Figure 3-11. Observed and Projected Average Temperatures for the Los Angeles Region

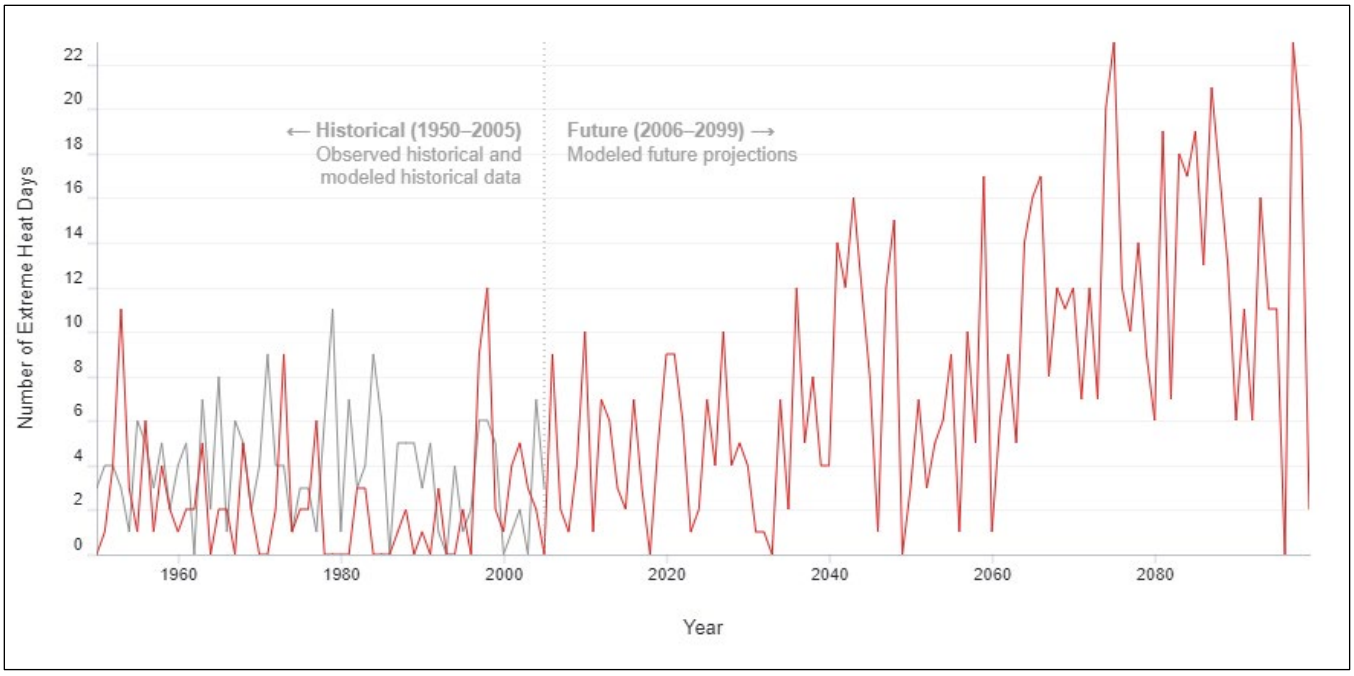


Figure 3-12. Projected Number of Extreme Heat Days by Year for the Los Angeles Region

Precipitation

California's climate varies between wet and dry years. Research suggests that for much of the state, wet years will become wetter and the dry years will become drier. Dry years are also likely to be followed by dry years, increasing the risk of drought. While California does not see the average annual precipitation changing significantly in the next 50 to 75 years, precipitation will likely be delivered in more intense storms and within a shorter wet season. Some of the impacts from a shift towards larger year to year fluctuations are becoming visible (Cal Adapt 2023).

Sea Level Rise

Scientific estimates suggest the magnitude of sea-level rise in California could be at least half of one foot in 2030 and as much as seven feet by 2100. Moreover, storm surges, exceptionally high "king tides," or El Niño events could produce notably higher water levels than sea-level rise alone. Encroaching seas and waves could result in negative impacts along California's coast not only through increased flooding, but also by eroding beaches and cliffs, and saltwater intrusion into groundwater supplies. Some key findings from existing research include:

- Between $8 billion and $10 billion of existing property in California is likely to be underwater by 2050, with an additional $6 billion to $10 billion at risk during high tides.
- Under scenarios of 3 feet to 6 feet of sea-level rise, up to two-thirds of Southern California beaches may become completely eroded by 2100 (The California Legislative Analyst's Office 2020).

Wildfire

Wildfire risk is expected to change in the coming decades (see Figure 3-13). Under both high- and low-emissions scenarios, the change in area burned may slightly increase until 2020 and then decrease by 10 to 20 percent by 2085.

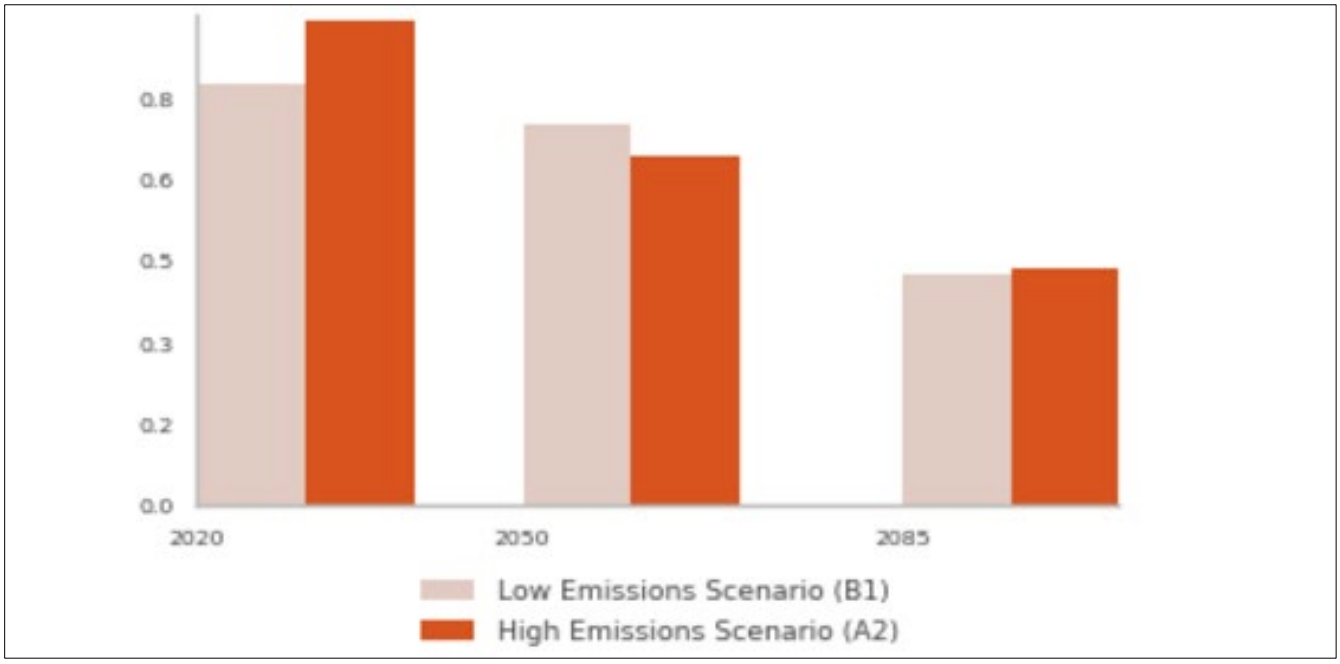


Figure 3-13. Projected Changes in Fire Risk for Los Angeles Region, Relative to 2010 Levels

Snowpack

While there are no snow water equivalency measurements for the Los Angeles region, Cal-Adapt indicates that parts of California should expect snowpack levels to be reduced by up to 25 inches from the baseline (1961-1990) by 2090. This will impact Metropolitan's imported water supplies from the State Water Project and Colorado River.

3.6 GROWTH PROFILE

Metropolitan estimates that 18.6 million people lived in Metropolitan's service area as of July 2023, based on official estimates from the California Department of Finance and on population distribution estimates from the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG). Recent population projections prepared by SCAG in 2020 and by SANDAG in 2019, which are used as base data for Metropolitan's 2020 Integrated Water Resources Plan, show expected population growth of 17 percent in Metropolitan's service area between 2010 and 2035, which is slightly lower than the 18 percent population growth rate projected by SCAG in 2012 and SANDAG in 2013. These projections were used as base data for Metropolitan's prior 2015 Integrated Water Resources Plan update.

3.6.1 Growth Trends

SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next 10 years. Generally speaking, however, annual growth rates will slow for all counties between 2010 and 2045. In part, this is due to changing patterns of migration, as well as aging of the overall population. It also reflects the effects of the recession of the late 2000s and the ongoing restructuring of the Southern California economy (Metropolitan 2021, Metropolitan 2020).

Employment growth is likely to occur unevenly across the six counties. Over the 25-year period between 2020 and 2045, the greatest employment increases are expected to occur in Riverside, Los Angeles, and San Diego Counties with estimated increases of 208,000, 375,000, and 237,000 jobs, respectively. Relative to existing employment, Riverside and San Bernardino counties are expected to have the highest rates of employment growth (Metropolitan 2021, Metropolitan 2020).

Long-term employment is based on SCAG and SANDAG's forecasts. Total urban employment is expected to increase from 8.6 million in 2020 to about 10.3 million in 2045. This increase of about 12 percent is less than the projected population increase of 14 percent, suggesting a slight decrease in the employed population over time due to aging population (Metropolitan 2021, Metropolitan 2020).

Southern California's regional planning agencies have forecast residential housing growth in all parts of the Metropolitan service area. The total occupied housing stock is expected to increase more than 20 percent between 2020 and 2045, growing from 6.3 to around 7.6 million households. Much of this growth will likely occur in hotter inland areas of Southern California. Within the service territory, the household occupancy size (household population divided by total occupied dwelling units) is projected to decline slightly from about 3.0 persons per unit currently to 2.9 persons per unit by 2045. Permits for new residential housing construction are another indicator of the future growth in water demand. In a departure from the previous trend since the late 1980s that favored single-family homes, new dwellings built since 2011 have been mostly multifamily units (Metropolitan 2021, Metropolitan 2020).

3.6.2 Regional Economy

The economy of Metropolitan's service area is exceptionally diverse. In 2022, the economy of the six-county area was larger than all but 11 nations of the world and all U.S. states except California, Texas, and New York; its estimated gross domestic product of $1.823 trillion lies between those of Brazil ($1.920 trillion) and Australia ($1.693 trillion) (Metropolitan 2024).

The six-county area economy is connected to the national and world economies, especially the Pacific Rim, and is subject to fluctuations and changes in long-term demographic trends around the world and changes in national policies that affect the economy. The six-county area economy has an economic base that is diversified and well positioned to participate in U.S. and world economic growth over the next 10 years. Job levels are expected to grow in the high-wage and fast growing professional, scientific, technical and information services sectors, which include architecture, design, computer, research and development, advertising, legal, accounting, and internet-related and management services. Other fast-growing sectors over the next 10 years include entertainment and tourism industries and healthcare (Metropolitan 2024).

4. LAWS, PROGRAMS, AND CAPABILITIES

Existing laws, ordinances, plans and capabilities at the federal, state, and local level can positively or negatively impact hazard mitigation initiatives identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process, as stated in 44 CFR, Section 201.6(b)(3). Pertinent federal, state, and local laws are described below.

4.1 RELEVANT FEDERAL AND STATE AGENCIES, PROGRAMS AND REGULATIONS

State and federal regulations and programs that need to be considered in hazard mitigation are constantly evolving. For this plan, a review was performed to determine which state and federal regulations and programs are currently most relevant to hazard mitigation planning for Metropolitan. The findings are summarized in Table 4-1 and Table 4-2. Short descriptions of each program are provided in Appendix B.

Table 4-1. Summary of Relevant Federal Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Americans with Disabilities Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
America's Water Infrastructure Act	Infrastructure Improvements	This act requires community drinking water systems across the nation to develop and update risk and resilience assessments and emergency response plans.
Bureau of Land Management	Wildfire Hazard	The Bureau funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands.
Civil Rights Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Clean Water Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Community Development Block Grant Disaster Resilience Program	Action Plan Funding	This is a potential alternative source of funding for actions identified in this plan.
Community Rating System	Flood Hazard	This voluntary program encourages floodplain management activities that exceed the minimum National Flood Insurance Program requirements.
Disaster Mitigation Act	Hazard Mitigation Planning	This is the current federal legislation addressing hazard mitigation planning.
California Environmental Protection Agency Drinking Water State Revolving Fund	Action Plan Funding	This is a possible funding source for actions identified in this plan.
Emergency Relief for Federally Owned Roads Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Endangered Species Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Federal Energy Regulatory Commission Dam Safety Program	Dam Failure Hazard	This program cooperates with a large number of federal and state agencies to ensure and promote dam safety.
Federal Wildfire Management Policy and Healthy Forests Restoration Act	Wildfire Hazard	These documents mandate community-based collaboration to reduce risks from wildfire.
National Dam Safety Act	Dam Failure Hazard	This act requires a periodic engineering analysis of most dams in the country
National Environmental Policy Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
National Fire Plan	Wildfire Hazard	This plan calls for joint risk reduction planning and implementation by federal, state, and local agencies.
National Flood Insurance Program	Flood Hazard	This program makes federally backed flood insurance available to homeowners, renters, and business owners in exchange for communities enacting floodplain regulations
National Incident Management System	Action Plan Development	Adoption of this system for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards is a prerequisite for federal preparedness grants and awards
National Landslide Preparedness Act	Risk Assessment of Landslide Hazard	This act authorized a national landslide hazards reduction program and a 3D elevation program, providing tools and data to assess the landside hazard.
Presidential Executive Order 11988 (Floodplain Management)	Flood Hazard	This order requires federal agencies to avoid long- and short-term adverse impacts associated with modification of floodplains
Presidential Executive Order 11990 (Protection of Wetlands)	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable presidential executive orders.
U.S. Army Corps of Engineers Dam Safety Program	Dam Failure Hazard	This program is responsible for safety inspections of dams that meet size and storage limitations specified in the National Dam Safety Act.
U.S. Army Corps of Engineers Flood Hazard Management	Flood Hazard, Action Plan Implementation, Action Plan Funding	The Corps of Engineers offers multiple funding and technical assistance programs available for flood hazard mitigation actions
U.S. Department of Agriculture Emergency Watershed Protection Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Department of Agriculture Watershed Surveys and Planning Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Department of Homeland Security (FEMA) Rehabilitation of High Hazard Potential Dams	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Department of Homeland Security (FEMA) Building Resilient Infrastructure and Communities	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Department of Homeland Security (FEMA) Hazard Mitigation Grant Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Department of Homeland Security (FEMA) National Earthquake Hazards Reduction Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
U.S. Department of Homeland Security (FEMA) Emergency Management Performance Grants	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Department of Interior (Bureau of Reclamation) WaterSMART Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Environmental Protection Agency Drinking Water System Infrastructure Resilience and Sustainability Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
U.S. Fire Administration	Wildfire Hazard	This agency provides leadership, advocacy, coordination, and support for fire agencies and organizations.
U.S. Fish and Wildlife Service	Wildfire Hazard	This service's fire management strategy employs prescribed fire throughout the National Wildlife Refuge System to maintain ecological communities.

Table 4-2. Summary of Relevant State Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
AB 32: The California Global Warming Solutions Act	Action Plan Development	This act establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020.
AB 756: Public Water System PFAs	Public Water System polyfluoroalkyl substances (PFAs)	This act requires the State Water Resources Control Board to administer provisions relating to the regulation of drinking water to protect public health, including conducting research, studies, and demonstration programs, enforcing the federal Safe Drinking Water Act, adopting regulations, and assessing the quality of water in private domestic water supplies
AB 2242: Urban Water Management Planning Act	Drought Hazard	Requires an urban water management plan, among other things, to describe the reliability of the water supply and vulnerability to seasonal or climatic shortage, to the extent practicable, and provide data for average, single-dry, and multiple-dry water years.
AB 2800: Climate Change—Infrastructure Planning	Action Plan Development	This act requires state agencies to take into account the impacts of climate change when developing state infrastructure.
Alquist-Priolo Earthquake Fault Zoning Act	Earthquake Hazard	This act restricts construction of buildings used for human occupancy on the surface trace of active faults.
California Department of Forestry and Fire Protection (CAL FIRE)	Wildfire Hazard	CAL FIRE has responsibility for wildfires in areas that are not under the jurisdiction of the Forest Service or a local fire organization.
California Department of Parks and Recreation	Wildfire Hazard	State Parks Resources Management Division has wildfire protection resources available to suppress fires on State Park lands.
California Department of Water Resources	Flood Hazard	This state department is the state coordinating agency for floodplain management.
California Division of Safety of Dams	Dam Failure Hazard	This division monitors the dam safety program at the state level and maintains a working list of dams in the state.
California Environmental Quality Act	Action Plan Implementation	This act establishes a protocol of analysis and public disclosure of the potential environmental impacts of development projects. Any project action identified in this plan will seek full California Environmental Quality Act compliance upon implementation.
California Fire Alliance	Wildfire Hazard	The alliance works with communities at risk from wildfires to facilitate the development of community fire loss mitigation plans.
California Fire Plan	Wildfire Hazard	This plan's goal is to reduce costs and losses from wildfire through pre-fire management and through successful initial response.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
California Fire Safe Council	Wildfire Hazard	This council facilitates the distribution of National Fire Plan grants for wildfire risk reduction and education.
California Fire Service and Rescue Emergency Mutual Aid Plan	Wildfire Hazard	This plan provides guidance and procedures for agencies developing emergency operations plans
California Multi-Hazard Mitigation Plan	Hazard Mitigation Planning	Local hazard mitigation plans must be consistent with their state's hazard mitigation plan.
California Water-Use Efficiency Legislation	Hazard Mitigation Planning	Could be a program promoted by Metropolitan outreach efforts.
Disadvantaged and Low-Income Communities Investments	Action Plan Funding	This is a potential source of funding for actions located in disadvantaged or low-income communities.
Governor's Executive Order B-37-16	Drought Hazard	Water districts must conduct a "stress test," that is, examine the projected reliability of all their water supply resources over the next three years, and assume that water demand is high, and that precipitation levels are low. Results of this analysis could support the identification of projects for this hazard mitigation plan.
Governor's Executive Order S-13-08 (Climate Impacts)	Action Plan Implementation	This order includes guidance on planning for sea level rise in designated coastal and floodplain areas for new projects.
Office of the State Fire Marshal	Wildfire Hazard	This office has a wide variety of fire safety and training responsibilities.
Senate Bill 97: Guidelines for Greenhouse Gas Emissions	Action Plan Implementation	This bill establishes that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for California Environmental Quality Act analysis.
Standardized Emergency Management System	Emergency Management including Hazard Mitigation	Cal OES oversees emergency management compliance including the use of Standardized Emergency Management System and approval of submitted hazard mitigation plans. Local governments must use this system to be eligible for state funding of response-related personnel costs.
Western Governors Association Ten-Year Comprehensive Strategy	Wildfire Hazard	This strategy implementation plan prepared by federal and Western state agencies outlines measures to restore fire-adapted ecosystems and reduce hazardous fuels.

4.2 DISTRICT POWERS

4.2.1 Metropolitan Water District Act and Administrative Code

As described in Section 3.1, Metropolitan was created pursuant to a 1928 act of the California legislature, referred to as the MWD Act, that is codified in an appendix in the California Water Code. Metropolitan's authority and powers arise out of the MWD Act. The Act authorizes Metropolitan to develop, store, and distribute water for domestic and municipal purposes and other beneficial uses if excess water is available, and to provide, generate, and deliver electric power within or outside the state for the purpose of developing, storing, and distributing water. (MWD Act §§ 120-160). Metropolitan also has the power to acquire and sell property and enter into contracts necessary for its water supply purposes. The Act also grants Metropolitan implied incidental powers to do any and all things necessary or convenient to carry out its powers (MWD Act §§ 130(e), 140).

Metropolitan's Board exercises these powers and adopted The Metropolitan Water District Administrative Code (MWD Administrative Code), establishing the Board's governance procedures and protocols for Metropolitan and its staff. The MWD Administrative Code was first adopted on January 11, 1977, and has been amended over time.

Metropolitan is granted emergency powers under the MWD Act and MWD Administrative Code. These powers are generally available for anticipated and unanticipated emergency response. Metropolitan's General Manager may declare an emergency when necessary. Metropolitan's Board may make findings of "urgent necessity" to authorize Metropolitan to waive competitive bidding, adopt urgency ordinances and incur indebtedness without prior introduction or reading, facilitating prompt mitigation of anticipated and unanticipated emergency conditions (MWD Act §§ 240, 241; MWD Admin. Code §§ 2752, 8122(b)).

4.2.2 Operating Policies

In addition to the MWD Act and Administrative Code, the General Manager issues Operating Policies to direct staff activities, including emergency management and business continuity. These include the following:

- Operating Policy A-06: Emergency Management and Business Continuity
- Operating Policy A-07: Authority to Evacuate Metropolitan Facilities
- Operating Policy D-01: Environmental Health & Safety Compliance
- Operating Policy E-01: Security and Protection of Infrastructure

4.2.3 Plans

Metropolitan has several plans, reports, and programs relevant to hazard mitigation, as listed in Table 2-2 and described below. They were considered in development of this hazard mitigation plan and in some cases will serve as the primary means of implementation for the strategies in Part 3 of the plan.

Infrastructure Focused

Capital Investment Plan

The Capital Investment Plan (CIP) communicates the planned CIP work that supports Metropolitan's mission to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way. The plan presents CIP projects that are authorized to be initiated or continued during the planned biennium and outlines the 2-year budget and 10-year expenditure forecast. As part of the CIP development process, all new and existing projects are evaluated against an objective set of criteria to ensure existing and future capital investments are aligned with Metropolitan's priorities for water supply reliability, water quality, and public safety. The projects that make up the CIP have been identified from many Metropolitan studies of projected water needs as well as ongoing monitoring and inspections, condition assessments, and focused vulnerability studies. Projects that propose to improve efficiency, sustainability, and resiliency, as well as projects that provide future cost savings and increase physical and cyber security, are also identified and included. The total planned CIP expenditures for FY 2024/25 and FY 2025/26 equal approximately $636.5 million.

Additional details on the programs in the CIP are discussed in Section 3.4.

Strategic Asset Management Program

The purpose of the Strategic Asset Management Program (SAMP) is to enhance infrastructure reliability by managing risk in an economically and environmentally responsible manner. It is also developing Metropolitan's capabilities in best-in-class asset management processes. The scope of the SAMP addresses Metropolitan-owned,

-operated and -maintained infrastructure assets, appurtenances, facilities, and information systems needed to convey, store, treat, and distribute water to Metropolitan's member agencies. All Metropolitan-owned residential facilities that house staff and their families are also included under the program.

The SAMP specifies how Metropolitan's strategic priorities are to be converted into goals. The SAMP bridges gaps between Metropolitan's business plans and the specific activities related to the life-cycle management of infrastructure assets, enhances communication, and strengthens relationships between internal stakeholders. The SAMP is a flexible and adaptive document that addresses uncertainties, challenges, and changes that arise over time. Metropolitan's SAMP is updated on a 5-year review cycle; however, more frequent reviews and revisions are considered if external or internal events trigger the need for adjustments in strategy.

Water Resources Focused

Integrated Water Resources Plan

The 2020 Integrated Water Resources Plan (IRP) was organized into a Regional Needs Assessment (Phase 1) and an implementation phase (Phase 2). The Needs Assessment was adopted by the Board in 2022 and established a tool for ensuring regional water reliability through 2045 and incorporated scenario planning to address wide-ranging uncertainties. Building upon the Needs Assessment, the implementation phase will be coordinated through the Climate Adaptation Master Plan for Water (CAMP4W) process. In collaboration with the member agencies, the Board of Directors, and other interested parties, the Needs Assessment for the 2020 IRP broadened Metropolitan's perspectives compared to past IRPs by constructing and modeling four plausible future scenarios. These scenarios explored uncertainties related to future climate conditions, population growth, regulatory requirements, and the economy. They represent divergent outcomes of imported supply stability and demands on Metropolitan. The 2020 IRP Regional Needs Assessment was developed in coordination with Metropolitan's 2020 Urban Water Management Plan.

2020 Urban Water Management Plan

Metropolitan's 2020 Urban Water Management Plan was prepared in compliance with the California Water Code. This plan provides an assessment of Metropolitan's water service reliability. It describes and evaluates sources of water supply, efficient uses of water, demand management measures, implementation strategy and schedule, and other relevant information and programs. In addition to the water reliability assessments, the plan includes an evaluation of frequent and severe periods of droughts, as described in the Drought Risk Assessment, and the preparation and adoption of the Water Shortage Contingency Plan.

Metropolitan's 2020 Urban Water Management Plan was developed as part of the 2020 IRP planning process and provides a representation of Metropolitan's planning elements reported under the conditions required by the MWD Act. The planning process involved extensive coordination with Southern California's water agencies, municipal service providers, and public planning agencies.

Water Surplus and Drought Management Plan

The Water Surplus and Drought Management Plan is a 10-year plan that is used to direct Metropolitan's resource operations to help attain the region's 100 percent reliability goal. The management plan recognizes the interdependence of surplus and shortage actions and is a coordinated plan that utilizes all available resources to

maximize supply reliability. The overall objective of the Water Surplus and Drought Management Plan is to ensure that shortage allocation of Metropolitan's imported water supplies is not required.

Water Shortage Contingency Plan

The Water Shortage Contingency Plan is a guide for Metropolitan's intended actions during water shortage conditions. It is meant to improve preparedness for droughts and other impacts on water supplies by describing the process used to address varying degrees of water shortages. Certain elements of the contingency plan are required by the California Water Code, including response actions that align with six standard water shortage levels based on water supply conditions, as well as shortages resulting from catastrophic supply interruptions. The Water Shortage Contingency Plan also describes Metropolitan's procedures for conducting an Annual Water Supply and Demand Assessment (Annual Assessment) that is required by California Water Code Section 10632.1 and is to be submitted to the DWR on or before July 1 of each year, or within 14 days of receiving final allocations from the State Water Project, whichever is later.

Climate Adaptation Focused

Climate Action Plan

Adopted in 2022, Metropolitan's Climate Action Plan (CAP) is a comprehensive long-range planning document that furthers Metropolitan's commitment to sustainability by adopting a near-term greenhouse gas (GHG) reduction target of 40 percent below 1990 levels by 2030 and sets a long-term target of carbon neutrality by 2045. The CAP describes in detail the reduction activities and policies Metropolitan will implement to achieve its GHG reduction targets. The CAP also meets the requirements of a qualified greenhouse gas reduction plan under the California Environmental Quality Act, which allows Metropolitan to streamline the environmental review process and mitigate GHG impacts for future capital projects.

The CAP includes an inventory of Metropolitan's historical and current GHG emissions, as well as a comprehensive forecast of future projected emissions. The emissions data was used to identify GHG reduction measures that Metropolitan can implement to achieve its goals. The CAP serves as a planning document that will guide policy and planning decisions on operations, water resources, capital investments, and conservation and resource programs to ensure that Metropolitan will meet its GHG reduction commitment.

Energy Sustainability Plan

Moving large quantities of water requires large amounts of energy. Metropolitan meets its energy demand through its investments in hydroelectric and solar power and the purchase of more than 2,000 gigawatt-hours of electricity from the regional power grid. The opportunities to manage energy use and conserve water translate into opportunities with both environmental and economic benefits. Metropolitan has developed an Energy Sustainability Plan that supports Metropolitan's Climate Action Plan. The Energy Sustainability Plan includes a framework of sustainable actions focused on energy cost containment, reliability, affordability, conservation, and adaptation.

Climate Adaptation Master Plan for Water

In February 2023, Metropolitan's Board directed staff to integrate water resources, climate, and financial planning into a Climate Adaptation Master Plan for Water (CAMP4W) that includes the following:

- Climate and growth scenarios
- Time-bound targets
- A framework for climate decision making and reporting
- Policies, initiatives, and partnerships
- Business models and funding strategies

CAMP4W is increasing Metropolitan's understanding of the climate risks to water supplies, infrastructure, operations, workforce, and financial sustainability. It is helping to prepare Metropolitan and its member agencies for an uncertain future by developing a process for evaluating and prioritizing capital investments and programs that support a reliable and resilient supply of water resources. Founded on the themes of reliability, resilience, financial sustainability, affordability, and equity, CAMP4W fosters collaboration throughout the region by applying a "stronger together" approach.

The information developed in the 2020 Integrated Resources Plan (IRP) Needs Assessment is a key input to CAMP4W, along with the Climate Vulnerability and Risk Assessment and Drought Mitigation Portfolio. The outcome of this process is a collaborative decision-making process for setting investment plans to ensure the continued ability to fulfill Metropolitan's mission to provide the service area with an adequate and reliable supply of high-quality water.

In conjunction with development of the CAMP4W, Metropolitan prepared a Climate Vulnerability and Risk Assessment to investigate how it is currently incorporating climate change risk into its planning and operational activities. The assessment informs the CAMP4W process by identifying how Metropolitan is currently managing risk associated with climate change and provides recommendations that will enable it to better adapt.

Emergency Preparedness and Response Focused

Risk and Resilience Assessment Report

The risk and resilience assessment was conducted in accordance with America's Water Infrastructure Act of 2018 and guidance provided by the U.S. Environmental Protection Agency (EPA). This risk and resilience assessment evaluates the physical asset categories (pipeline and conveyance, treatment, source water, storage, pump plants, intake/outlets, dams) as well as programs and systems (physical and electronic security, cybersecurity, finance, operations and maintenance, capital). The threat analysis evaluates the hazards and business impacts (seismic, aging infrastructure, flooding, wildfires, power outage, drought, intentional/unintentional contamination, vandalism, theft, assault, sabotage, supply chain dependency, proximity, key employees) paired with the physical assets. The risk for each hazard is rated as low, medium, or high. The highest risk hazards are seismic, aging infrastructure, drought, flooding, wildfires and cyber. The risk assessment was conducted through interviews with subject matter experts for each of the asset categories and review of relevant documents.

Dam Emergency Action Plans

Metropolitan owns and operates 20 reservoirs and 24 associated dams that are regulated by DWR's Division of Safety of Dams (DSOD). Metropolitan is working with DSOD and Cal OES to develop emergency action plans for 23 of the dams; one dam does not require an emergency action plan. For further discussion, see Chapter 7 and Metropolitan's and DWR's websites at https://www.mwdh2o.com/how-we-plan/ and https://water.ca.gov/programs/all-programs/division-of-safety-of-dams.

Seismic Resilience Report

In February 2018, Metropolitan published Report No. 1551, Seismic Resilience First Biennial Report, which defined Metropolitan's Seismic Resilience Strategy and identified a number of near-term goals to improve Metropolitan's seismic resilience. The 2020 Seismic Resilience Report Update is a supplement to the Seismic Resilience First Biennial Report (2018 Report). The update documents revisions to Metropolitan's Seismic Resilience Strategy, documents seismic-resilience-related studies completed since publication of the 2018 Report, lists the achievements related to the seismic performance objectives and near-term goals identified in the 2018 Report, and communicates new performance objectives and goals that will further increase the seismic resilience of Metropolitan's system.

Business Continuity Plans

The role of Metropolitan's Business Continuity Program is to ensure that plans are in place to mitigate, prepare for, respond to, and recover from disruptive events that can impact normal business operations (e.g., earthquakes, power outages, wildfires, and cybersecurity attacks). The goal of the program is to ensure that strategies are in place to continue critical business operations in the event of impacts on information technology systems, facilities, staffing levels, key resources, or vendors. This goal is accomplished by creating awareness throughout the Metropolitan organization about business continuity and working with the business units to develop, maintain and exercise plans on a regular basis.

Using a continuous improvement model, plans are reviewed, updated, and exercised on a regular basis. The business continuity program strives to stay current with industry trends and identify opportunities to enhance the program.

Emergency Response Plan

The Emergency Response Plan presents Metropolitan's organization and strategy for response to emergencies caused by natural hazards, malevolent acts, or other unavoidable circumstances. Metropolitan operates in accordance with the California Standardized Emergency Management System, the Incident Command System, and the National Incident Management System. The Emergency Response Plan provides guidelines for evaluating an emergency, responding to an emergency, and activating incident command posts and the Emergency Operations Center. It also describes the Emergency Response Organization. Although this plan provides a framework for emergency response, it does not attempt to identify and discuss every potential situation or problem that may occur during an emergency. Rather, it provides a multi-hazard approach to response.

4.2.4 Financial 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 fees. An assessment of Metropolitan's fiscal capabilities is presented in Table 4-3.

Table 4-3. Fiscal Capability

Financial Resources	Accessible or Eligible to Use?
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes
User Fees for Water	Yes
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
State-Sponsored Grant Programs	Yes
Federal-Sponsored Grant Programs	Yes
Other	N/A

4.2.5 Administrative and Technical Capabilities

Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. An assessment of Metropolitan's administrative and technical capabilities is presented in Table 4-4.

Table 4-4. Administrative and Technical Capability

Staff/Personnel Resources	Available?	Department/Agency/Position
Planners or engineers with knowledge of water supply infrastructure	Yes	Engineering Services Division, Water System Operations Division
Planners or engineers with an understanding of natural hazards	Yes	Engineering Services Division, Water Resources Management Division
Staff with training in benefit/cost analysis	Yes	Can Contract for this Service
Personnel skilled or trained in GIS applications	Yes	Geodetics
Scientist familiar with natural hazards in local area	Yes	Through collaboration with USGS, NOAA, DWR, academia, others
Emergency Manager	Yes	Emergency Management Program Manager
Business Continuity Manager	Yes	Business Continuity Program Manager
Grant writers	Yes	Centralized Grants Office

4.2.6 Fabrication and Construction Capabilities

Metropolitan maintains stockpiles and materials on hand at various facilities throughout its service area and has its own construction equipment and crews ready to mobilize if necessary. Metropolitan forces—including personnel, material, and equipment—are maintained at a level adequate to repair two major simultaneous pipeline failures. The ability to rapidly and progressively mobilize additional resources as needed also is maintained and documented. Pre-selected urgent repair contractors can provide additional construction support in case of an emergency.

The machine, fabrication, coating, and valve shops located at the La Verne facility are used extensively for the following:

- To support system-wide maintenance
- To provide emergency services within Metropolitan, for member agencies, and for DWR
- To perform fee-for-service work that supports member agencies and the State Water Project

In 2015, Metropolitan expanded the La Verne Shops to enable the fabrication of two pipe sections up to 12 feet in diameter simultaneously. The fabrication shop can roll pipe on a 24-hour-per-day basis. Metropolitan has been developing standardized pipeline repair drawings and shoring drawings to expedite repair operations.

Maintaining these manufacturing and construction capabilities supports Metropolitan's efforts to efficiently operate and maintain its infrastructure and to quickly repair components or systems that may be damaged.

4.2.7 Public Outreach Capabilities

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community. An assessment of Metropolitan's education and outreach capabilities is presented in Table 4-5.

Table 4-5. Education and Outreach Capability

Criterion	Available/In Use?
Public information officer or communications office Personnel skilled or trained in website development	Yes Yes
Hazard mitigation information posted on website • If yes, briefly describe.	Yes mwdh2o.com has comprehensive information on water system and supply, as well as plans, including the Hazard Mitigation Plan and Dam Emergency Action Plans
Use of social media for hazard mitigation education and outreach • If yes, briefly describe.	Yes Metropolitan is active on all major social media platforms
Citizen boards or commissions that address issues related to hazard mitigation • If yes, briefly describe.	Yes Metropolitan's 38 directors are appointed by their member agencies to Metropolitan's Board. Member agencies have committees open to the public to discuss Metropolitan issues, including actions to mitigate hazards
Other programs in place that could be used to communicate hazard-related information? • If yes, briefly describe.	Yes Metropolitan has comprehensive public outreach and engagement programs that reach local governments; elected federal, state, and local officials; community leaders; and community-based, environmental, and business organizations
Established warning systems for hazard events? • If yes, briefly describe.	Yes • Metropolitan staff: The MetAlert system sends real-time emergency notifications to Metropolitan staff via phone, text, email, etc. Alerts are sent to Metropolitan staff and member agency emergency points of contact only, not the general public. • Member agencies: Coordination per Emergency Response Plan • Public: coordination with six counties in the service area

4.2.8 Opportunities to Improve Capabilities

There are several opportunities for Metropolitan to improve upon its hazard mitigation capabilities. Within the area of funding, Metropolitan can expand its grant writing capabilities to request grant funding. Completion of the Local Hazard Mitigation Plan will also open new opportunities to apply for federal grants currently not accessible to Metropolitan. Other potential opportunities include improvements to the current fabrication capabilities and expansion of the stockpile program. Within the technical areas, Metropolitan staff continues to assess new technologies for integration into Metropolitan's system to improve resilience to seismic and other natural hazards.

4.3 OPPORTUNITIES FOR INTEGRATION

As this capability assessment has identified, Metropolitan has a high degree of capability with its existing plans, programs, and capacities for funding, administrative and technical functions, and public outreach. Each of these capabilities represents an opportunity for integrating hazard mitigation planning with other Metropolitan plans, member agency plans, and plans for other jurisdictions within, and adjacent to, Metropolitan's service area. Metropolitan is fully committed to plan integration where feasible and valuable. Chapter 19 provides detailed mechanisms for ongoing plan integration.

Part 2. Risk Assessment

5. HAZARDS OF CONCERN

5.1 HISTORY OF HAZARD EVENTS IN THE PLANNING AREA

Presidential disaster declarations are typically issued for hazard events that cause more damage than state and local governments can handle without federal assistance. A presidential disaster declaration puts federal recovery programs into motion to help disaster victims, businesses, and public entities. Table 5-1 lists declared major disaster (DR) hazard events whose effective area included the hazard mitigation planning area. Such a declaration does not necessarily indicate that any Metropolitan community lifeline assets were damaged by the event.

Table 5-1. Presidential Disaster Declarations with Affected Area Including the Planning Area

Declaration Title	Date	Disaster Declaration	Counties Impacted
Wildfires and Straight-Line Winds	1/08/2025	DR-4856	**Los Angeles**
Severe Winter Storms, Tornadoes, Flooding, Landslides, and Mudslides	4/13/2024	DR-4769	Butte, Glenn, **Los Angeles**, Monterey, San Luis Obispo, Santa Barbara, Santa Cruz, Sutter, **Ventura**
Severe Storm and Flooding	2/19/2024	DR-4758	**San Diego**
Tropical Storm Hilary	11/21/2023	DR-4750	Imperial, Inyo, Kern, **Riverside**, Siskiyou
Severe Winter Storms, Winds, Flooding, Landslides, and Mudslides	04/03/2023	DR-4699	Alameda, Alpine, Amador, Butte, Calaveras, Del Norte, Eldorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, **Los Angeles**, Madera, Marin, Mariposa, Mendoaiacino, Merced, Modoc, Mono, Monterey, Napa, Nevada, Plumas, Sacramento, San Benito, **San Bernardino**, **San Diego**, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Solano, Sonoma, Stanislaus, Trinity, Tulare, Tuolumne, **Ventura**
Severe Winter Storms, Flooding, Landslides, and Mudslides	2022-23	DR-4683	Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, Eldorado, Fresno, Glenn, Humboldt, Inyo, **Los Angeles**, Madera, Marin, Mariposa, Mendocino, Merced, Monterey, Napa, Nevada, Placer, Sacramento, San Benito, **San Diego**, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, **Ventura**, Yolo
Wildfires	10/16/2020	DR-4569	Fresno, **Los Angeles**, Madera, Mendocino, Napa, **San Bernardino**, **San Diego**, Shasta, Siskiyou, Sonoma
COVID-19 Pandemic	03/22/2020	DR-4482	All California Counties
Severe Winter Storms, Flooding, Landslides, and Mudslides	05/01/2019	DR-4431	Calaveras, Colusa, Marin, Mariposa, Mendocino, Modoc, Napa, **Riverside**, Santa Barbara, Shasta, Trinity
Wildfires	11/12/2018	DR-4407	Butte, **Los Angeles**, **Ventura**
Wildfires, Mudflows, and Debris Flows	01/02/2018	DR-4353	**Los Angeles**, **San Diego**, Santa Barbara, **Ventura**

Declaration Title	Date	Disaster Declaration	Counties Impacted
Wildfires	10/10/2017	DR-4344	Butte, Lake, Mendocino, Napa, Nevada, **Orange**, Sonoma, Yuba
Severe Winter Storms, Flooding, and Mudslides	03/16/2017	DR-4305	Alameda, Calaveras, Contra Costa, El Dorado, Inyo, Kern, **Los Angeles**, Mendocino, Modoc, Mono, Napa, **Orange**, Sacramento, **San Diego**, San Francisco, San Luis Obispo, San Mateo, Santa Barbara, Trinity, Tuolumne, Yolo
Winter Storms, Flooding, and Debris and Mud Flows	03/03/2011	DR-1952	Inyo, Kern, Kings, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, San Luis Obispo, Santa Barbara, Tulare
Severe Winter Storms, Flooding, and Debris and Mud Flows	03/08/2010	DR-1884	Calaveras, Imperial, **Los Angeles**, **Riverside**, **San Bernardino**, Siskiyou
Wildfires	11/18/2008	DR-1810	**Los Angeles**, **Orange**, **Riverside**, Santa Barbara
Wildfires	10/24/2007	DR-1731	**Los Angeles**, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, Santa Barbara, **Ventura**
Severe Freeze	03/13/2007	DR-1689	Fresno, Imperial, Kern, Kings, **Los Angeles**, Madera, Merced, Monterey, **Riverside**, **San Bernardino**, **San Diego**, San Luis Obispo, Santa Barbara, Tulare, **Ventura**
Severe Storms, Flooding, Landslides, and Mud and Debris Flows	04/14/2005	DR-1585	Kern, **Los Angeles**, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, **Ventura**
Severe Storms, Flooding, Debris Flows, and Mudslides	02/04/2005	DR-1577	Kern, **Los Angeles**, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, Santa Barbara, **Ventura**
Wildfires	10/27/2003	DR-1498	**Los Angeles**, **Riverside**, **San Bernardino**, **San Diego**, **Ventura**
Severe Storms, Tornadoes, High Winds and Flooding	02/09/1999	DR-1267	Fresno, Kern, Kings, Madera, Merced, Monterey, Tulare, **Ventura**
Severe Winter Storms and Flooding	02/09/1998	DR-1203	Alameda, Amador, Butte, Calaveras, Colusa, Contra Costa, Del Norte, Fresno, Glenn, Humboldt, Kern, Lake, **Los Angeles**, Marin, Mendocino, Merced, Monterey, Napa, **Orange**, **Riverside**, Sacramento, San Benito, **San Bernardino**, **San Diego**, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, **Ventura**, Yolo, Yuba
Severe Winter Storms, Flooding, Landslides, Mud Flows	03/12/1995	DR-1046	Alameda, Alpine, Amador, Butte, Calaveras, Colusa, Contra Costa, El Dorado, Fresno, Glenn, Humboldt, Imperial, Inyo, Kern, Kings, Lake, Lassen, **Los Angeles**, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono, Monterey, Napa, Nevada, **Orange**, Placer, Plumas, **Riverside**, Sacramento, San Benito, **San Bernardino**, **San Diego**, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, Tulare, Tuolumne, **Ventura**, Yolo, Yuba
Severe Winter Storms, Flooding, Landslides, Mud Flows	01/10/1995	DR-1044	Alameda, Amador, Butte, Colusa, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Kern, Kings, Lake, Lassen, **Los Angeles**, Madera, Marin, Mendocino, Modoc, Monterey, Napa, Nevada, **Orange**, Placer, Plumas, **Riverside**, Sacramento, **San Bernardino**, **San Diego**, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Sonoma, Sutter, Tehama, Trinity, **Ventura**, Yolo, Yuba
Northridge Earthquake	01/17/1994	DR-1008	**Los Angeles**, **Orange**, **Ventura**

Declaration Title	Date	Disaster Declaration	Counties Impacted
Fires, Mud & Landslides, Soil Erosion, Flooding	10/28/1993	DR-1005	**Los Angeles**, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, **Ventura**
Severe Winter Storm, Mud & Landslides, Flooding	02/03/1993	DR-979	Alpine, Contra Costa, Del Norte, Fresno, Humboldt, Imperial, Lassen, **Los Angeles**, Madera, Mendocino, Modoc, Monterey, Napa, **Orange**, Plumas, **Riverside**, **San Bernardino**, **San Diego**, Santa Barbara, Shasta, Sierra, Siskiyou, Sonoma, Tehama, Trinity, Tulare, **Ventura**
Earthquake, Aftershocks	07/02/1992	DR-947	**Riverside**, **San Bernardino**
Fire During a Period of Civil Unrest	05/02/1992	DR-942	**Los Angeles**
Snowstorm, Heavy Rain, High Winds, Flooding, Mudslide	02/25/1992	DR-935	Kern, **Los Angeles**, **Orange**, **San Bernardino**, **Ventura**
Severe Freeze	02/11/1991	DR-894	Alameda, Butte, Colusa, Fresno, Glenn, Imperial, Kern, **Los Angeles**, Madera, Marin, Mendocino, Merced, Monterey, Napa, **Riverside**, San Benito, **San Bernardino**, **San Diego**, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Solano, Sonoma, Stanislaus, Sutter, Tehama, Tulare, **Ventura**, Yolo, Yuba
Fires	06/30/1990	DR-872	**Los Angeles**, **Riverside**, **San Bernardino**, Santa Barbara
Severe Storms, High Tides, Flooding	02/05/1988	DR-812	**Los Angeles**, **Orange**, **San Diego**, Santa Barbara, **Ventura**
Earthquake & Aftershocks	10/07/1987	DR-799	**Los Angeles**, **Orange**
Flash Flooding	09/22/1983	DR-690	**Riverside**, **San Bernardino**
Flooding	07/01/1983	DR-687	Imperial, **Riverside**, **San Bernardino**
Coastal Storms, Floods, Slides, Tornadoes	02/09/1983	DR-677	Alameda, Butte, Colusa, Contra Costa, Del Norte, Glenn, Humboldt, Kern, Kings, Lake, **Los Angeles**, Marin, Mariposa, Mendocino, Merced, Monterey, Napa, **Orange**, Placer, **Riverside**, Sacramento, San Benito, **San Bernardino**, **San Diego**, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Shasta, Solano, Sonoma, Stanislaus, Sutter, Tehama, Trinity, **Ventura**, Yolo, Yuba
Urban Fire	04/24/1982	DR-657	**Orange**
Brush, Timber Fires	11/27/1980	DR-635	**Los Angeles**, **Orange**, **Riverside**, **San Bernardino**
Severe Storms, Mudslides, Flooding	01/08/1980	DR-615	**Los Angeles**, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, Santa Barbara, Santa Cruz, **Ventura**
Heavy Rains, Flooding, Mud Flows	07/27/1979	DR-594	**Riverside**
Landslides	10/09/1978	DR-566	**Orange**
Coastal Storms, Mudslides, Flooding	02/15/1978	DR-547	Inyo, Kern, Kings, **Los Angeles**, Mono, Monterey, **Orange**, **Riverside**, **San Bernardino**, **San Diego**, San Luis Obispo, Santa Barbara, Tulare, **Ventura**
Flooding, Tropical Storm Kathleen	09/21/1976	DR-521	Imperial, **Riverside**, **San Bernardino**
Severe Storms, High Tides, Flooding	02/08/1973	DR-364	Marin, **San Diego**, San Luis Obispo, Santa Barbara, Solano, **Ventura**
San Fernando Earthquake	02/09/1971	DR-299	**Los Angeles**
Forest, Brush Fires	09/29/1970	DR-295	Alameda, Kern, **Los Angeles**, **San Bernardino**, **San Diego**, **Ventura**
Severe Storms, Flooding	01/26/1969	DR-253	Amador, Contra Costa, El Dorado, Fresno, Humboldt, Inyo, Kern, Kings, **Los Angeles**, Madera, Marin, Mariposa, Mendocino, Merced, Modoc, Mono,

Declaration Title	Date	Disaster Declaration	Counties Impacted
			Monterey, **Orange**, Placer, Plumas, **Riverside**, Sacramento, San Benito, **San Bernardino**, San Joaquin, San Luis Obispo, Santa Barbara, Shasta, Sierra, Solano, Sonoma, Stanislaus, Tehama, Tulare, Tuolumne, **Ventura**, Yuba
Severe Storms, Flooding	01/01/1967	DR-223	Inyo, Kern, Monterey, **Riverside**, **San Bernardino**, **San Diego**, San Luis Obispo, Tulare
Heavy Rains, Flooding	12/07/1965	DR-211	**Riverside**, **San Bernardino**, **San Diego**, **Ventura**
Fire	11/16/1961	DR-119	**Los Angeles**

Note: Metropolitan planning area counties are indicated in **bold**.
Source: (FEMA 2025)

5.2 HAZARDS IDENTIFIED FOR RISK ASSESSMENT

In its most recent state hazard mitigation plan, the State of California identified 34 hazards with the potential to impact communities across the state (Cal OES 2023). The Planning Committee considered this full range of hazards and identified those that present the greatest concern in the Metropolitan planning area. Only hazards that are considered to be natural hazards were considered (other hazards, such as cyber threats and hazardous materials releases, are considered to be human-caused rather than natural). The process incorporated review of state and local hazard planning documents, as well as local, state, and federal information on the frequency, magnitude and costs associated with hazards that have impacted or could impact the planning area. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on that review plan, the Planning Committee selected the following natural hazards to be included in this plan:

- Dam failure
- Drought
- Earthquake
- Extreme heat
- Flood
- Landslide
- Wildfire
- Wind

Table 5-2 reflects how these hazards for Metropolitan's planning area compare to those listed in the state hazard mitigation plan.

Table 5-2. Review of State-Identified Hazards for Risk to Metropolitan Planning Area

2023 California State Hazard Mitigation Plan Hazard	Where Addressed in 2025 Metropolitan Local Hazard Mitigation Plan	Reason, If Not Addressed
Air Pollution	Not included	Not a natural hazard
Civil Disorder	Not included	Not a natural hazard
Cyber Threats	Not included	Not a natural hazard
Dam Failure	Chapter 7, Dam Failure	—
Drought	Chapter 8, Drought	—
Earthquake	Chapter 9, Earthquake	—
Electromagnetic Pulse Attack	Not included	Not a natural hazard
Energy Shortage	Not included	Not a natural hazard
Epidemic/Pandemic/Vector-Borne Disease	Not included	Does not present a risk to the assets addressed in this plan
Extreme Cold or Freeze	Not included	Does not present a risk to the assets addressed in this plan
Extreme Heat	Chapter 10, Extreme Heat	—
Geomagnetic Storm (Space Weather)	Not included	Does not present a risk to the assets addressed in this plan
Hazardous Materials Release	Not included	Not a natural hazard
Invasive and Nuisance Species	Not included	Does not present a risk to the assets addressed in this plan
Landslide, Debris Flow, and other Mass Movements	Chapter 12, Landslide	—
Levee Failure	Not included	Does not present a risk to the assets addressed in this plan
Natural Gas Pipeline Hazards	Not included	Not a natural hazard
Oil Spills	Not included	Not a natural hazard
Other Potential Causes of Long-Term Electrical Outage	Not included	Not a natural hazard
Public Safety Power Shutoff	Not included	Not a natural hazard
Radiological Accidents	Not included	Not a natural hazard
Riverine, Stream and Alluvial Flood	Chapter 11, Flood	—
Sea-Level Rise, Coastal Flooding and Erosion	Sea-Level Rise discussed in climate change discussion in Chapter 3	—
Severe Wind, Weather, and Storms	Chapter 14, Wind (storms not addressed as a separate hazard)	—
Snow Avalanche	Not included	Does not present a risk to the assets addressed in this plan
Subsidence	Not included	Does not present a risk to the assets addressed in this plan
Terrorism	Not included	Not a natural hazard
Transportation Accidents Resulting in Explosions or Toxic Releases	Not included	Not a natural hazard
Tree Mortality	Not included	Does not present a risk to the assets addressed in this plan
Tsunami and Seiche	Not included	Does not present a risk to the assets addressed in this plan
Urban Structural Fire	Not included	Not a natural hazard
Volcano	Not included	Does not present a risk to the assets addressed in this plan
Well Stimulation and Hydraulic Fracturing	Not included	Not a natural hazard
Wildfire	Chapter 13, Wildfire	—

6. RISK ASSESSMENT METHODOLOGY

The risk assessments in this hazard mitigation plan describe the risks associated with each identified hazard of concern. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - A summary of past events that have impacted the planning area
  - Geographic areas most affected by the hazard
  - Event frequency estimates
  - Severity estimates
  - Warning time likely to be available for response.
- **Determine exposure to each hazard**—Exposure was determined by overlaying hazard maps with an inventory of Metropolitan's structures, facilities, and systems to determine which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of Metropolitan's exposed structures and infrastructure was determined by interpreting the probability of occurrence of each event and assessing structures, facilities, and systems that are exposed to each hazard. Tools such as geographic information system (GIS) mapping and FEMA's hazard-modeling program called Hazus were used to perform this assessment for the flood and earthquake hazards. Outputs similar to those from Hazus were generated for other hazards, using maps generated by the Hazus program.

6.1 RISK ASSESSMENT TOOLS

6.1.1 Mapping

National, state, county, and district databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using GIS software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document.

6.1.2 Hazus

Overview

FEMA's standardized GIS-based Hazus software program estimates losses caused by earthquakes, hurricanes and floods and identifies areas that face the highest vulnerability and potential for loss. Hazus is used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, community lifelines, and transportation and utility infrastructure, and multiple models to estimate potential losses from natural disasters. The program maps and calculates hazard data and damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

For earthquake, once the location and size of a hypothetical earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and community lifelines. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

6.1.3 Risk Quantification Engineering

The Risk Quantification and Engineering (RQE) natural hazard computer model is a proprietary software owned by CoreLogic, Inc. The earthquake simulation model within the software program calculates ground shaking for an earthquake event by simulating magnitude, location, and attenuation from the source through the local soils to a specified location. The hazard model's database of earthquake events used for the simulation was developed using data from the USGS 2014 National Seismic Hazard Mapping Project hazard model (USGS 2019) and the 2014 Working Group on California Earthquake Probabilities. The California portion of the USGS mapping project is based on the 2015 Uniform California Earthquake Rupture Forecast (Version 3) seismic source models (SCEC 2017).

6.2 RISK ASSESSMENT APPROACH

6.2.1 Hazard Profile Development

Hazard profiles were developed for Metropolitan through web-based research and review of previously developed reports and plans, including state and local hazard mitigation plans. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others.

6.2.2 Exposure and Vulnerability

Dam Failure

An exposure analysis was performed for Metropolitan Water District facilities that are within the very high risk and high risk dam failure inundation hazard areas. No quantitative analysis of vulnerability was performed.

Flood

An exposure analysis was performed for Metropolitan Water District facilities in flood zones. Current flood mapping for the planning area was used to delineate flood hazard areas and estimate potential losses from the 1 percent-annual-chance, 0.2 percent-annual-chance flood events, and the Department of Water Resources (DWR) Awareness Floodplain zones. Awareness floodplains identify the 100-year flood hazard areas using approximate assessment procedures. These are flood-prone areas without specific depths and other flood hazard data. No quantitative analysis of vulnerability was performed.

Earthquake

Exposure analyses were performed for Metropolitan facilities that are within the liquefaction susceptibility hazard area, the earthquake significant shaking potential hazard area, and the National Earthquake Hazard Reduction Program (NEHRP) soils (Class D & E) hazard area.

The RQE model was used as part of a separate recent Metropolitan study (Underground Conveyance and Distribution System Scenario Earthquake Modeling and Repair Analysis) to estimate the potential number of repairs to Metropolitan's conveyance and distribution pipelines from earthquakes. The study assessed 12 earthquake scenarios with the potential to impact different parts of Metropolitan's service area. The 12 scenarios were considered to ensure that all areas of Metropolitan's system were adequately assessed against potential impacts from earthquake hazards. Details of the seismic scenarios are included in the report of the study (ABS Consulting 2020).

A Level 2 Hazus analysis was performed to assess the vulnerability of above-ground Metropolitan structures to earthquake, including water treatment plants, pumping plants, hydroelectric plants, and other assets. Twelve USGS scenario events—chosen to be of similar or same magnitude to those used in the RQE model—were modeled to simulate earthquake events, as listed in Table 6-1. Maps showing the intensity of these events are provided in Appendix C.

Table 6-1. Earthquake Scenarios Used in Hazus Analysis for This Plan and in Previous RQE Study

Fault Zone (Name per RQE Study)	Magnitude		Approx. Return Period (Years)
	RQE	Hazus	
Compton	M7.39	M7.5	4000
Cucamonga & San Jose	M6.73	M6.9	1700
Elsinore (Glen Ivy & Julian)	M7.27	M7.6	1600
Mission Hills/Sierra Madre	M6.82	M6.5	1800
Newport-Inglewood	M7.11	M7.2	2300
Northridge Hills/Santa Susana East	M6.99	M7.0	4100
Peralta Hills	M6.42	M6.5	6400
Puente Hills	M6.55	M6.6	1800
San Andreas (Mojave S & Coachella)	M7.8	M7.8	200
San Gabriel	M6.89	M7.2	3300
San Jacinto (San Bernardino &Clark)	M7.66	M7.7	600
Whittier/Elsinore	M7.11	M7.0	1800

Landslide

An exposure analysis was performed for Metropolitan Water District facilities that are within the deep-seated landslide hazard area. No quantitative analysis of vulnerability was performed.

Wildfire

An exposure analysis was performed for Metropolitan Water District facilities that are within the high and very high wildfire severity hazard zones. No quantitative analysis of vulnerability was performed.

Drought, Extreme Heat, and Wind

Quantitative historical datasets were not adequate to analyze exposure or model future losses related to the weather-related hazards of drought, extreme heat, and wind. A qualitative analysis was conducted for these hazards using the best available data and professional judgment.

6.3 SOURCES OF DATA USED IN MODELING AND EXPOSURE ANALYSES

6.3.1 Structure Data

Replacement cost values and detailed structure information from the Metropolitan Water District were loaded into Hazus. The analysis using Hazus was conducted to determine exposure and vulnerability for water treatment plants, hydroelectric plants, pressure-control structures, pump stations, and other above-ground structures of significance. For treatment plants, hydroelectric plants, and pump plants, the amount of damage is dependent on the capacity of the facility in addition to the level of shaking from the earthquake hazard. Hazus differentiates these facilities as either small, medium or large, with the assumption that system redundancies at the facilities increase for medium and large categories. All of Metropolitan's water treatment plants, hydroelectric plants, and pump stations fall into the large category. Hazus models the water treatment plants as a single point facility even though a treatment plant consists of multiple buildings. The model does not reflect seismic upgrades that Metropolitan has already completed as part of its facility seismic upgrade program

Information needed for risk assessment was not available for all of Metropolitan's key assets (as listed in Section 3.3). The exposure and vulnerability analyses were performed for subsets of the total assets, as listed in Table 6-2

and Table 6-3. Although this approach does not indicate total risk for Metropolitan's assets, it is suitable for comparing the relative risk of the hazards evaluated for this plan.

Table 6-2. Metropolitan Non-linear Assets Included in Analysis of Exposure and Vulnerability

	Structures Included in Exposure Analysis	
	Number of Structures	Replacement Cost Value
Colorado River Aqueduct Facilities		
Airstrip[a]	4	$744,912
Pumping Plant	5	$1,385,939,975
Pumping Plant Support Buildings	5	$59,478,171
Residences	5	$50,881,309
Conveyance, Treatment and Distribution Facilities		
Water Treatment Plants	5	$5,287,875,895
Hydroelectric Plants	15	$328,416,196
Power Plants	4	n/a
Meter Structure[a]	479	n/a
Pressure Reducing Structure[b]	58	$308,646,600
Service Connection[a]	543	$221,112,315
Dams[a]	20	n/a
Building Facilities		
Headquarters	1	$230,337,633
La Verne	1	$201,747,367
Eagle Rock	1	$15,733,961
Soto Street	1	$5,835,176
Reservoirs[a]		
Finished Water Reservoir	3	$226,642,832
Raw Water Reservoir	6	$3,715,961,964

a. Facilities not included in vulnerability assessment because data required for Hazus modeling is not available
b. Only 33 of the identified pressure reducing structures are included in the Hazus modeling for vulnerability

Table 6-3. Metropolitan Linear Assets Included in Analysis of Exposure and Vulnerability

	Length (miles)	Replacement Cost Value
Colorado River Aqueduct	242	$5,317,333,152
Conveyance and Distribution Lines	830	$9,122,286,538

6.3.2 Hazard Area Data Inputs for Hazus

Earthquake ShakeMaps and probabilistic data prepared by the USGS were used for the analysis of the earthquake hazard. A NEHRP soils map from the California Department of Conservation, planning area liquefaction zones data, and susceptibility to deep-seated landslides data from the California Geological Survey were also integrated into the Hazus model. Earthquake shaking potential data was acquired from California Geological Survey.

6.3.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources:

- **Landslide**—Susceptibility to deep-seated landslides data were provided by the California Geological Survey. Areas categorized as very high and high susceptibility (Categories X, XI, VIII, and VII) were used in the exposure analysis.

- **Wildfire**—Fire severity zone data were acquired from California Department of Forestry and Fire Protection (CAL FIRE). The high and very high fire hazard severity zone categories were used in the exposure analysis.
- **Flood**—The 1- and 0.2-percent annual chance flood data was acquired from the Effective FEMA digital Flood Insurance Rate Maps for Los Angeles, Orange, Riverside, San Bernadino, and San Diego counties. The Awareness Floodplain zone data was acquired from the Department of Water Resources (DWR).
- **Dam Failure**—Dam failure inundation area data was collected from California Department of Water Resources.
- **Drought, Extreme Heat, and Wind**—No area datasets in GIS format were identified for these weather-related hazards.

6.3.4 Data Source Summary

Table 6-4 summarizes the data sources used for the risk assessment for this plan.

Table 6-4. Hazus Model Data Documentation

Data	Source	Date	Format
Facilities & Infrastructure	Metropolitan Water District; Tetra Tech	2020	Digital (tabular) format
FEMA Flood	FEMA effective digital Flood Insurance Rate Maps Los Angeles: 06/02/2021 Orange: 03/21/2019 Riverside: 03/22/2022 San Bernardino: 03/22/2022 San Diego: 03/22/2022	2019; 2021; 2022	Digital (GIS) format
Awareness Floodplain	California Department of Water Resources	2023	Digital (GIS) format
Earthquake ShakeMaps	USGS Earthquake Hazards Program website	2017	Digital (GIS) format
Susceptibility to Deep-Seated Landslides	CA Geological Survey	2018	Digital (GIS) format
Liquefaction zones	CA Department of Conservation	2021	Digital (GIS) format
National Earthquake Hazard Reduction Program Soils	California Department of Conservation	2021	Digital (GIS) format
Dam failure inundation	California Department of Water Resources	2022	Digital (GIS) format
Earthquake Shaking Potential	CA Geological Survey	2019	Digital (GIS) format
Fire Hazard Severity Zones	CAL FIRE	2023	Digital (GIS) format

6.4 LIMITATIONS

Loss estimates, exposure assessments and hazard-specific vulnerability 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 a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice Metropolitan has to prepare for a specific hazard event.

Specific to Metropolitan, the Hazus model looks at water treatment plants as a single point when estimating potential damage and losses. Metropolitan's water treatment plants are comprised of multiple facilities. These facilities have been constructed over several years to different code iterations. Additionally, Metropolitan has completed numerous seismic upgrade projects at its treatment plants and other facilities, which are not considered in the model.

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk. Over the long term, Metropolitan will collect additional data to assist in estimating potential losses associated with other hazards.

7. DAM FAILURE

7.1 GENERAL BACKGROUND

A dam is an artificial barrier that can store water, or liquid-borne materials for many reasons—flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control. Many dams fulfill a combination of these functions. They are an important part of the infrastructure in the United States.

Dams can be classified according to their purpose, construction material, slope, cross-section, or means of controlling seepage. Materials used to construct dams include earth, rock, tailings from mining or milling, concrete, masonry, asphalt, steel, timber, plastic, rubber, and combinations of these.

7.1.1 Causes of Dam Failures

Partial or complete failure of dams has the potential to cause the loss of human life, massive destruction to property and the ecosystems located downstream. Partial or complete failure can occur as a result of one or a combination of the following reasons:

- Overtopping caused by floods that exceed the dam capacity (inadequate spillway capacity)
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate or negligent operation, maintenance, and upkeep
- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides)

Many dam failures in the United States have been secondary results of other disasters. The most common causes are failure due to seepage and piping, overtopping (hydrologic failure), deformation, liquefaction, concrete failure, and neglected maintenance or deterioration. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

7.1.2 Residual Risk

All dams face a "residual risk" of failure, which represents the risk that conditions may exceed those for which the dam is capable of withstanding. For example, dams may be designed to withstand a probable maximum precipitation, defined as the greatest depth of precipitation for a given duration that is theoretically possible over a given storm area at a particular geographical location at a given time of the year. The chance of occurrence of a precipitation event of a greater magnitude than that represents residual risk for such dams.

7.1.3 Dam Regulation

Regulatory oversight of dams is assigned to various agencies (see Appendix B):

- FEMA monitors dams under the National Dam Safety Act.
- The Federal Energy Regulatory Commission (FERC) promotes safety of power-producing dams through its Dam Safety Program.
- The U.S. Army Corps of Engineers operates and maintains hundreds of dams nationwide and is responsible for safety inspections of dams that meet size and storage limitations specified in the National Dam Safety Act.
- California's Division of Safety of Dams (DSOD), Department of Water Resources monitors the Dam Safety Program at the state level and maintains a working list of dams in the state.

The following sections summarize key regulatory issues relevant to hazard mitigation planning for dam failure.

Hazard Ratings

Federal

FEMA uses the following classification system for the hazard potential of dam failures (FEMA 2004):

- **Low Hazard Potential**—Dams where failure or mis-operation results in no probable loss of human life and low economic and/or environmental losses. Losses are principally limited to the owner's property.
- **Significant Hazard Potential**—Dams where failure or mis-operation results in no probable loss of human life but can cause economic loss, environmental damage, or disruption of lifeline facilities or can impact other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be located in areas with population and significant infrastructure.
- **High Hazard Potential**—Dams where failure or mis-operation will probably cause loss of human life.

State

California's DSOD developed a hazard potential classification system for state-jurisdiction dams, as shown on Table 7-1. The state system is modified from the three-tier federal guidelines, adding a fourth hazard classification of "extremely high." Dams classified as extremely high hazard may impact highly populated areas or critical infrastructure or have short evacuation warning times. The federal and state rating systems are both based on the potential consequences of a dam failure; they do not address the probability of such failures.

Table 7-1. State of California Downstream Hazard Potential Classification

Hazard Category	Direct Loss of Life	Economic, Environmental, and Lifeline Losses
Low	None expected	Low and principally limited to dam owner's property
Significant	None expected	Yes
High	Probable (one or more expected)	Yes, but not necessary for this classification
Extremely High	Considerable	Yes, major impacts to critical infrastructure or property

Source: (FEMA 2004)

Planning Requirements

Federal

Dams that fall under the jurisdiction of FERC also have specified planning requirements. FERC has the largest dam safety program in the United States. It cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. FERC requires licensees to prepare emergency action plans (EAPs) and conducts training sessions on how to develop and test these plans. The plans are designed to serve as an early warning system if there is a potential for, or a sudden release of water from, a dam failure or accident to the dam. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows and procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that in emergency situations everyone knows what to do, thus saving lives and minimizing property damage. None of Metropolitan's dams fall under the jurisdiction of FERC.

State

All extreme high hazard, high hazard, and significant hazard dams whose inundation areas may impact the planning area have EAPs. The EAPs must include the following (Cal OES 2024):

- 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 safety agencies and first responders 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.

7.1.4 Secondary Hazards

Dam failure can cause severe downstream flooding. Overland flows from dam breech are likely to transport large amounts of debris, which can impact Metropolitan assets. Other potential secondary hazards of dam failure are landslides around a reservoir perimeter, bank erosion on streams, and destruction of downstream habitat. Dam failure may worsen the severity of a drought by releasing water that might have been used as a raw water source.

7.2 HAZARD PROFILE

7.2.1 Past Events

According to the 2023 California State Hazard Mitigation Plan, there have been multiple recorded dam failures in the state. Since 1953, FEMA issued three federal Major Disaster Declarations (DR) and Emergency Declarations (EM) related to dam failure events. Between 1950 and 2022, the state declared nine California Emergency Proclamations related to dam/levee failures. There have been no agricultural disaster declarations by the U.S. Department of Agriculture.

Between 2018 and 2022, California recorded six dam failure events. Of these occurrences, two were caused by overtopping, one due to poor conditions or equipment failures, one by seepage, and another by sediment build-up.

7.2.2 Location

According to the California DSOD, there are 274 dams in Metropolitan's six service counties. Of these, 236 dams are rated as high or extremely high hazard. Table 7-2 through Table 7-7 list key information about the dams in each service county that have the potential to impact Metropolitan Water District should they fail. Figure 7-1 shows dam locations and aggregate dam-failure inundation areas. Metropolitan owns 15 of the 236 reservoirs listed, and 19 associated dams (Diamond Valley Lake and Lake Mathews have three dams each); they are highlighted in orange.

7.2.3 Frequency

A major dam failure is a rare event for which there is no defined recurrence interval. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs experience significant changes over time due to the impacts of climate change (i.e., increased precipitation), dam design and operations may no longer be valid for the changed condition. This could have significant impacts on dams that provide flood control. Specified release rates and impound thresholds may have to be changed. This would result in increased discharges downstream of these facilities, increasing the probability and severity of flooding.

7.2.4 Severity

Table 7-2 through Table 7-7 list the hazard potential of dams that could impact Metropolitan, using the State of California rating system described in Section 7.1.3. These ratings indicate the potential severity of dam failure impacts in Metropolitan.

Table 7-2. Los Angeles County Dams with Potential to Impact the Metropolitan Water District

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
10 MG Walteria	High	Satisfactory	City of Torrance	1953	Reinforced concrete tank	1,022	40	31
18 MG Walteria	High	Satisfactory	City of Torrance	1987	Reinforced concrete tank	1,287	31	58
Bailey Debris Basin	High	Satisfactory	LA Co. Dept. of Public Works	1954	Earthen	585	43	49
Big Dalton	High	Satisfactory	LA Co. DPW	1929	Multiple arch	480	153	1,290
Big Dalton Debris Basin	High	Satisfactory	LA Co. DPW	1960	Earthen	840	59	208
Big Santa Anita	Extremely High	Satisfactory	LA Co. DPW	1927	Variable radius arch	612	225	858
Big Tujunga No. 1	Extremely High	Satisfactory	LA Co. DPW	1931	Variable radius arch	505	220	5,750
Blanchard Debris Basin	High	Satisfactory	LA Co. DPW	1966	Earthen	925	50	26
Bouquet Canyon	Extremely High	Satisfactory	LA Dept. of Water & Power (LADWP)	1934	Earthen	1,180	190	36,505
Brand Debris Basin	High	Satisfactory	LA Co. DPW	1965	Earthen	400	45	42
Brand Park	High	Satisfactory	City of Glendale	1930	Earthen	230	99	32
Castaic	Extremely High	Poor	CA DWR	1973	Earthen	5,200	340	323,700
Chatsworth	Extremely High	Satisfactory	LADWP	1918	Hydraulic fill	2,700	45	9,886
Chevy Chase 1290 Reservoir	High	Satisfactory	City of Glendale	1940	Earthen	300	90	17
Cogswell	Extremely High	Satisfactory	LA Co. DPW	1935	Rock fill	585	266	8,969
Devils Gate	Extremely High	Satisfactory	LA Co. DPW	1920	Gravity	252	108	2,600
Diederich Reservoir	Extremely High	Satisfactory	City of Glendale	1950	Earthen	100	60	174
Dry Canyon	Extremely High	Satisfactory	LADWP	1912	Hydraulic fill	780	66	1,140
Eagle Rock	Extremely High	Satisfactory	LADWP	1953	Earthen	495	113	254
East Glorietta	High	Satisfactory	City of Glendale	1932	Reinforced concrete tank	1,730	22	71
Eaton Wash Debris Basin	Extremely High	Satisfactory	LA Co. DPW	1936	Earthen	1,545	63	721
Elysian	High	Satisfactory	LADWP	1943	Earthen	480	71	167
Encino	Extremely High	Satisfactory	LADWP	1924	Earthen	1,850	168	9,789
Fairmont	Extremely High	Satisfactory	LADWP	1912	Hydraulic fill	4,300	121	7,507
Garvey Reservoir	Extremely High	Satisfactory	Metropolitan Water District	1954	Earthen	5,164	160	1,610
Glenoaks 968 Reservoir	High	Satisfactory	City of Glendale	1949	Earthen	220	62	28
Green Verdugo	High	Satisfactory	LADWP	1953	Earthen	452	118	99
Greystone Reservoir	Extremely High	Satisfactory	City of Beverly Hills	1970	Reinforced concrete tank	1,140	75	60
Harold Reservoir	High	Satisfactory	Palmdale Water District	1891	Earthen	2,800	30	3,870
La Tuna Debris Basin	Extremely High	Satisfactory	LA Co. DPW	1960	Earthen	654	47	207
Little Dalton Debris Basin	Extremely High	Satisfactory	LA Co. DPW	1960	Earthen	543	71	234
Littlerock	Extremely High	Satisfactory	Littlerock Creek Irrigation District	1924	Roller compacted concrete	576	124	4,600
Live Oak	Extremely High	Satisfactory	LA Co. DPW	1922	Gravity	303	76	239
Live Oak Reservoir	Extremely High	Satisfactory	Metropolitan Water District	1975	Earthen	3,000	105	2,500
Los Angeles Reservoir	High	Satisfactory	LADWP	1977	Earthen	3,415	130	10,000
Lower Franklin	Extremely High	Satisfactory	LADWP	1922	Hydraulic fill	500	103	920

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
Lower San Fernando	Extremely High	Satisfactory	LADWP	1918	Hydraulic fill	1,840	125	9,843
Lower Sunset Debris Basin	High	Satisfactory	LA Co. DPW	1963	Earthen	379	86	37
Malibou Lake Club	High	Satisfactory	Malibou Lake Mountain Club, Inc.	1923	Constant radius arch	190	44	500
Morgan Debris Basin	High	Satisfactory	LA Co. DPW	1962	Earthen	380	37	21
Morris	Extremely High	Satisfactory	LA Co. DPW	1935	Gravity	750	245	27,500
Morris S. Jones	Extremely High	Satisfactory	Pasadena City DWP	1952	Earthen	1,470	49	153
Mulholland	Extremely High	Satisfactory	LADWP	1924	Gravity	933	195	4,036
Pacoima	Extremely High	Satisfactory	LA Co. DPW	1929	Variable radius arch	640	365	3,777
Palos Verdes Reservoir	Extremely High	Satisfactory	Metropolitan Water District	1939	Earthen	2,150	82	1,100
Potrero (Lake Sherwood)	High	Satisfactory	Westlake Lake Management Assoc.	1967	Gravity	730	40	1,600
Puddingstone	Extremely High	Satisfactory	LA Co. DPW	1928	Earthen	2,698	147	16,342
Puddingstone Diversion	High	Satisfactory	LA Co. DPW	1928	Earthen	825	34	150
Pyramid	Extremely High	Satisfactory	CA DWR	1973	Earth and rock	1,080	386	171,196
Reservoir No. 4	Extremely High	Satisfactory	City of Burbank	1955	Reinforced concrete tank	210	38	34
Reservoir No. 5	Extremely High	Satisfactory	City of Burbank	1949	Reinforced concrete tank	870	36	77
Riviera Reservoir	High	Satisfactory	City of Santa Monica DPW	1962	Reinforced concrete tank	1,280	40	76
Rubio Debris Basin	High	Satisfactory	LA Co. DPW	1944	Earthen	780	64	44
San Dimas	Extremely High	Satisfactory	LA Co. DPW	1922	Gravity	340	131	1,534
San Gabriel No. 1	Extremely High	Satisfactory	LA Co. DPW	1938	Earth and rock	1,520	320	44,183
Santa Ynez Canyon	Extremely High	Satisfactory	LADWP	1968	Earthen	455	157	356
Sawpit	Extremely High	Satisfactory	LA Co. DPW	1927	Constant radius arch	527	150	406
Sawpit Debris Basin	Extremely High	Fair	LA Co. DPW	1955	Earthen	520	82	152
Schoolhouse Debris Basin	High	Satisfactory	LA Co. DPW	1962	Earthen	265	38	19
Sierra Madre	High	Satisfactory	LA Co. DPW	1928	Constant radius arch	200	69	51
Sierra Madre Villa	Extremely High	Satisfactory	LA Co. DPW	1958	Earthen	906	50	109
Silver Lake	Extremely High	Satisfactory	LADWP	1976	Earthen	760	43	2,020
Stevenson Ranch	High	Satisfactory	LA Co. DPW	2004	Earthen	280	54	105
Stone Canyon	Extremely High	Satisfactory	LADWP	1924	Earthen	1,150	188	10,372
Stough Debris Basin	Extremely High	Satisfactory	LA Co. DPW	1961	Earthen	567	46	67
Thompson	Significant	Satisfactory	Southern California Edison	1925	Earthen	445	114	1,010
Thompson Creek	Extremely High	Satisfactory	LA Co. DPW	1928	Earthen	1,500	66	543
Westlake Reservoir	Extremely High	Satisfactory	Las Virgenes Municipal Water District	1972	Earthen	1,400	158	9,200
Weymouth Memorial Reservoir	Extremely High	Satisfactory	Metropolitan Water District	1966	Reinforced concrete tank	2,400	18	151
Wilson Debris Basin	High	Satisfactory	LA Co. DPW	1961	Earthen	666	50	84

Note: Dams highlighted in orange are those owned by Metropolitan Water District

Table 7-3. Orange County Dams with Potential to Impact the Metropolitan Water District

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
30 MG Central Reservoir	High	Satisfactory	City of Brea	1924	Earthen	1,596	30	92
Agua Chinon	High	Satisfactory	County of Orange	1998	Earthen	480	41	256
Big Canyon	Extremely High	Satisfactory	Newport Beach	1959	Earthen	3,824	65	600
Diemer Ozone Contact Basin	Extremely High	Satisfactory	Metropolitan Water District	2011	Reinforced concrete tank	1,012	22	80
Diemer Reservoir	Extremely High	Satisfactory	Metropolitan Water District	1963	Reinforced concrete tank	1,880	22	80
Dove Canyon	High	Satisfactory	Dove Canyon Master Assoc.	1989	Earthen	700	88	415
Eastfoot Retarding Basin	Extremely High	Satisfactory	City of Irvine	2007	Earthen	1,000	39	213
El Toro Reservoir	Extremely High	Satisfactory	El Toro Water District	1967	Earthen	900	113	877
Harbor View	High	Satisfactory	Co. of Orange	1964	Earthen	330	65	28
Lake Mission Viejo	Extremely High	Satisfactory	Lake Mission Viejo Assoc.	1976	Earthen	1,750	123	4,300
Lower Peters Canyon Retarding Basin	Extremely High	Satisfactory	Co. of Orange	1990	Earthen	1,166	52	206
Marshburn Retarding Basin	Extremely High	Satisfactory	Co. of Orange	1998	Earthen	2,456	27	424
Orchard Estates Retarding Basin	Extremely High	Satisfactory	Co. of Orange	1999	Earthen	810	21	138
Palisades Reservoir	Extremely High	Satisfactory	South Coast WD	1963	Earthen	620	146	147
Peters Canyon	Extremely High	Satisfactory	Co. of Orange	1932	Earthen	580	54	1,090
Portola	High	Satisfactory	Santa Margarita WD	1980	Earthen	1,200	53	586
Rattlesnake Canyon	Extremely High	Satisfactory	Irvine Ranch WD	1959	Earthen	980	79	1,480
Rossmoor No. 1	High	Satisfactory	El Toro WD	1964	Earthen	305	36	43
San Joaquin Reservoir	Extremely High	Satisfactory	Irvine Ranch WD	1966	Earthen	873	224	3,036
Sand Canyon	Extremely High	Satisfactory	Irvine Ranch WD	1912	Earthen	861	58	960
Santiago Creek	Extremely High	Poor	Serrano WD & Irvine Ranch WD	1933	Earthen	1,425	136	25,000
Sulphur Creek	High	Satisfactory	Co. of Orange	1966	Earthen	485	42	520
Syphon Canyon	Extremely High	Satisfactory	Irvine Ranch WD	1949	Earthen	843	59	578
Trabuco	High	Satisfactory	Trabuco Canyon WD	1984	Earthen	620	108	138
Trabuco Retarding Basin	Extremely High	Satisfactory	Co. of Orange	1996	Earthen	2,250	18	390
Trampas Canyon	Extremely High	Satisfactory	Santa Margarita WD	1975	Earthen	1,300	229	5,314
Upper Chiquita	Extremely High	Satisfactory	Santa Margarita WD	2012	Earthen	965	177	754
Upper Oso	Extremely High	Satisfactory	Santa Margarita WD	1979	Earthen	800	142	3,700
Veeh	High	Satisfactory	Lake Hills Community Church	1936	Earthen	417	37	185
Villa Park	Extremely High	Satisfactory	Co. of Orange	1963	Earthen	1,475	118	15,600
Walnut Canyon	Extremely High	Satisfactory	City of Anaheim	1968	Earthen	930	187	2,570
Yorba	Extremely High	Satisfactory	Co. of Orange	1907	Hydraulic fill	920	45	1,200

Note: Dams highlighted in orange are those owned by Metropolitan Water District

Table 7-4. Riverside County Dams with Potential to Impact the Metropolitan Water District

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
Alessandro	High	Satisfactory	RCFCWCD	1956	Earthen	470	66	370
Boxsprings	Extremely High	Satisfactory	RCFCWCD	1960	Earthen	550	49	405
Declez Retention	High	Satisfactory	Co. of San Bernardino DPW	1984	Earthen	1,500	30	331
Diamond Valley Lake	Extremely High	Satisfactory	Metropolitan Water District	2000	Earth and rock	8,300	284	800,000
Dunn Ranch	High	Satisfactory	The Agri-Empire Corporation	1987	Earthen	425	44	90
Eagle Canyon Debris Basin	Extremely High	Satisfactory	RCFCWCD	2015	Earthen	370	55	222
Fairmount Park	High	Satisfactory	City of Riverside	1923	Earthen	800	12	200
Foster	High	Satisfactory	Idyllwild WD	1945	Earthen	277	38	56
Goodhart Canyon Detention Basin	High	Satisfactory	Metropolitan Water District	1999	Earthen	6,823	15	1,026
Harrison Street	High	Satisfactory	RCFCWCD	1954	Earthen	760	50	208
Henry J. Mills No. 2	High	Satisfactory	Metropolitan Water District	1996	Earthen	2,044	34	92
Henry J. Mills Reservoir	High	Satisfactory	Metropolitan Water District	1979	Earthen	2,038	23	83
Jurupa Basin	High	Satisfactory	RCFCWCD	1983	Earthen	1,350	22	167
Lake Hemet	Extremely High	Satisfactory	Lake Hemet Municipal Water District	1895	Gravity	324	135	14,000
Lakeview	High	Satisfactory	RCFCWCD	1994	Earthen	3,100	37	530
Lee Lake	High	Poor	Elsinore Valley Municipal Water District	1893	Earthen	520	47	1,100
Mabey Canyon	High	Satisfactory	RCFCWCD	1974	Earthen	520	46	68
Mary Street	Extremely High	Satisfactory	RCFCWCD	1981	Earthen	1,035	40	320
Mathews	Extremely High	Satisfactory	Metropolitan Water District	1938	Earthen	6,522	264	182,000
Metz Road Debris Basin	High	Satisfactory	RCFCWCD	1981	Earthen	4,505	12	88
Mockingbird Canyon	Extremely High	Satisfactory	City of Riverside	1914	Hydraulic fill	1,525	74	1,250
Oak Street	High	Satisfactory	RCFCWCD	1979	Earthen	2,000	36	138
Perris	Extremely High	Satisfactory	CA DWR	1973	Earthen	11,600	130	131,452
Pigeon Pass	Extremely High	Satisfactory	RCFCWCD	1958	Earthen	2,915	36	900
Prenda	High	Satisfactory	RCFCWCD	1954	Earthen	1,313	44	192
Quail Valley	High	Satisfactory	Canyon Heights Assoc.	1959	Earthen	275	37	103
Railroad Canyon	Extremely High	Satisfactory	Elsinore Valley Municipal Water District	1928	Variable radius arch	590	94	11,586
Robert A. Skinner	Extremely High	Satisfactory	Metropolitan Water District	1973	Earthen	5,150	109	43,800
Skinner Clearwell	High	Satisfactory	Metropolitan Water District	1991	Earthen	1,910	44	356
Sunnymead Ranch	High	Satisfactory	Sunnymead Ranch Planned Community Assoc.	1985	Earthen	780	41	400
Sycamore	Extremely High	Satisfactory	RCFCWCD	1956	Earthen	620	63	1,150
Tachevah	Extremely High	Satisfactory	RCFCWCD	1964	Earthen	3,600	42	650
Tahquitz Creek Debris	Extremely High	Satisfactory	RCFCWCD	1991	Earthen	1,697	32	75

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
Vail	Extremely High	Satisfactory	Rancho California WD	1949	Variable radius arch	788	152	51,000
Wide Canyon	Extremely High	Satisfactory	RCFCWCD	1968	Earthen	2,225	84	1,490
Woodcrest	Extremely High	Satisfactory	RCFCWCD	1954	Earthen	900	44	420

Note: Dams highlighted in orange are those owned by Metropolitan Water District

Table 7-5. San Bernardino County Dams with Potential to Impact the Metropolitan Water District

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
Alta Loma Basin #1	High	Satisfactory	Co. of SB DPW	1964	Earthen	2,600	30	70
Alta Loma Basin #2	High	Satisfactory	Co. of SB DPW	1971	Earthen	3,000	22	85
Amethyst Basin	Extremely High	Satisfactory	Co. of SB DPW	-	Earthen	600	46	348
Bear Valley	High	Satisfactory	Big Bear Municipal Water District	1911	Multiple arch	360	80	74,000
Cactus Basin #3	Extremely High	Satisfactory	Co. of SB DWP	2017	Earthen	4,150	38	528
Cedar Lake	High	Satisfactory	Cedar Lake Camp, Inc.	1928	Variable radius arch	220	28	30
Cedar Springs	High	Satisfactory	CA DWR	1971	Earth and rock	2,235	236	78,000
Copper Basin	Extremely High	Satisfactory	Metropolitan Water District	1938	Variable radius arch	265	184	22,000
Crafton Hills	High	Satisfactory	CA DWR	2001	Earthen	496	95	130
Cucamonga Creek Debris Basin	High	Satisfactory	Co. of SB DPW	1980	Earthen	2,980	60	355
Day Creek Debris Basin	High	Satisfactory	Co. of SB DPW	1988	Earthen	975	90	140
Deer Canyon Debris Basin	High	Satisfactory	Co. of SB DPW	1980	Earthen	1,857	78	24
Demens Creek Debris Basin	High	Satisfactory	Co. of SB DPW	1980	Earthen	4,237	35	35
Devil Canyon	High	Satisfactory	CA DWR	1995	Earthen	370	77	980
Devils Canyon Dike #1	High	Satisfactory	Co. of SB DPW	1934	Earthen	3,290	15	79
Etiwanda Debris Basin	High	Satisfactory	Co. of SB DPW	2008	Earth and rock	4,175	51	283
Gene Wash	High	Satisfactory	Metropolitan Water District	1937	Variable radius arch	383	140	6,300
Glen Martin	High	Fair	Highest and Best Use, LLC	1950	Earthen	302	55	33
Grass Valley	High	Satisfactory	Arrowhead Lake Assoc.	1964	Earthen	170	35	243
Jurupa Basin	Extremely High	Satisfactory	Co. of SB DPW	2001	Earthen	7,000	29	1,680
Lake Gregory	High	Satisfactory	SB Co. Regional Parks	1938	Earthen	475	90	2,100
Little Mountain	High	Satisfactory	Co. of SB DPW	1958	Earthen	2,100	28	150
Mineral Hot Springs Lake	High	Satisfactory	San Manuel Band of Mission Indians	1967	Earthen	200	54	31
New Lake Arrowhead	High	Satisfactory	Co. of SB	1976	Earthen	1,300	225	1,970
Perris Hill Reservoir	Extremely High	Satisfactory	City of San Bernardino	1962	Reinforced concrete tank	1,150	31	31
Rancho Cielito	High	Satisfactory	Rolling Ridge Ranch	1912	Earthen	1,000	9	110
San Sevaine Basin #5	Extremely High	Satisfactory	Co. of SB DPW	2004	Earthen	9,000	49	2,765
Seven Oaks	Extremely High	Satisfactory	Co. of SB DPW	1999	Rock fill	2,980	550	145,600
Small Canyon	High	Satisfactory	Co. of SB DPW	1957	Earthen	245	68	20
Upland Basin	Extremely High	Satisfactory	City of Upland	2008	Earthen	2,275	20	362
Yucaipa No. 2	High	Satisfactory	SB Valley Municipal Water District (MWD)	1978	Earthen	480	49	100
Yucaipa No. 3	Low	Satisfactory	SB Valley MWD	1978	Earthen	340	35	32

Note: Dams highlighted in orange are those owned by Metropolitan Water District

Table 7-6. San Diego County Dams with Potential to Impact the Metropolitan Water District

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
4-S Ranch Reclamation Reservoir	High	Satisfactory	Olivenhain Municipal Water District	2000	Earthen	1,270	22	410
Barrett	Extremely High	Fair	City of San Diego	1922	Gravity	750	161	44,755
Beck	High	Satisfactory	Rainbow Municipal Water District	1963	Earthen	3,500	95	625
Bernardo Reservoir	Extremely High	Satisfactory	City of San Diego	1964	Earthen	830	54	30
Black Mountain Water Tank	High	Satisfactory	City of San Diego	2002	Reinforced concrete tank	0	55	77
Blossom Valley Reservoir	High	Satisfactory	Padre Dam Municipal Water District	1962	Earth and rock	350	42	22
Calavera	High	Satisfactory	Carlsbad Municipal Water District	1940	Earthen	490	67	520
Chet Harritt	Extremely High	Satisfactory	Helix Water District	1962	Earthen	1,117	200	9,790
Chollas	Extremely High	Satisfactory	City of San Diego	1901	Earthen	565	50	167
Cuyamaca	High	Satisfactory	Helix WD	1887	Earthen	665	40	11,740
Dixon	Extremely High	Satisfactory	City of Escondido	1970	Earth and rock	830	116	2,500
Eastlake	High	Satisfactory	Eastlake 1 Assoc.	1986	Earthen	900	35	77
El Capitan	Extremely High	Poor	City of San Diego	1934	Hydraulic fill	1,170	237	112,800
Fairbanks	High	Satisfactory	Fairbanks Ranch Assoc.	1927	Gravity	194	36	100
Henshaw	Extremely High	Satisfactory	Vista Irrigation District	1923	Hydraulic fill	650	123	50,000
Lake Hodges	Extremely High	Poor	City of San Diego	1918	Multiple arch	729	131	37,700
Lake Loveland	Extremely High	Satisfactory	Sweetwater Authority	1945	Variable radius arch	765	203	25,400
Lake Wohlford	Extremely High	Fair	City of Escondido	1924	Hydraulic fill	422	100	6,950
Lower Stehly	High	Satisfactory	Private Entity	-	Earthen	420	60	287
Maerkle	Extremely High	Satisfactory	Carlsbad Municipal Water District	1963	Earthen	800	165	600
Melrose Avenue	High	Satisfactory	Rancho Carrillo Homeowners Assoc.	1998	Earthen	700	57	52
Miramar	Extremely High	Satisfactory	City of San Diego	1960	Earthen	2,265	165	7,250
Morena	Extremely High	Fair	City of San Diego	1912	Rock fill	550	181	50,206
Mt. Woodson	High	Fair	Ramona Municipal Water District	1958	Earthen	1,130	38	30
Murray	Extremely High	Fair	City of San Diego	1918	Multiple arch	870	110	4,818
Olivenhain	Extremely High	Satisfactory	San Diego Co. Water Authority	2003	Roller compacted concrete	2,500	309	24,900
Palo Verde	High	Satisfactory	Palo Verde Ranch Homeowners Assoc.	1970	Earthen	758	67	1,000
Poway	High	Satisfactory	City of Poway	1971	Earthen	970	162	3,300

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
Ramona	High	Satisfactory	Ramona Municipal Water District	1988	Earthen	970	228	12,200
Red Mountain Reservoir	Extremely High	Satisfactory	Fallbrook Public Utility District	1985	Earthen	1,500	120	1,350
San Dieguito	High	Satisfactory	Santa Fe Irrigation and San Dieguito WD	1918	Multiple arch	650	51	883
San Marcos	High	Satisfactory	Citizens Dev. Corp.	1946	Variable radius arch	290	52	480
San Marcos	High	Satisfactory	Vallecitos WD	1958	Earthen	400	85	320
San Vicente	Extremely High	Satisfactory	City of San Diego	1943	Roller compacted concrete	1,425	338	245,000
San Vicente Storage Pond 2	High	Satisfactory	Ramona Municipal Water District	1991	Earthen	2,350	30	137
Santa Fe Seasonal Storage	High	Satisfactory	Santa Fe Community Services District	2004	Earthen	500	22	132
Santa Maria	High	Satisfactory	Ramona Municipal Water District	1995	Earthen	2,240	25	217
Savage	Extremely High	Poor	City of San Diego	1919	Gravity	750	149	56,500
Stanley A. Mahr Reservoir	High	Satisfactory	Vallecitos WD	1981	Earthen	950	79	166
Sutherland	Extremely High	Satisfactory	City of San Diego	1954	Multiple arch	1,020	162	29,000
Sweetwater Main	Extremely High	Fair	Sweetwater Authority	1888	Gravity	700	112	37,689
Turner	High	Satisfactory	Valley Center Municipal Water District	1971	Earthen	700	111	2,000
Upper Stehly	High	Satisfactory	Private Entity	1999	Earthen	420	29	229

Table 7-7. Ventura County Dams with Potential to Impact the Metropolitan Water District

Name	Hazard Potential	Condition Assessment	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)
Arundell Barranca	Extremely High	Satisfactory	Ventura Co. Watershed Protection District	1996	Earthen	368	57	155
Lake Eleanor	High	Satisfactory	Conejo Open Space Conservation Agency	1881	Constant radius arch	140	37	104
Lake Sherwood	Extremely High	Satisfactory	Sherwood Development Company	1904	Constant radius arch	350	45	2,600
Lang Creek Detention Basin	Extremely High	Satisfactory	VCWPD	2004	Earthen	345	67	263
Las Llajas	Extremely High	Satisfactory	VCWPD	1981	Earthen	580	96	1,250
Matillija	Extremely High	Poor	VCWPD	1949	Variable radius arch	620	163	1,800
Runkle	Extremely High	Satisfactory	VCWPD	1949	Earthen	250	41	100
Santa Felicia	Extremely High	Fair	United Water Conservation District	1955	Earthen	1,275	213	100,000
Senior Canyon	High	Satisfactory	Senior Canyon Mutual Water Company	1964	Earthen	970	76	73
Sinaloa Lake	High	Satisfactory	Sinaloa Lake Owners Associates, Inc.	1925	Earthen	800	30	205
Stewart Canyon Debris Basin	Extremely High	Satisfactory	VCWPD	1963	Earthen	1,263	34	67
Sycamore Canyon	Extremely High	Satisfactory	VCWPD	1981	Earthen	1,520	40	890
Wood Ranch	Extremely High	Satisfactory	Calleguas Municipal Water District	1965	Earthen	1,020	146	11,000

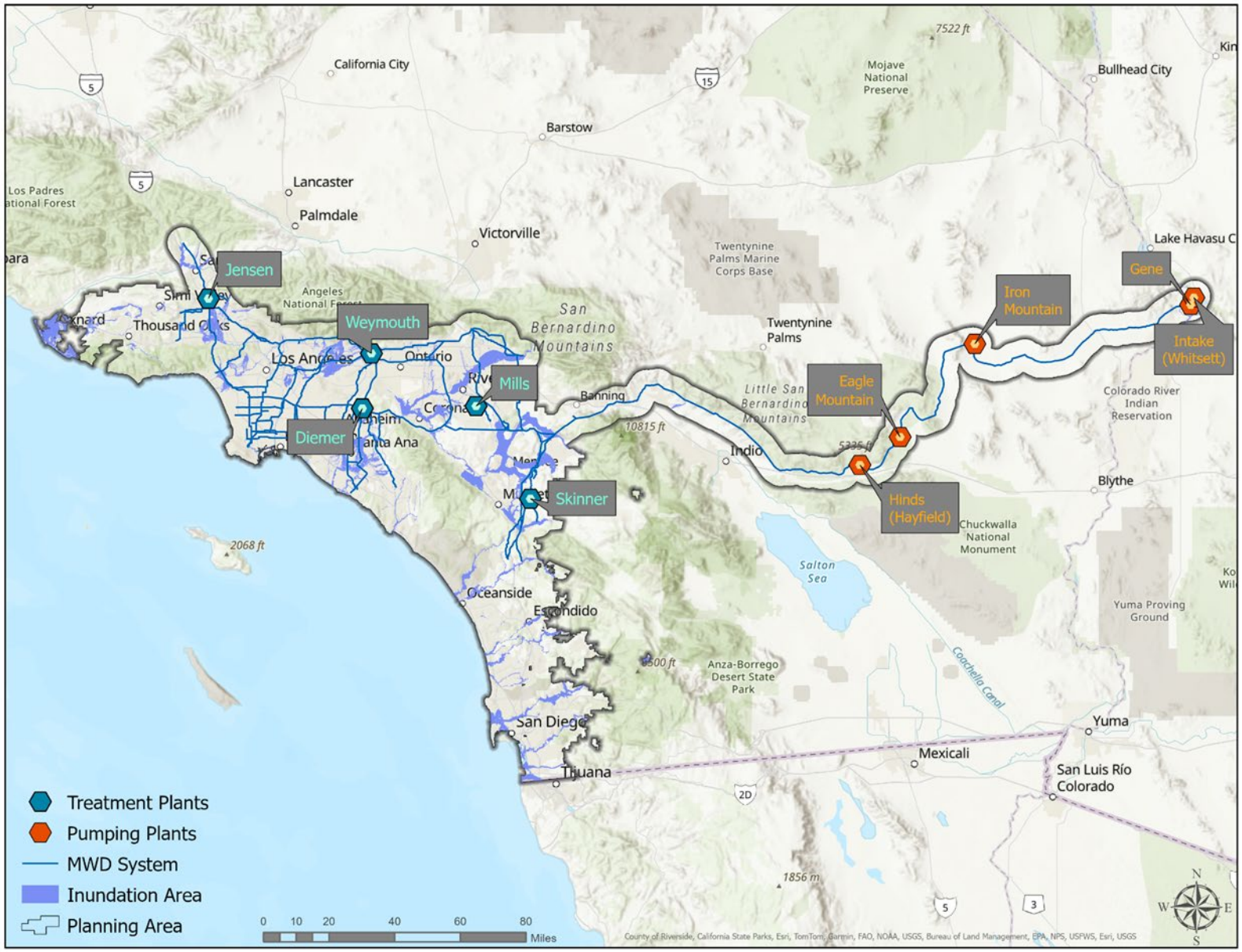


Figure 7-1. Dam Locations and Combined Dam Inundation Area

7.2.5 Warning Time

Warning time for dam failure depends on the cause of the failure. In case of extreme precipitation, evacuations can be planned with sufficient time. In the event of a structural failure due to an earthquake, there may be little to no warning time. A dam's structural type also affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until the reservoir is empty or the breach resists further erosion. Concrete dams also tend to begin with a partial breach. The time of breach formation ranges from a few minutes to a few hours.

All six of Metropolitan's service counties have mass notification systems. Alert LA County is a free mass notification system for Los Angeles County residents and businesses. AlertOC is a mass notification system designed to keep Orange County, California residents and businesses informed of emergencies that may require immediate lifesaving actions. Alert RivCo is used to alert Riverside County community members of urgent actions to take during disasters, such as earthquakes, wildfires, and floods.

In an effort to quickly communicate information on impending dangers, the San Bernardino County Sheriff and Fire Departments send high-speed mass notifications via telephone and text messages. This system is known as the Telephone Emergency Notification System (TENS). The Ready San Bernardino County app also helps County residents prepare and plan for how to respond to a disaster.

The County of San Diego, in partnership with Blackboard Connect Inc., has instituted a regional notification system that will be able to send telephone notifications to residents and businesses within San Diego County impacted by, or in danger of being impacted by, an emergency or disaster. This system, called AlertSanDiego, is used by emergency response personnel to notify those homes and businesses at risk with information on the event and/or actions (such as evacuation, shelter in place, gas leak, missing person, etc.) the County is asking them to take.

Ventura County utilizes a state-of-the-art emergency notification system to deliver time-sensitive emergency alerts in English and Spanish to areas within Ventura County where there is a threat to health and safety. This system is called VC Alerts, which can reach 100,000 contacts simultaneously per hour.

7.3 EXPOSURE

The dam failure risk assessment evaluated Metropolitan assets within the mapped inundation area of any high-hazard or extremely-high-hazard dam included in DSOD's dam failure inundation database (see Figure 7-1). Table 7-8 and 7-9 summarize the number of assets by category within the aggregate mapped inundation area and the total replacement cost value (RCV) of those assets. For the linear assets, it is assumed that below-ground pipelines would not be impacted and only those portions that are above ground and within the dam inundation areas are considered exposed. Details by type of facility are included in Appendix D. Figure 7-2 shows these results as the percent of planning area totals for each asset type.

7.4 VULNERABILITY

Based on the exposure analysis, several of Metropolitan's conveyance and distribution assets are at risk from inundation due to dam failure. Four of Metropolitan's water treatment plants are located within potential dam inundation areas. For example, the Weymouth Water Treatment plant is within the mapped inundation area for

the Live Oak Reservoir, which is owned and operated by Metropolitan. While the depth of flooding is expected to be relatively shallow, the areas within the inundation zone could include buildings that oversee plant operations, monitor system-wide water quality, or hold Metropolitan's in-house manufacturing capabilities which could impact plant operations. A large portion of the Weymouth plant service area can also be supplied by the Jensen and Diemer treatment plants. However, the areas served exclusively by the Weymouth plant could have their deliveries impacted. This includes areas directly south of the plant such as La Verne, San Dimas and Walnut and communities to the west along the foothills including Glendora, Azusa, Duarte, Monrovia, and Pasadena. People within these areas would likely be required to conserve water use and demands would be met by local supplies such as groundwater while Metropolitan works to resume operations. Similar population impacts could be seen if other treatment plants were impacted instead of the Weymouth plant. Buried pipelines within mapped inundation areas are assumed to not be impacted.

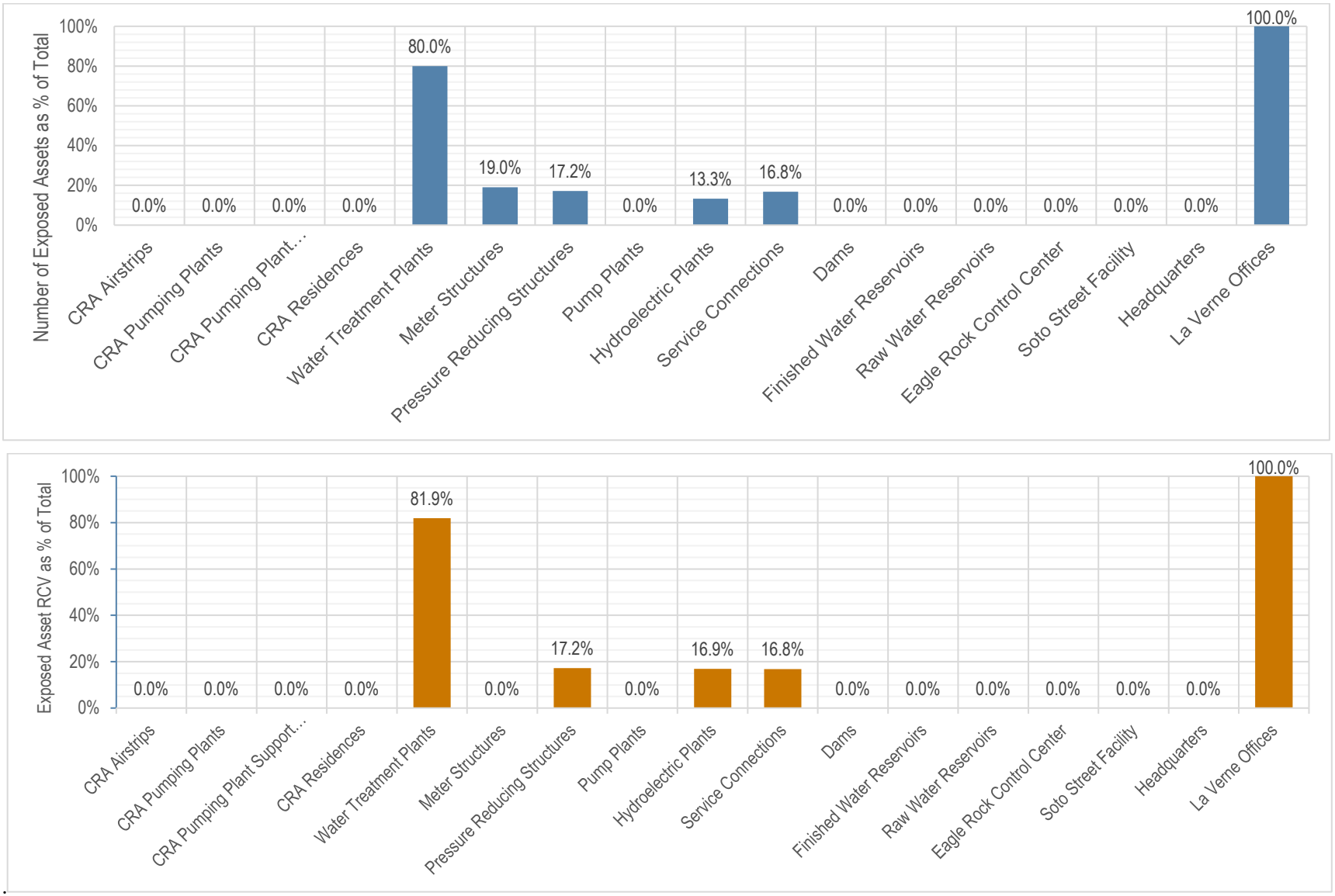
Table 7-8. Metropolitan Non-linear Assets in the Combined Dam Failure Hazard Area

	Structures Within in the Hazard Area	
	Number of Structures	Replacement Cost Value
Colorado River Aqueduct Facilities		
Airstrips	0	$0
Pumping Plants	0	$0
Pumping Plant Support Buildings	0	$0
Residences	0	$0
Conveyance and Distribution Facilities		
Water Treatment Plants	4	$4,328,980,923
Hydroelectric Plants	2	$55,417,999
Pump Plants	0	$0
Meter Structures	91	n/a
Pressure Reducing Structures	10	$53,214,931
Service Connections	91	$37,055,655
Dams	0	n/a
Building Facilities		
Headquarters	0	$0
La Verne Offices	1	$201,747,367
Eagle Rock	0	$0
Soto Street	0	$0
Reservoirs		
Finished Water Reservoirs	0	$0
Raw Water Reservoirs	0	$0

Table 7-9. Metropolitan Linear Assets in the Combined Dam Failure Hazard Area*

	Length (miles) within Hazard Area	Replacement Cost Value
Colorado River Aqueduct	0	$0
C&D Pipelines	9.25	$101,664,037

*Only above-ground sections are considered for the dam failure exposure analysis.



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 7-2. Percent of Total Assets (Number and Value) in the Combined Dam Failure Hazard Area

7.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands. In addition, Metropolitan works with local jurisdictions on development projects within the vicinity of existing infrastructure to protect public safety, easements and the integrity of the system. Metropolitan's Capital Investment Plan includes a program for Dams & Reservoirs Improvements. Projects under this program will upgrade or refurbish Metropolitan's dams, reservoirs, and appurtenant facilities to reliably meet water storage needs and regulatory compliance.

7.6 CLIMATE CHANGE

Property exposure and vulnerability to the dam failure hazard are unlikely to significantly increase as a result of climate change, since most of Metropolitan's reservoirs are off stream. For the reservoirs that do have contributing watersheds, Metropolitan may need to alter maintenance and operations to account for changes in the inflow hydrographs for those dams. Changes in rainfall and runoff conditions may have some impacts on dam operations. Dams are designed partly based on assumptions about runoff inflows, and changes in weather patterns can affect the inflow estimates used for the design of a dam. If the hydrograph changes significantly resulting in larger inflows into the reservoir, dam operators may be required to release increased volumes of water earlier in a storm cycle to maintain the required margins of safety. In most cases, such early releases of increased volumes are made by utilizing Metropolitan's distribution system and do not increase flood potential downstream.

Dams are constructed with safety features known as "spillways." Spillways are a safety measure that allow for flow releases to be made during heavy runoff inflows to prevent overtopping of the dams in the event the reservoir fills too quickly. Spillways are designed with adequate capacities to safely pass inflows from extreme storm events, such as the probable maximum flood. Spillway overflow events, also referred to as high-flow events in the dam's EAP, result in discharges downstream, and in some cases, increased flooding potential. For dams with potential for high-flow events, the EAP includes notification procedures to minimize the risk to public safety and property damage downstream. Although climate change will not increase the probability of catastrophic dam failure, it may increase the probability of spillway releases for Metropolitan's reservoirs that have contributing watersheds.

7.7 ISSUES

Flooding as a result of a dam failure would significantly impact properties and populations in the inundation areas. There is often limited warning time for such failures. These events are frequently associated with other natural hazard events such as earthquakes or landslides, which limits their predictability and compounds the hazard. Important issues for Metropolitan associated with dam failure hazards include the following:

- Metropolitan has community lifelines exposed to the aggregate dam failure inundation area (200 assets out of more than 1,100 evaluated in the risk assessment).

- Twenty-four dams are owned and maintained by Metropolitan. Failure of any of these dams would have a significant impact on Metropolitan's ability to provide services, as each dam is critical to Metropolitan's stored water supply.
- Most dam failure mapping at the state and federal levels requires determination of the probable maximum flood. While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence. For non-federally regulated dams, mapping of dam failure scenarios that are less extreme than the probable maximum flood but have a higher probability of occurrence can be valuable to emergency managers and community officials downstream. Such mapping can indicate areas potentially impacted by more frequent events to support emergency response and preparedness.

The concept of residual risk associated with structural flood control projects is not always, but should be, considered in the design of capital projects and the application of land use regulations.

8. DROUGHT

8.1 GENERAL BACKGROUND

Drought is a significant decrease in water supply relative to what is typical in a given location. It originates from a deficiency of precipitation over an extended period of time, usually a season or more. This leads to a water shortage for some activity, group or environmental sector. Drought can be characterized based on various impacts or measurements:

- Meteorological measurements such as rainfall or snowpack deficit compared to normal or expected precipitation
- Hydrological measurements of stream flows, groundwater, runoff and reservoir levels relative to normal conditions
- Agricultural impacts due to reduced rainfall and water supply (e.g., crop loss, herd culling, etc.)
- Direct and indirect socio-economic impacts on society and the economy (e.g., water use restrictions, increased unemployment due to failure of an industry because of drought, increased risk of wildfire in urban-wildland interface zones)

Drought is a normal phase in the climactic cycle of most geographical regions. If the weather pattern that causes a drought lasts a short time (a few weeks or a couple of months), the drought is considered short-term. If the weather pattern becomes entrenched and the precipitation deficits last for several months or years, the drought becomes long-term. It is possible for a region to experience a long-term circulation pattern that produces drought and to have short-term changes in this long-term pattern that result in short-term wet spells. Likewise, it is possible for a long-term wet circulation pattern to be interrupted by dry spells that result in short-term drought.

8.1.1 Monitoring Drought

National Oceanic and Atmospheric Administration Drought Indices

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations, including the following:

- The ***Crop Moisture Index*** measures weekly short-term drought to quantify drought impacts on agriculture during the growing season.
- The ***Palmer Z Index*** measures monthly short-term drought.
- The ***Palmer Drought Severity Index*** measures the duration and intensity of long-term drought-inducing circulation patterns. Long-term drought is cumulative, so the intensity of drought during a given month is dependent on the current weather patterns plus the cumulative patterns of previous months. Weather

patterns can change quickly from a long-term drought pattern to a long-term wet pattern, and the Palmer Drought Index can respond fairly rapidly.

- The hydrological impacts of drought (e.g., reservoir levels, groundwater levels, etc.) take longer to develop and it takes longer to recover from them. The ***Palmer Hydrological Drought Index*** quantifies long-term hydrological effects. It responds more slowly to changing conditions than the Palmer Drought Index.
- While the Palmer indices consider precipitation, evapotranspiration and runoff, the ***Standardized Precipitation Index*** considers only precipitation. In the Standardized Precipitation Index, an index of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months.

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a map that is updated weekly to show the location and intensity of drought across the country. The USDM uses a five-category system, which includes the following:

- D0—Abnormally Dry
  - Short-term dryness slowing planting, growth of crops
  - Some lingering water deficits
  - Pastures or crops not fully recovered
- D1—Moderate Drought
  - Some damage to crops, pastures
  - Some water shortages developing
  - Voluntary water-use restrictions requested
- D2—Severe Drought
  - Crop or pasture loss likely
  - Water shortages common
  - Water restrictions imposed
- D3—Extreme Drought
  - Major crop/pasture losses
  - Widespread water shortages or restrictions
- D4—Exceptional Drought
  - Exceptional and widespread crop/pasture losses
  - Shortages of water creating water emergencies

The USDM categories show experts' assessments of conditions related to drought. These experts check variables including temperature, soil moisture, water levels in streams and lakes, snow cover, and meltwater runoff. They also check whether areas are showing drought impacts such as water shortages and business interruptions. Associated statistics show what proportion of various geographic areas are in each category of dryness or drought, and how many people are affected. U.S. Drought Monitor data go back to 2000.

Figure 8-1 shows examples of the NOAA indices and USDM maps as of August 2024.

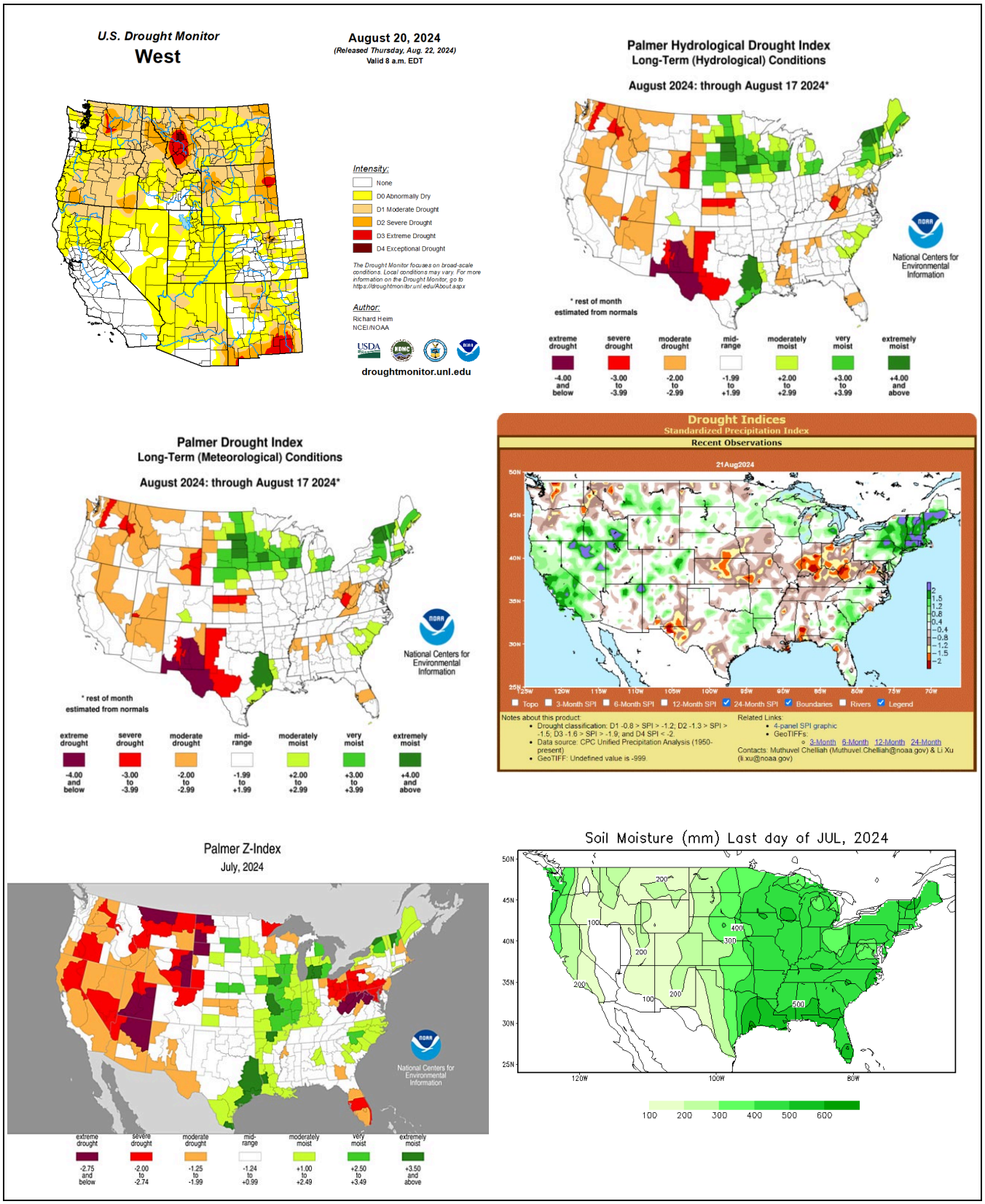


Figure 8-1. Example Drought Index and Drought Monitor Maps, Current as of August 2024

8.1.2 Drought Regulations for Urban Water Suppliers

During critically dry years, the California State Water Resources Control Board (SWRCB or "the Board") can mandate water restrictions to address regional water shortages. The SWRCB responds to drought impacts based on unique and evolving conditions in different regions. The Board uses hydrologic forecasts, real-time conditions, and water-use data reported by water right holders to closely monitor watersheds. To address California's new normal of climate extremes and prepare for long-term droughts, every urban water supplier is required to prepare and adopt a water shortage contingency plan as part of its urban water management plan (California Water Code §10632). The plan must include six standard water shortage levels corresponding to progressive ranges of up to 10, 20, 30, 40, and 50 percent shortages and greater than 50 percent shortage. Urban water suppliers define these shortage levels based on the suppliers' water supply conditions, including percentage reductions in water supply, changes in groundwater levels, changes in surface elevation or level of subsidence, or other changes in hydrological or other local conditions indicative of the water supply available for use. Metropolitan adopted its Water Shortage Contingency Plan in May 2021. Actions are implemented based on emergency water conservation regulations issued by the SWRCB.

8.1.3 Drought Impacts

Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to structures, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Economic Impacts**—Drought costs people and businesses money. Farmers' crops are destroyed; low water supply necessitates spending on irrigation or drilling of new wells. Businesses may experience increased risk due to unreliable water supplies; long-term drought may alter production processes, reduce revenue and workforce, and disincentivize investment in drought-prone regions.
- **Environmental Impacts**—Drought can affect ecosystems in the short-term and long-term. Reduced water supply and degraded water quality can affect habitat, food supply and plant and animal species. Long-term drought can lead to plant community succession as the environment changes. Drought in urban areas can affect trees and the tree canopy that mitigates urban heat island effects and other environmental issues.
- **Social Impacts**—Drought can impact human health and public safety. It creates conflicts between regions, priorities for uses, and changes in lifestyle.

Drought can lead to difficult decisions regarding the allocation of water, as well as stringent water use restrictions, water quality problems, and inadequate water supplies for human health and safety. Conflicts arise between agricultural and urban uses, water for the environment and human needs, and surface water and groundwater interrelationships.

Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand. The impacts of drought vary between sectors of the community in both timing and severity:

- **Water supply—**The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes water supplies due to sub-average precipitation through rainfall or snowpack.
- **Agriculture and commerce—**The agriculture and commerce sectors include the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover

for grazing. It also includes impacts to industry and businesses due to unreliable water supplies and water use restrictions.

- **Environment, public health, and safety**—The environmental, public health, and safety sector focuses on wildfires that are both detrimental to the forest ecosystem and hazardous to the public. It includes the impact to ecosystems through decreased water supply, desiccating streams, and the reduction of in-stream habitats for native species. For urban areas, it includes impacts to landscape and trees that mitigate environmental issues.

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. It can also lead to ground subsidence and seawater intrusion into coastal groundwater basins. Reduced replenishment of groundwater also affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when stream flows are lowest.

8.1.4 Secondary Hazards

The secondary hazard most associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to igniting as the duration of the drought extends. In addition, lack of sufficient water resources can stress trees and other vegetation, making them more vulnerable to infestation from pests, which in turn, can make them more vulnerable to ignition. The other hazard relates to climate change and adaptation. Trees in urban areas provide important mitigation for environmental issues through carbon capture, stormwater management, and reduced urban heat island effects. Drought can cause loss of urban tree canopy and reduction in benefits to climate adaptation.

8.2 HAZARD PROFILE

8.2.1 Past Events in California

The California Department of Water Resources has state hydrologic data back to the early 1900s (CA DWR, 2017) that show multi-year droughts are common. The following sections describe more recent prolonged periods of drought in California, all of which impacted Metropolitan and its service area to some degree.

2020 to 2023 Drought

The drought from 2020 to 2023 was the driest three-year period on record, breaking the old record set by the previous drought during 2013 to 2015. As in 2014, a record-low allocation was provided by the State Water Project in 2021. In 2022, a second record-low State Water Project allocation was supplemented for the first time ever by water deliveries to meet human health and safety needs.

On October 19, 2021, Governor Gavin Newsom extended drought proclamations to the entire state of California. Eight counties (Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, San Francisco, and Ventura) had not been included in the proclamation which initially went into effect earlier in the year. This proclamation required local water suppliers to implement water shortage contingency plans that are responsive to local conditions and prepare for the possibility of a third dry year. On March 24, 2023, Governor Newsom’s

Executive Order N-5-23 eased drought restrictions as water conditions improved, including a voluntary 15 percent water conservation target and implementation of Level 2 shortage actions from urban water providers' Water Shortage Contingency Plan.

The 2022 to 2023 snow season started off relatively active across the western United States, with a few modest storms bringing snow accumulations to the mountains in early November. By the start of December 2022, the snow water equivalent across much of the West was above normal. Starting in early December, several storm cycles brought moisture-laden families of atmospheric rivers to the West Coast. Most of the landfalls occurred in California. The strongest series of storms occurred steadily from December 27 through January 17. By the end of January, snow telemetry sites across much of the Sierra Nevada, Great Basin, Utah, Arizona, and western Colorado were at more than 150 percent of normal snow water equivalent. Unlike the 2021 to 2022 water year, in which snowfall was abundant early in winter but scarce after early January, the storm train continued with another series of strong storms across the West from late February through mid-March. By April 1, snowpack was above normal across nearly the entire West, with few areas of snow drought. For California, the Great Basin, and the Colorado River Basin, the cool, wet, and snowy year brought major drought relief after the three consecutive dry years. Observed water year runoff in these regions was above normal through early June, and the forecasts indicated above-normal flows persisting throughout summer. Major reservoirs, with the exception of Lakes Powell and Mead, filled. This year was still beneficial for Lakes Powell and Mead, the two largest reservoirs in the country, but it will take much more than one wet year to refill these reservoirs after over 20 years of falling water levels (NOAA 2023).

2012 to 2017 Drought

This drought set several records:

The period from 2013 to 2015 ranked as the driest three consecutive years for statewide precipitation at the time.

2014 set new climate records for statewide average temperatures and for record-low water allocations in the State Water Project and federal Central Valley Project.

2013 set minimum annual precipitation records for many communities.

On January 17, 2014, the governor declared a state of emergency for drought throughout California. This declaration followed release of a report that California had had the least amount of rainfall in its 163-year history. Californians were asked to voluntarily reduce their water consumption by 20 percent. Drought conditions worsened into 2015. On April 1, 2015, following the lowest snowpack ever recorded, the governor announced actions to save water, increase enforcement to prevent wasteful water use, streamline the state's drought response, and invest in new technologies to make California more drought resilient. The governor directed the State Water Resources Control Board to implement mandatory water reductions in cities and towns across California to reduce water usage by 25 percent on average.

The drought ended with a wet water year of 2017 — the second-wettest year on record in terms of statewide runoff, and wettest year of record in the Sacramento River Basin. Responding to the wet conditions, Executive Order B-40-17 in April 2017 terminated the statewide drought proclamation (State Water Resources Control Board 2017).

2007 to 2009 Drought

The governor issued an Executive Order that proclaimed a statewide drought emergency on June 4, 2008, after spring 2008 was the driest spring on record and snowmelt runoff was low. On February 27, 2009, the governor proclaimed a state of emergency for the entire state as the severe drought conditions continued widespread impacts and the largest court-ordered water restriction in state history at the time.

1987 to 1992 Drought

California received precipitation well below average levels for four consecutive years. During this drought, only 56 percent of average runoff for the Sacramento Valley was received, totaling just 10 million acre-feet. By February 1991, all 58 counties in California were suffering from drought conditions. Urban areas as well as rural and agricultural areas were impacted.

1976 to 1977 Drought

California had one of its most severe droughts due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California to that time, with the previous winter recorded as the fourth driest. The cumulative impact led to widespread water shortages and severe water conservation measures throughout the state. Only 37 percent of the average Sacramento Valley runoff was received, with just 6.6 million acre-feet recorded. A federal disaster declaration was declared.

8.2.2 Drought on the Colorado River System

The Colorado River Basin has been in a historic drought since 2000. For 2022, U.S. Bureau of Reclamation declared a Tier 1 Shortage. This was the first ever shortage declaration on the Colorado River. Then, in March 2022 Lake Powell dropped below elevation 3,525 feet, with the reservoir less than 35 feet above the minimum power pool of 3,490 feet (i.e., minimum elevation at which hydropower can be generated). By June 2022, both Lake Powell and Lake Mead – the two largest reservoirs in the United States – were at their lowest levels since initial filling, with combined storage at 28 percent of capacity. While Reclamation and its partners were successful in conserving water in Lake Mead and Colorado River System reservoirs over the past several years, due to these conditions Reclamation Commissioner Camille Calimlim Touton called for more to be done. As a result, the Lower Basin is planning to conserve an additional 3 million acre-feet between 2023 and 2026. Lake Powell rebounded in the summer of 2023, with above-average snowmelt from the Rocky Mountains providing some short-term relief to the reservoir, but long-term drought remains. In August 2023, Reclamation announced that the Colorado River system is in a Tier 1 water shortage for calendar year 2024, after being in a Tier 2 Shortage for calendar year 2023. Reclamation continues to carefully monitor hydrologic and operational conditions and assess the need for additional responsive actions and/or changes to operations.

8.2.3 Location

Drought is a regional phenomenon. A drought that affects the planning area would affect the entirety of the area to various degrees, depending on a member agency's local supplies and Metropolitan's ability to deliver its supplemental supplies. Moreover, since Metropolitan relies on water imported from areas outside its region, droughts in Northern California or on the Colorado River system directly impact Metropolitan's water supply as well. Southern California's mix of water supply sources fluctuates greatly from year to year, with historical averages of approximately 25 percent of its water from the Colorado River and another 30 percent from the State Water Project in Northern California, and the remainder coming from local supplies including groundwater,

recycling, desalination, conservation and the Los Angeles Aqueduct. For Metropolitan, the extent and location of the drought hazard is related to conditions in the source watersheds for the State Water Project and Colorado River as well as the six counties within its service area. Mapping for this hazard is very large scale, and risk assessments based on location are qualitive in nature.

8.2.4 Frequency

Historical drought data for California and the West indicate there have been several significant multi-year droughts since the year 2000. As noted above, California droughts continue to break records and the Colorado River system has been in drought since 2000. Figure 8-2 displays the percent of land area within California and the West affected by each USDM rating since the year 2000. With the effects of climate change on temperature, weather patterns and hydrology, the probability and severity of future droughts is expected to increase.

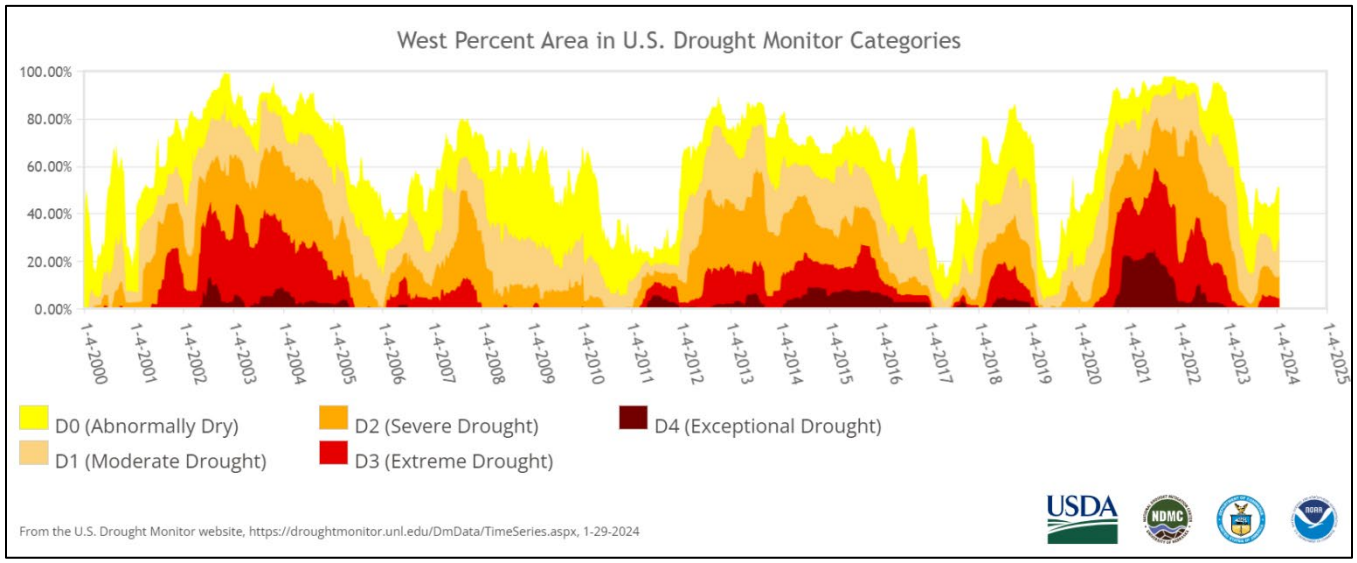


Figure 8-2. Percent of Land Area within California and the West Affected by Each USDM Rating since 2000

8.2.5 Severity

U.S. Drought Monitor Ratings

The western United States has a history of severe droughts. As shown in Figure 8-2, California and the West, which includes the Colorado River system, have experienced extreme (D3) or exceptional (D4) droughts in each of the multi-year droughts since 2000.

Drought Impact Reporter

The National Drought Mitigation Center developed the Drought Impact Reporter as a national drought impact database for the United States. Information comes from a variety of sources: online, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and members of relevant government agencies. The Drought Impact Reporter contains information on impacts from droughts that specifically affected each county within Metropolitan's service area from January 1970 through December 2021. Table 8-1 summarizes the categories and reported number of impacts in the six counties (note that some impacts have been assigned to more than one category):

Table 8-1. Drought Impact Reports in Counties Included in Metropolitan Service Area

Drought Impact Category	Number of Reported Impacts in Counties Encompassed by Metropolitan[a]
Agriculture	486
Business and Industry	121
Energy	17
Fire	275
Plants and Wildlife	426
Relief, Response, and Restrictions	758
Society and Public Health	450
Tourism and Recreation	148
Water Supply and Quality	1081

a. Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura

Planning Scenarios

In planning for water supply reliability, Metropolitan uses both long-range planning and shorter-term operational strategies. For long-range integrated resources planning through 2045, Metropolitan is using planning scenarios that range from low demand/reduced imports to high demand/reduced imports. Metropolitan has adopted the use of Representative Concentration Pathway (RCP) 8.5 that represents more pronounced climate change under both scenarios.

For operations, Metropolitan has evaluated how to manage through a scenario of (1) a future three-year drought sequence with conditions like 2020 to 2022, and (2) a four-year drought. This assumes annual SWP allocations of 20 percent, 5 percent, and 5 percent, with no health and human safety allocation. Both approaches consider a future where drought is more likely and more severe.

8.2.6 Warning Time

Droughts are the result of climatic patterns that occur over long periods of time and across the planet. Only generalized warning can take place due to the numerous variables that make it difficult to make accurate and precise predictions. Drought is generally predictable about a month in advance for most locations as it depends on the ability to forecast precipitation and temperature. Although there is extensive modeling that can help with forecasts, climate change is impacting the ability to forecast and predict droughts. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depend upon interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of weather systems on the global scale.

8.3 EXPOSURE

Given the region-wide nature of droughts, it can be assumed that all Metropolitan assets are equally exposed to some extent to the drought hazard profiled in this chapter.

8.4 VULNERABILITY

Metropolitan's primary purpose is to provide a supplemental supply of water for domestic and municipal uses to its 26-member public agencies. Metropolitan's main sources of water are imported from the Colorado River and the State Water Project (SWP). One of the challenges that Metropolitan faces in providing adequate, reliable, and high-quality supplemental water supplies is the widely variable hydrologic conditions that can have a significant

impact on Metropolitan's imported water supply sources. Drought also affects operations of treatment, conveyance, and distribution systems to deliver the water. Metropolitan has significant exposure to drought and is using its Climate Adaptation Master Plan for Water (CAMP4W) to plan and take other actions to increase the region's resiliency to this hazard.

The following sections discuss drought impacts in Metropolitan with a focus on SWP-dependent areas within the planning area. The most recent drought revealed constraints in Metropolitan's conveyance and distribution infrastructure when there are limited SWP supplies, such that Metropolitan was not able to deliver supplemental supplies to meet demands for six member agencies. As a result, local water providers serving about six million Southern Californians mandated emergency drought restrictions to stretch the region's severely limited water supplies for over six months including severe restrictions on outdoor water use, and volumetric limits on water use to meet health and human safety needs. The water-saving restrictions affected dozens of cities and communities in Los Angeles, Ventura and San Bernardino counties. During severe droughts, infrastructure constraints prevent these agencies from accessing additional supplies that may be available from the Colorado River Aqueduct or from storage in Diamond Valley Lake. These agencies are Calleguas Municipal Water District, Inland Empire Utilities Agency, Las Virgenes Municipal Water District, Los Angeles Department of Water and Power, Three Valleys Municipal Water District, and Upper San Gabriel Valley Municipal Water District. These six agencies are referred to as "SWP-dependent" because they rely on deliveries of Metropolitan's SWP supplies. In normal years, Metropolitan serves the SWP-dependent areas with supplies from two different branches of the California Aqueduct. The East Branch from Silverwood Lake serves Inland Empire Utilities Agency, Three Valleys, and Upper San Gabriel Valley. The West Branch from Castaic Lake serves Calleguas, Las Virgenes, and Los Angeles.

8.4.1 Drought Impact on Water Supply Reliability

Integrated Water Resources Plan Needs Assessment

The Integrated Water Resources Plan (IRP) Needs Assessment, adopted in April 2022, presents a broad collection of potential climate impacts. The analysis consisted of long-term, scenario-based water supply planning and the identification of the supply gap based on multiple future demand projections and climate change scenarios. Metropolitan completed the assessment under the direction of its Board and in collaboration with its 26 member agencies and other interested parties. The assessment presents Metropolitan's broadened perspectives with scenario planning by thoroughly analyzing four different and plausible potential futures. In the scenarios, demands on Metropolitan's imported supplies varied due to different weather and demographic patterns, among other factors. Supplies varied as well, due to reasons such as climate change severity and regulatory impacts (Metropolitan 2020).

After analyzing these futures, a potential for water shortages emerged. The planning revealed that a large portion of Metropolitan's service area is vulnerable to Northern California drought and regulatory restrictions. To this end, the 2020 IRP Regional Needs Assessment highlights important areas of vulnerability to Metropolitan's reliability goal. The outcome of this assessment is summarized through a set of findings grounded in the scenario reliability analysis:

SWP-dependent areas:

- Vulnerabilities in the SWP-dependent areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Actions identified through implementation of CAMP4W must prioritize addressing the SWP-dependent areas' reliability challenge.

- New core supplies must be accessible to the SWP-dependent areas. Greater access to existing core supplies can also increase SWP-dependent area reliability.
- Enhanced accessibility to core supplies and storage, both existing and new, will improve SWP-dependent area and overall reliability. This includes improvements to Metropolitan's distribution system and capacity to deliver non-SWP supply and storage.
- Storage capacity, put/take capabilities, and accessibility are critical considerations for the SWP-dependent areas. New storage capacity and put/take capabilities should be consistent with the portfolio analysis. New storage must be accessible to the SWP-dependent areas.

Storage:

- Storage capacity, put/take capabilities, and accessibility are critical considerations in maintaining reliability under the region's current and future conditions, especially for SWP-dependent areas.
- Maintaining Metropolitan's existing storage portfolio is critical, including the consideration of re-negotiating contracts when they expire.
- Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change.
- When evaluating storage options, put/take capabilities are essential; even storage programs with modest put/take capabilities help reduce the need for flexible supply.

Retail Demand/Demand Management:

- Metropolitan's future supply reliability may fluctuate based on demand increases and decreases.
- Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures.
- It is important to pay attention to demand rebound, demand growth, and demand reductions, and take appropriate regional measures as necessary.
- Managing long-term demands through the efficient use of water reduces dependency on supplies, helps preserve storage, and helps reduce the need for extraordinary conservation measures.

Metropolitan Imported Supplies:

- Existing imported supplies are at risk from various drivers of uncertainty.
- Maintaining existing imported supply reliability reduces the need for new core supply development and leverages years of investments.
- SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions.
- Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years, including Colorado River storage. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP-dependent areas. The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage.
- Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future.

Local Supply:

- Maintaining existing and developing new local supplies is critical in helping manage demands on Metropolitan.
- Impacts to reliability occur if local supply assumptions are not achieved; therefore, it is important to track the progress of local supply development as one of the signposts in the One Water Implementation phase.

- Additional actions may be needed should existing and future local supply levels deviate from IRP assumptions.

Colorado River

The Colorado River was Metropolitan's original source of water. Metropolitan was established in 1928 to obtain an allotment of Colorado River water, and its first mission was to construct and operate the Colorado River Aqueduct (CRA). Metropolitan has a legal entitlement to receive water from the Colorado River under a permanent service contract with the United States Secretary of the Interior. The CRA has a capacity of 1.25 million acre-feet per year. It transports water from Lake Havasu, at the border of the state of California with Arizona, approximately 242 miles to its terminus at Metropolitan's Lake Mathews in Riverside County.

The U.S. Bureau of Reclamation, within the Department of the Interior, uses an August projection of end of calendar year lake elevations to determine if the system will be in shortage the following calendar year. Water supply reductions in the Lower Basin are managed through negotiated agreements between California, Arizona and Nevada.

Over the years, Metropolitan increased reliable CRA supply through programs that it helped fund and implement including farm and irrigation district conservation programs, improved reservoir system operations, land management programs, and water transfers and exchanges through arrangements with agricultural water districts in southern California, entities in Arizona and Nevada that use Colorado River water, and Reclamation. Metropolitan also receives additional Colorado River supplies pursuant to an exchange agreement with its member agency, San Diego County Water Authority.

Since 2000, the Colorado River Basin has experienced the driest 23-year period recorded in more than 100 years. This 23-year drought has been mitigated by actions taken by Metropolitan in cooperation with other Colorado River water users to reduce demands and maintain system storage. These actions were successful in avoiding a shortage declaration until 2021, which was then implemented in 2022. At the close of 2022, however, system storage was at its lowest since the main reservoirs were constructed and began to fill, so there was less water available to buffer future dry conditions. A reduction in runoff efficiency seen in 2021 and 2022 increased the drought's impact on the Colorado River. At a Senate Committee hearing in June 2022, USBR Commissioner Camille Calimlim Touton stated that if poor runoff conditions continued, additional conservation of 2 to 4 million acre-feet would be needed.

Although Lake Powell rebounded in the summer of 2023 with above-average snowmelt from the Rocky Mountains providing some short-term relief to the reservoir, long-term drought remains. In August 2023, Reclamation announced that the Colorado River system is in a Tier 1 water shortage for calendar year 2024, after being in a Tier 2 Shortage for calendar year 2023. In Fall 2023, Reclamation issued a revised Draft Supplemental Impact Environmental Statement analyzing proposed changes to operations of Lake Powell and Lake Mead through 2026. The Lower Basin (California, Nevada and Arizona) is planning to conserve an additional 3 million acre-feet between 2023 and 2026. In late 2023, Metropolitan entered into agreements with Coachella Valley Water District, Imperial Irrigation District, and San Diego County Water Authority to allow water to be added to Lake Mead under Reclamation's Lower Colorado River Basin System Conservation and Efficiency Program. These agreements will help California achieve the goals set out in 2022 by the Colorado River Board of California that California agencies conserve 400,000 acre-feet per year of water in Lake Mead between 2023 and 2026. Reclamation continues to carefully monitor hydrologic and operational conditions and assess the need for additional responsive actions and/or changes to operations.

State Water Project

Metropolitan imports water from the SWP, owned by the state of California and operated by the Department of Water Resources (DWR). This project transports Feather River water stored in and released from Lake Oroville and conveyed through the Sacramento – San Joaquin Delta, as well as unregulated flows diverted directly from the Delta south via the California Aqueduct to four delivery points – one from the Aqueduct's West Branch at the northwestern portion of Metropolitan's service area and three from the East Branch at the northeastern portion of Metropolitan's service area.

In 1960, Metropolitan signed a long-term water supply contract with DWR for participation in the SWP. Of the 29 State Water Project contractors, Metropolitan is the largest agency in terms of the number of people it serves (19 million), the share of SWP water that it is allocated pursuant to the State Water Contract (approximately 46 percent), and the percentage of total annual payments made to DWR (approximately 53 percent in 2020).

Per the State Water Contract, DWR updates the SWP Table A Allocation to the State Water Contractors periodically throughout the calendar year. An initial SWP Allocation is provided on December 1 of the preceding calendar year. The initial SWP Allocation is based on various factors, including projected reservoir storage levels, and takes a conservative approach by considering dry hydrologic conditions for the upcoming year.

Subsequently, the DWR continually monitors evolving hydrologic conditions, reservoir storage levels, regulatory obligations, and demands from State Water Contractors. Monthly assessments are conducted to evaluate DWR's ability to deliver SWP supplies. If warranted, adjustments to the SWP Allocation may be made to meet changing conditions.

DWR's monthly water supply assessments rely on Bulletin 120 data, which offer forecasts of snowmelt runoff and is updated monthly during the winter to spring timeframe. Additionally, automated snow sensors and physical snow surveys are conducted to verify snowpack and snow water content, which are factored into the comprehensive assessment.

A final update to the SWP Table A Allocation is typically provided in the spring, following the conclusion of the winter season. Metropolitan, under its long-term contract with DWR, receives its allotted share of available SWP water supplies. Metropolitan sometimes receives additional supplies through agreements with other State Water Contractors as well.

Dramatic swings in annual hydrologic conditions have impacted the availability of SWP supplies, especially during the past decade. 2014 saw the lowest allocation of contract supplies from the SWP up to that point, and 2015 saw the lowest ever Northern Sierra snowpack. Just two years later in 2017, the SWP watershed experienced the highest ever Sacramento River runoff, and the highest SWP allocation since 2006. Wet conditions returned in 2019, helping Metropolitan to build dry year storage reserves to record high levels. Record dry conditions returned in 2020 through 2022, with DWR providing allocations of only 20 percent, 5 percent, and 5 percent of total contract amounts in those years. Due to the unprecedented back-to-back dry years, in 2022 DWR invoked a contract provision for the first time ever, providing water to meet human health and safety needs in addition to the 5 percent contract amount for contractors with unmet human health and safety needs. Metropolitan received approximately 134,000 acre-feet of human health and safety supply in 2022.

Metropolitan is actively participating with the State Water Contractors to improve reliability of the State Water Project. This includes evaluation of the proposed Delta Conveyance Project that features two new state-of-the-art intakes with fish screens on the Sacramento River in the north Delta and a tunnel with a maximum diversion

capacity of 6,000 cubic feet per second that would move water below the Delta to the Bethany Reservoir at the start of the California Aqueduct. A tunnel minimizes impacts to the Delta community and provides greater seismic resilience than a canal, and the location of the intakes provides resiliency to a climate-changed future, as well as extreme sea level rise. The fish screens and operational criteria are designed to meet all regulatory protections for sensitive fish species and water quality in the Delta. The proposed project would allow for the capture of water supplies during particularly wet periods to be stored for use during dry periods. For Metropolitan, stored SWP supplies are able to offset drought on either the SWP or the Colorado River, and vice versa.

Other work includes participating with State, federal and local agencies to advance a transformational, watershed-wide approach to increase river flows, restore ecosystems and strengthen water supply reliability across the state. Proposed agreements would support healthy rivers and landscapes through the collaboration of numerous water agencies with the state and federal governments to pool resources and take actions to provide targeted river flows and expand habitat in the Sacramento and San Joaquin Rivers and Delta.

Another major project that Metropolitan is evaluating is the proposed Sites Reservoir, an off-river reservoir north of the Delta that will capture excess water from major storms and save it for drier periods, helping California's farms, businesses and cities continue to supply reliable water when other sources are low. Metropolitan is participating in the planning effort led by the Sites Project Authority.

Metropolitan uses a portfolio of storage and transfer programs south of the Delta to support the reliability of SWP supplies. A notable example is the new High Desert Water Bank, a partnership between Metropolitan and the Antelope Valley-East Kern Water Agency (AVEK), that allows Metropolitan to store up to 280,000 acre-feet of SWP supplies in the Antelope Valley groundwater basin. After three years of construction, the first stage of this critical new groundwater storage project is complete, and water is flowing into storage. The water bank significantly increases Metropolitan's total storage capacity along the SWP and allows Metropolitan to annually store and withdraw up to 70,000 acre-feet of water – enough to serve the annual needs of 210,000 Southern California homes. The partnership between Metropolitan and AVEK to build the High Desert Water Bank began in 2019. Metropolitan is funding the $211 million construction of the project on AVEK property, which was formerly farmland and vacant land. To date, AVEK has completed the construction of the stage 1 recharge basins, which are approximately 40 percent of the total recharge area; 10 recovery wells; five monitoring wells; and the turn-in/turn-out facilities from the California Aqueduct. AVEK is currently building the stage 2 recharge basins and over the next couple of years will construct 17 additional recovery wells for a total of 27 wells and an arsenic treatment facility. The project will be fully operational in 2027.

8.4.2 Drought Impact on Metropolitan's Infrastructure

Drought impacts Metropolitan's infrastructure in addition to water supply reliability. Treatment facilities designed to operate at a certain capacity can be impacted by reduced raw water supplies from the State Water Project or Colorado River Aqueduct, necessitating a change in operations for flow and water quality. Conveyance and distribution infrastructure and operations are impacted if water supplies moving through Metropolitan's system are reduced or increased from one imported source to adjust to lower supplies on the other. Reservoir operations and infrastructure may be impacted if stored water is used to offset shortages from other supplies. Lower flows through the system or lower storage in reservoirs may impact hydropower generation.

The recent drought and the impacts on SWP-dependent areas revealed a number of constraints in Metropolitan's conveyance and distribution system. The infrastructure constraints to deliver CRA and stored supplies to these six

agencies prompted Metropolitan's Board to authorize various projects to improve access, discussed in Section 8.4.3.

Metropolitan and its member agencies are currently engaged in a collaborative effort to identify additional infrastructure and supply projects that can improve reliability for the SWP-dependent areas. Further studies will evaluate other potential conveyance projects to move additional supply into the west side. Additionally, several Metropolitan member agencies made modifications within their own local systems to maximize the use of more readily available Colorado River water and Diamond Valley Lake supplies and to further reduce the use of scarce SWP supplies.

8.4.3 Drought Mitigation Action Portfolio

As described above, extreme drought between 2020 and 2022 resulted in the lowest cumulative 3-year total water supply allocation from the SWP. The low allocations required that Metropolitan and member agencies adjust operations and implement measures developed during the previous drought on the SWP, including Greg Avenue Pump Station, Diamond Valley Lake to Mills Treatment Plant, and the Operational Shift Cost Offset Program. These actions allowed Metropolitan to preserve water for areas in the system that are solely dependent on supplies from the SWP. Despite the efforts to conserve SWP supplies, in April 2022, Metropolitan's Board approved a resolution declaring a water shortage emergency within the SWP-dependent areas mandating conservation within those areas. Member agencies within the SWP-dependent areas include the Inland Empire Utilities Agency, Three Valleys Municipal Water District, and Upper San Gabriel Water District off the California Aqueduct East Branch, and the City of Los Angeles, Calleguas Municipal Water District, and Las Virgenes Municipal Water District off the California Aqueduct West Branch.

Prior to implementing the mandatory conservation, in November 2021, the Board adopted a resolution declaring a regional drought emergency and directing staff to implement measures to "ensure all portions of the service area attain a high level of reliability against multi-year, severe droughts, such as system improvements, local water supply development, new water storage opportunities, and water efficiency gains". This commitment was reaffirmed in August 2022 with a second resolution and call to action. The resolution noted that with its existing infrastructure Metropolitan cannot provide member agencies in the SWP-dependent area with full access to water supply and storage assets during severe droughts. To address this problem, the Board committed to the following actions:

> Metropolitan will reconfigure and expand its existing infrastructure portfolio—to provide sufficient access to the integrated system of water sources, conveyance and distribution, storage—and its programs to achieve equivalent levels of reliability to all member agencies.
>
> Identify a portfolio of projects and programs, in coordination with the member agencies, to address the problem statement in this resolution. The selected portfolio must include infrastructure improvements to deliver available water supplies to the SWP-dependent areas. The portfolio must also be balanced through new storage and supply programs and local supply development and management.

Adhering to the Board's direction, staff worked with the member agencies to develop a Drought Mitigation Action Portfolio. The portfolio includes system improvements to provide the SWP-dependent areas greater access to existing Colorado River and stored Diamond Valley Lake supplies, new supply opportunities, and options for increased storage.

The Drought Mitigation Action Portfolio was developed through a series of 11 workshops with the member agencies held between April 2022 and December 2023. Analysis conducted during the workshop process found

that enhanced system flexibility can improve supply reliability in the near-term; however, long-term reliability will require the development of additional supplies and storage to meet increased demand and offset deterioration of existing supplies due to climate change. The portfolio recommends projects for implementation to provide greater reliability to the SWP-dependent areas in the near-term that can be completed within the constraints of the existing system and identifies potential mid-term projects that can be implemented after removal of the system constraints through projects currently in development. The portfolio also provides alternative pathways to achieve long-term equitable reliability for the region through a balanced approach of system improvements, new storage and supply programs, and local supply development and management as directed by the Board. The recommended drought portfolio is divided into two categories: Category 1 – Cost Effective Projects for Timely Relief and Category 2 – Projects for Further Consideration.

Category 1 projects provide a baseline of improved reliability for the SWP-dependent areas via improved access to existing storage and Colorado River supplies. Category 1 projects are further divided into Projects Under Implementation and Projects Prepared for Implementation. Projects Under Implementation are those projects that have been previously approved by the Board and are in design or construction. Projects Prepared for Implementation are proposed for inclusion in the CIP so that more detailed studies or design work can commence.

Category 2, Projects for Further Consideration, have the potential to provide broader drought relief and offer region-wide benefits beyond SWP-dependent areas, but would require heavier investment and have higher implementation risks. These potential projects include options for new conveyance in Metropolitan's system to deliver existing and potential new supplies to the western SWP-dependent area, in-region and out-of-region storage, and opportunities for groundwater storage. Metropolitan plans to continue to develop these concepts and identify critical attributes, with further evaluation anticipated to take place in the Climate Adaptation Master Plan for Water (CAMP4W) process.

Projects

The final Drought Mitigation Action Portfolio provides timely drought relief to the SWP-dependent member agencies and a comprehensive and fiscally responsible approach to overall supply reliability. Projects in the portfolio include the following:

Cost-Effective Projects Providing Timely Relief

- Eastern State Water Project Dependent Area
  - **Diamond Valley Lake to Rialto Pipeline Interconnection** includes four projects that will enable Metropolitan to deliver up to 120 cubic feet per second of previously stored SWP from Diamond Valley Lake to the Rialto Pipeline utilizing the existing Wadsworth Pump Station and San Bernardino Valley Municipal Water District's Foothill Pump Station. The projects would also enable Metropolitan to deliver Colorado River supplies to the area if necessary.
  - **Three Valleys Municipal Water District Miramar Pumpback System Upgrades** will take treated water from the F. E. Weymouth Water Treatment Plant and deliver those supplies to the Miramar system through a series of pumps, offsetting the need for SWP deliveries from the Rialto Pipeline.
- Western State Water Project Dependent Area
  - **Sepulveda Feeder Pumping Project, Stage 1** will install two pump stations on the Sepulveda Feeder to allow for delivery of water from the Common Pool into the western SWP-dependent area. (More than 60 percent of Metropolitan's demand for supplemental treated water is located

in a region of the service area referred to as the "Central Pool." The Central Pool serves agencies entirely or partially in Los Angeles, Orange, and Ventura Counties. Three plants together jointly produce water for a common area of the Central Pool referred to as the "Common Pool.")

- **Service Connection B-5 to Service Connection B-5A Shift Project** will construct a pump station at the Valley Blending Facility to enable Burbank to blend water from the supply side of the Greg Avenue Pump Station enabling Metropolitan to deliver additional water from the Colorado River that is treated at the Weymouth plant to the West Branch SWP-dependent area.
- **Sepulveda Feeder Pumping Project, Stage 2** will expand the Sepulveda Feeder Pumping Project to an ultimate capacity of 160 cubic feet per second.

Projects for Further Consideration

- **Antelope Valley East Kern (AVEK) High Desert Water Bank to West Branch** will evaluate options to deliver High Desert Water Bank supplies to the West Branch along with options to increase the amount of storage beyond 280,000 acre-feet and the recovery beyond 70,000 acre-feet per year.
- **East Valley Feeder Parallel Pipeline** will evaluate increasing the conveyance capacity of treated water from the F.E. Weymouth Water Treatment Plant to the western SWP-dependent area.
- **East-West Raw Water Conveyance** will evaluate the feasibility of a new pipeline to convey up to 300 cubic feet per second of raw water upstream of the Jensen water treatment plan to the western SWP-dependent area.
- **New Surface Storage** continues analysis of potential locations for new surface storage in-region that can provide a direct benefit to the western SWP-dependent area as well as locations within the west San Joaquin Valley that can provide a benefit to the whole service area.
- **Flexible Storage** will identify opportunities to increase Metropolitan's storage capacity within existing SWP reservoirs.
- **Groundwater Storage** will evaluate groundwater storage opportunities including new or expanded groundwater banking programs, programs to augment local groundwater basins, and exchange of banked groundwater supplies that can provide additional SWP supplies to the SWP-dependent areas.
- **Recycled Water** will **e**valuate opportunities to enhance the potential for Metropolitan's Pure Water Southern California program to benefit the SWP-dependent areas and explore opportunities to integrate Los Angeles Department of Water and Power's reuse program Pure Water Los Angeles with Metropolitan's program.
- **Desalination** will identify the potential for development of additional potable water supplies through both brackish and seawater desalination.

Portfolio Implementation Strategy

Implementation of the Drought Mitigation Action Portfolio is designed to achieve immediate gains toward improved reliability for the SWP-dependent areas while allowing for a balanced and thorough analysis of potential pathways to achieve long-term equitable reliability for all member agencies. The near-term projects in the portfolio take advantage of existing system capacity and provide timely relief to the SWP-dependent areas by adding pumping facilities and interconnectivity. The next group of projects takes advantage of the planned upgrade of the existing system to expand the system capacity and deliver additional flow to the SWP-dependent areas by adding companion conveyance components. These projects can provide enhanced drought resilience in the mid-term to the SWP-dependent areas before long-term projects are in place to achieve overall supply reliability.

Drought Portfolio Nexus to CAMP4W

The increasing climatic variability and water supply uncertainty have prompted Metropolitan's Board to pursue the integration of climate and water resource planning with its financial plans. The Board charged the leadership and staff of Metropolitan to expand the focus of water resource and financial planning to include climate adaptation strategies and to develop a CAMP4W. The effort focuses on strengthening the resilience and reliability of Metropolitan and its individual member agencies in the face of a changing climate and the associated risks to our economic and environmental stability. As such, the information developed in the 2020 IRP Needs Assessment is a key input to the CAMP4W along with the ongoing Climate Vulnerability and Risk Assessment and Drought Portfolio. The outcome of this process is a collaborative decision-making process for setting investment plans to ensure the continued ability to fulfill Metropolitan's mission to provide the service area with adequate and reliable supply of high-quality water.

The IRP identified the risk to the SWP-dependent agencies from extended drought on the SWP system. The Drought Portfolio provides the CAMP4W with the building blocks to develop solutions to mitigate that risk. The Category 1 projects (Cost Effective Projects for Timely Relief) inform the CAMP4W process by applying them as existing system components in simulation models to quantify the demand/supply gaps under the different IRP scenarios. The Category 2 projects (Projects for Further Consideration) require greater time and investment for implementation and demand a thorough and collaborative assessment of their effectiveness, benefits, and risks. It is not expected that all projects identified within the drought mitigation action portfolio will be included in the recommended CAMP4W strategy. However, the recommended CAMP4W strategy is expected to meet the supply reliability needs of the SWP-dependent areas. Implementation of different Category 2 projects will be simulated within the IRP analysis so that the CAMP4W team can assess the effectiveness of the different projects in mitigating the long-term supply and demand gaps. This process will allow for a thorough evaluation considering both risk and reward of future investments and apply the adaptive management framework to adjust the implementation plan of drought mitigation actions based on changing conditions.

8.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands; this planning considers drought risks on imported and local water supplies.

8.6 CLIMATE CHANGE

Climate change will have a significant effect on Metropolitan's exposure to the drought hazard, necessitating investments in water supplies, infrastructure and demand management. The region's ability to continue to effectively manage surplus water during wet years to quickly recover from dry conditions will prove vital for managing through future droughts. The analysis conducted for the IRP Needs Assessment, adopted in April 2022, revealed important insights and constraints that will be addressed under the CAMP4W process. Imported supplies remain essential as core supplies to the region. They are a valuable legacy of decades of planning and investment. As source waters, they provide good water quality and supply benefits that, once lost, are very difficult to replace. Metropolitan's core supplies from the Colorado River Aqueduct are generally less susceptible to volatility from

year-to-year hydrologic conditions than Metropolitan's core supplies from the SWP. However, all of the region's imported supplies face significant threats from various drivers of uncertainty, including climate change.

Metropolitan will continue to conduct long-range planning, actively manage resources and adapt its management and operational practices to changing conditions.

8.7 ISSUES

Important issues associated with drought include the following:

- Enhanced system flexibility can improve supply reliability in the near-term; however, long-term reliability will require the development of additional supplies and storage to meet increased demand and offset deterioration of existing supplies due to climate change.
- Vulnerabilities in the SWP-dependent areas are more severe given reduced reliability of SWP supplies and Metropolitan distribution system constraints. Greater access to existing core supplies can also increase SWP-dependent area reliability.
- Storage capacity, put/take capabilities, and accessibility are critical considerations in maintaining reliability under the region's current and future conditions.
- Expanding existing or developing new storage programs and investments in Metropolitan's distribution system can reduce the need for new core supply development to meet potential future shortages and adapt to climate change.
- Metropolitan's future supply reliability may fluctuate based on demand increases and decreases. Variability in retail demand largely comes from changes in outdoor water use. Outdoor water use behavior is complex, influenced by weather and climate and by awareness of water scarcity and other conservation measures.
- Existing imported supplies are at risk from various drivers of uncertainty. SWP supplies are highly susceptible to varying hydrologic conditions, climate change, and regulatory restrictions. Variability and capacity in SWP supplies provide opportunities to store water during wet periods for use in dry years. Metropolitan's ability to distribute or store SWP supplies when they materialize will enhance the region's reliability, particularly the SWP-dependent areas.
- The Colorado River system and Colorado River Aqueduct capacity do not offer the same opportunities concerning SWP storage. Shortages on the Colorado River will limit the reliability of Colorado River Aqueduct deliveries as a core supply in the future. A multi-party agreement is needed to address continuing shortages on the Colorado River.
- Maintaining existing and developing new local supplies and conservation are critical in helping manage demands on Metropolitan.

9. EARTHQUAKE

9.1 GENERAL BACKGROUND

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

California is seismically active because of movement of the North American Plate, on which everything east of the San Andreas Fault sits, and the Pacific Plate, which includes coast communities west of the fault. The planning area is mostly on the Pacific Plate, which is constantly moving northwest past the North American Plate, at a relative rate of movement of about 2 inches per year. However, Metropolitan's Colorado River supply and State Water Project supply both utilize infrastructure that must cross the San Andreas Fault zone before reaching Metropolitan's service area.

Geologists have found that earthquakes tend to reoccur along faults, which are zones of weakness in the earth's crust. The stress in a fault zone is not guaranteed to be released after an earthquake. Another earthquake could still occur. In fact, relieving stress on one part of a fault may increase the stress in another part.

Active faults have experienced displacement in historical time. However, inactive faults, where no such displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville (Nevada County), California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause movement along currently inactive fault systems.

9.1.1 Earthquake Classifications

Earthquakes are typically classified in one of two ways: by the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (M_w), the most common scale used today (USGS

n.d.). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved, and the force required to move it). The scale is as follows:

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

Intensity

The most used intensity scale is the modified Mercalli intensity scale. Ratings of the scale as well as the perceived shaking and damage potential for structures are shown in Table 9-1. The modified Mercalli intensity scale is generally represented visually using ShakeMaps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A ShakeMap shows the variation of ground shaking in a region immediately following significant earthquakes (USGS 2023).

Table 9-1. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% – 1.4%
IV	Light	None	None	1.4% – 3.9%
V	Moderate	Very Light	Light	3.9% – 9.2%
VI	Strong	Light	Moderate	9.2% – 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% – 34%
VIII	Severe	Moderate/Heavy	Heavy	34% – 65%
IX	Violent	Heavy	Very Heavy	65% – 124%
X – XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA measured in percent of g, where g is the acceleration of gravity
Sources: (USGS 2023)

9.1.2 Ground Motion

An earthquake hazard assessment is also based on expected ground motion. During an earthquake when the ground is shaking, the ground also experiences acceleration. The peak acceleration is the largest rate of increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground accelerations (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in multiples of "g" (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code and the California State Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g., single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (e.g., apartment buildings, factories, high-rises, bridges).

9.1.3 Liquefaction and Soil Types

Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Pipelines may experience damage due to ground deformations beyond what the pipeline material can withstand.

Liquefaction maps available through state and federal agencies identify as either liquifiable or not liquefiable based on soil type. In 2019, Metropolitan developed a report that resulted in a set of liquefaction maps for its conveyance and distribution system to provide more granularity to the service area's susceptibility to liquefaction. The report, Liquefaction Susceptibility Mapping for the Metropolitan Water District of Southern California's Feeder System, provides 5 different classifications for liquefaction susceptibility: Very Low, Low, Medium, High, Very High. The maps were developed using geologic deposit maps, historical groundwater data, and historical occurrences of liquefaction. Two maps were created. The first map considers the historical high groundwater table using multiple sets of well data with some data dating back to 1904. The second map considers more recent high groundwater levels between 1999 and 2019.

9.1.4 USGS Earthquake Mapping Programs

ShakeMaps

The USGS Earthquake Hazards Program produces maps called ShakeMaps that map ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking caused by the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. A ShakeMap shows the extent and variation of ground shaking immediately across the surrounding region following significant earthquakes. Such mapping is derived from peak ground motion amplitudes recorded on seismic sensors, with interpolation where data are lacking based on estimated amplitudes. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. In addition to the maps of recorded events, the USGS creates the following:

- Scenario ShakeMaps of hypothetical earthquakes of an assumed magnitude on known faults
- Probabilistic ShakeMaps, based on predicted shaking from all possible earthquakes over a 10,000-year period. In a probabilistic map, information from millions of scenario maps is combined to make a forecast for the future. The maps indicate the ground motion at any given point that has a given probability of being exceeded in a given timeframe, such as a 100-year (1-percent-annual chance) event.

National Seismic Hazard Map

National probabilistic maps of earthquake shaking hazards have been produced since 1948. The USGS last updated its National Seismic Hazard Maps in 2018, incorporating the best available seismic, geologic, and geodetic information on earthquake rates and associated ground shaking. The map produced for this update include maps of the PGA expected at various probability levels of different NEHRP soil types. Figure 9-1 shows the peak ground acceleration with 10 percent probability of exceedance in 50 years. This level of ground shaking has been used for designing buildings in high seismic areas.

Source: USGS, 2021

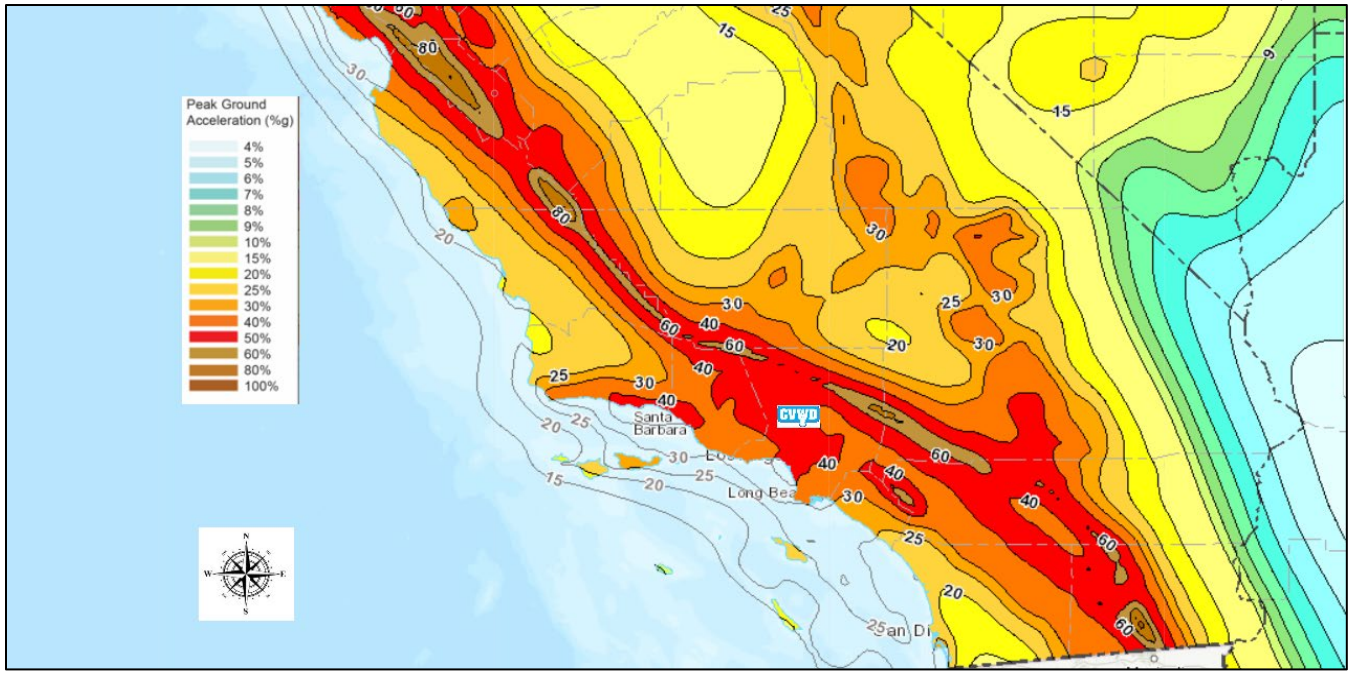


Figure 9-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years in Southern California

The National Seismic Hazard Maps integrate lessons learned by scientists about earthquake sources, crustal deformation, active faulting, and ground shaking. This information is translated into a form that can be used to reduce the risk from earthquakes and to improve public safety. The resulting seismic hazard maps are improved and updated on a periodic basis by incorporating new information. The USGS maps are the basis for seismic provisions in building codes and for risk models used in insurance rate structures. An integral part of this project is a database describing Quaternary faults and digital maps of those faults for the U.S. and its territories (USGS 2022).

9.1.5 Secondary Hazards

Earthquakes can cause large and sometimes disastrous landslides. River valleys are vulnerable to slope failure, often because of loss of cohesion in clay-rich soils. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes.

Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. Fires may be difficult to control if the water lines feeding fire hydrants are also broken.

9.2 HAZARD PROFILE

9.2.1 Past Events

Metropolitan Water District's service counties have been included in four FEMA major disaster declarations for earthquakes: the 1994 Northridge Earthquake (DR-1008); the 1992 Landers and Big Bear Earthquakes (DR-947); the 1987 Whittier Narrows earthquake (DR-799); and the 1971 San Fernando earthquake (DR-299). Table 9-2 lists earthquakes of magnitude 5.0 or greater within a 100-mile radius of the planning area.

Table 9-2. Earthquakes Magnitude 5.0 or Larger Within Southern California

Date	Magnitude	Epicenter Location
04/14/2025 Julian Earthquake	5.2	3 miles south of Julian, CA
08/20/2023 Ojai Earthquake	5.1	4 miles southeast of Ojai, CA
06/05/2021 Calipatria Earthquake	5.3	7 miles west of Calipatria, CA
07/2019 Ridgecrest Sequence	6.4 and 7.1	Ridgecrest, CA
07/29/2008 Chino Hills Earthquake	5.4	2 miles southwest of Chino Hills, CA
10/16/1999 Running Springs Earthquake	5.6	4 miles east northeast of Running Springs, CA
01/17/1994 Simi Valley Earthquake	5.0	4 miles north northeast of Simi Valley, CA
01/17/1994 Granada Hills Earthquake	5.9	Half-mile east northeast of Granada Hills, CA
01/17/1994 Northridge Earthquake	6.7	1 mile south-southwest of Northridge
06/29/1992 Yucca Valley Earthquake	5.7	2 miles east southeast of Yucca Valley, CA
06/28/1992 Big Bear City Earthquake	6.3	4 miles south southeast of Big Bear City, CA
06/28/1992 Big Bear Lake Earthquake	5.5	7 miles south southeast of Big Bear Lake, CA
06/28/1992 Joshua Tree Earthquake	5.7	1 mile south southwest of Joshua Tree, CA
06/28/1992 Yucca Valley Earthquake	5.8	2 miles northeast of Yucca Valley, CA
06/28/1992 Landers Earthquake	7.3	In Landers, 4 miles from Fontana, CA
04/23/1992 Thousand Palms Earthquake	6.1	11 miles north northeast of Thousand Palms, CA
06/28/1991 Sierra Madre Earthquake	5.8	8 miles north northeast of Sierra Madre, CA
02/28/1990 Claremont Earthquake	5.5	4 miles north northeast of Claremont, CA
10/01/1987 Rosemead (aka Whittier Narrows) Earthquake	5.9	1 mile south southwest of Rosemead, CA
07/08/1986 Morongo Valley Earthquake	6.0	4 miles south southwest of Morongo Valley, CA
02/09/1971 Agua Dulce Sequence	6.6, 5.8, 5.8	6 miles south southwest of Agua Dulce, CA
12/26/1951 San Clemente Island Earthquake	5.8	7 miles north northeast of San Clemente Island, CA
12/04/1948 Desert Hot Springs Earthquake	6.0	10 miles east of Desert Hot Springs, CA
03/25/1937 Oasis Earthquake	6.0	10 miles west southwest of Oasis, CA
3/10/1933 Long Beach Earthquake	6.4	3 miles south of Huntington Beach, CA
02/18/1926 Channel Islands Earthquake	5.5	3 miles from Santa Cruz Island, CA
07/23/1923 Los Angeles Earthquake	6.0	3 miles north of Loma Linda, CA

Source: (SCEDC 2025)

The most recent damaging earthquake affecting Southern California was the Ridgecrest event, which included one strong earthquake (M6.4, July 4, 2019) and one major earthquake (M7.1 July 5, 2019). Maximum shaking was estimated to be MMI IX (violent) at the epicenter and MMI VII (very strong) over a surrounding region that included the city of Ridgecrest, which has a population of 28,000. Shaking was widely felt throughout California, including light to moderate ground shaking in Los Angeles and weak shaking in the San Francisco Bay Area (Berkeley Seismology Lab 2019). Damage estimates for the Ridgecrest earthquakes exceeded $1 billion according to the U.S. Geological Survey. Long stretches of Highway 178 were visibly cracked (CEA 2019).

Prior to the Ridgecrest event, the most recent damaging earthquake event affecting Southern California was the 1994 Northridge Earthquake. At 4:31 a.m. on January 17, a moderate but very damaging earthquake with a magnitude of 6.7 struck the San Fernando Valley. In the following days and weeks, thousands of aftershocks occurred, causing additional damage to affected structures. Fifty-seven people were killed, and more than 1,500 people seriously injured. For days afterward, thousands of homes and businesses were without electricity, tens of thousands had no gas, and nearly 50,000 had little or no water.

Approximately 15,000 structures were moderately to severely damaged, which left thousands of people temporarily homeless. Of 66,500 buildings inspected, nearly 4,000 were severely damaged and over 11,000 were moderately damaged. Several collapsed bridges and overpasses created commuter havoc on the freeway system. Extensive damage was caused by ground shaking, and earthquake-triggered liquefaction and dozens of fires caused additional severe damage. This extremely strong ground motion resulted in record economic losses.

9.2.2 Location

Faults

Earthquakes are considered a major threat to Metropolitan due to the numerous faults zones that cross the planning area, notably including the San Andreas Fault Zone and the San Jacinto Fault Zone. A significant earthquake along one of these major fault zones could cause damage to buildings, pipelines, or other of Metropolitan's critical water delivery infrastructure. Beyond Metropolitan assets, a significant earthquake could cause substantial casualties, extensive damage to buildings, roads and bridges, fires, and other threats to life and property. The effects could be aggravated by aftershocks and by secondary effects such as fire, landslide, and dam failure. A major earthquake could be catastrophic in its effect on the population and could exceed the response capability of the local communities and even the state.

Figure 9-2 shows the major faults zones in the planning area. Major faults that could affect the planning area include the San Andreas Fault, the San Jacinto Fault, the Elsinore Fault, the Whittier Fault, and the Newport-Inglewood Fault, among others. Information on these and other fault zones capable of generating large earthquakes within the planning area is provided in the following sections.

San Andreas Fault Zone

The San Andreas Fault is a continental transform fault that extends roughly 1,200 kilometers through California. It forms the tectonic boundary between the Pacific Plate and the North American Plate, and its motion is right-lateral strike-slip (horizontal). The fault divides into three segments, each with different characteristics and a different degree of earthquake risk (Caltech n.d.). The southern segment, which stretches from Parkfield in Monterey County all the way to the Salton Sea, is capable of an 8.1-magnitude earthquake. At its closest, this fault passes about 35 miles to the northeast of Los Angeles. Such a large earthquake on this southern segment would likely result in the deaths of thousands of people in Los Angeles, San Bernardino, Riverside, and surrounding areas, and cause hundreds of billions of dollars in damage (Lin II 2010).

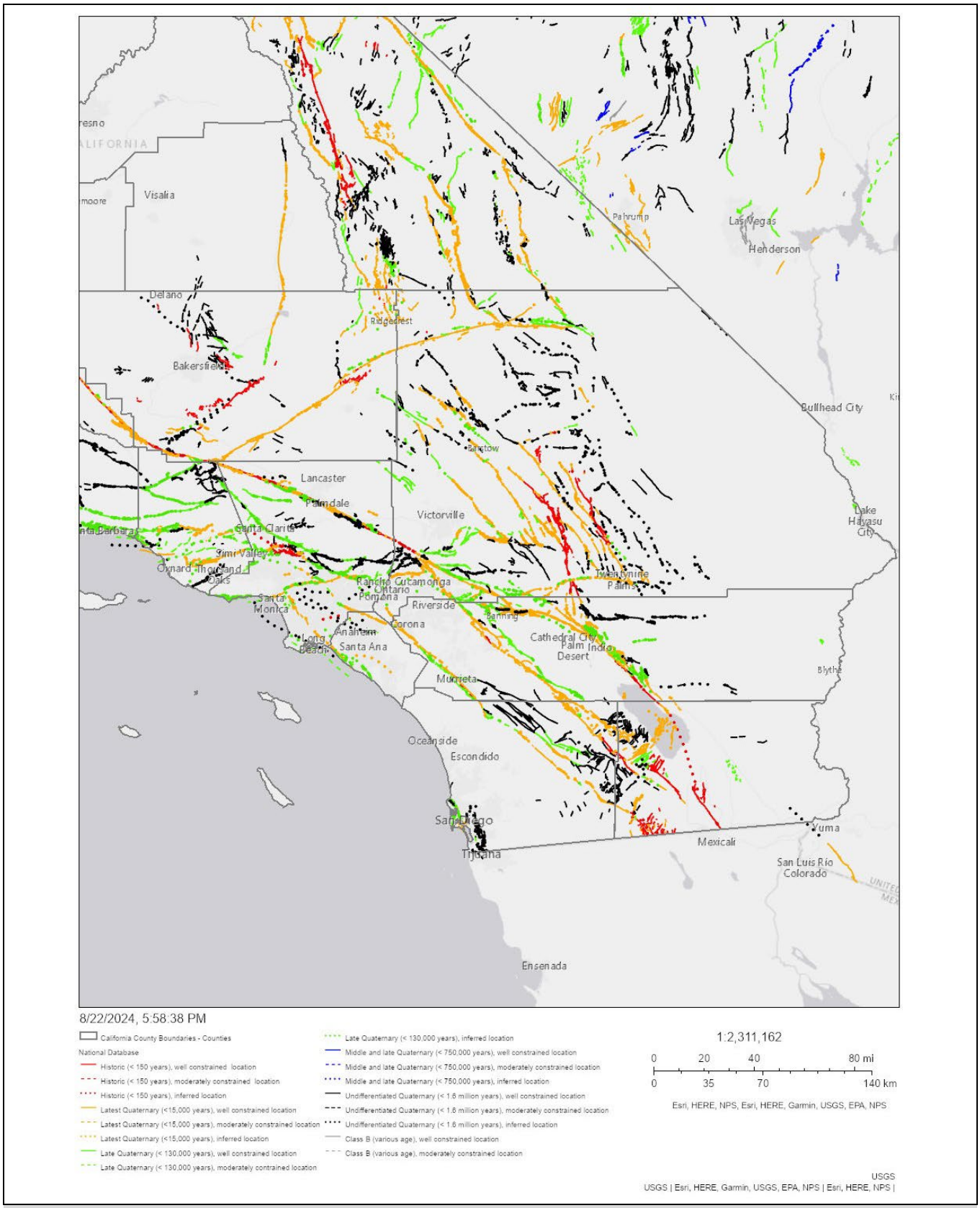


Figure 9-2. Earthquake Fault Zones in Southern California

San Jacinto Fault Zone

The San Jacinto Fault Zone is a major strike-slip fault zone that runs through San Bernardino, Riverside, San Diego, and Imperial Counties in Southern California. The San Jacinto Fault Zone is a component of the larger San Andreas transform system and is considered to be the most seismically active fault zone in the area. Together they relieve the majority of the stress between the Pacific and North American tectonic plates (Yeats 2012). This fault zone consists of many individual fault segments, some of which have only been individualized as recently as the 1980s, but activity along the line of faults has been documented since the 1890s. One segment of the San Jacinto Fault Zone, the Anza seismic gap, has not experienced any major activity since instrumental records have been kept. Each segment was evaluated for its seismic risk and was assigned a probability for the occurrence of a large rupture for the 30-year period starting in 1995 (Working Group on California Earthquake Probabilities 1995).

Elsinore Fault

The Elsinore fault zone, not including Whittier, Chino, and Laguna Salada faults, is 180 kilometers long with a slip-rate of 4.0 millimeters/year. It is estimated that this zone is capable of producing a quake of M6.5 to M7.5. The projected interval between major rupture events is 250 years. The last major rupture event on the main Elsinore fault was in 1910 with a M6 earthquake centered just northwest of the city of Lake Elsinore (Southern California Earthquake Data Center n.d.).

Whittier Fault

The Whittier Fault is a 25-mile right-lateral strike-slip fault that runs along the Chino Hills range between the cities of Chino Hills and Whittier. The fault has a slip rate of 2.5 to 3.0 millimeters per year. It is estimated that this fault could generate a quake of M6.0 to M7.2 on the moment magnitude scale (Southern California Earthquake Data Center n.d.).

Newport-Inglewood Fault

The Newport–Inglewood Fault is a right-lateral strike-slip fault in Southern California. The fault extends for 47 miles from Culver City southeast through Inglewood and other coastal communities to Newport Beach at which point the fault extends east-southeast into the Pacific Ocean where it is known as the Rose Canyon Fault. The fault can be inferred on the Earth's surface as passing along and through a line of hills extending from Signal Hill to Culver City. The fault has a slip rate of approximately 0.6 mm (0.024 in) per year and is predicted to be capable of a 6.0- to 7.4-magnitude earthquake on the moment magnitude scale (Southern California Earthquake Data Center n.d.). A 2017 study concluded that, together, the Newport–Inglewood Fault and Rose Canyon Fault could produce an earthquake of 7.3 or 7.4 magnitude (Associated Press 2017).

Sierra Madre and Cucamonga Fault Zone

The Sierra Madre Fault Zone is a reverse fault in Southern California. The fault is approximately 34 miles long and is located near the communities of Sunland, Altadena, Sierra Madre, Monrovia, Duarte, and Glendora. The fault has a slip rate of between 0.36 and 4 mm per year and is projected to be capable of a 6.0 to 7.0 M earthquake (CalTech 2023). The eastern continuation of this Sierra Madre Fault Zone is the Cucamonga Fault Zone, which is a thrust fault. The Cucamonga Fault Zone runs near the communities of Claremont, Upland, and Rancho Cucamonga with a slip rate of between 5 and 14 mm per year. This fault zone is much more active than the Sierra Madre and is projected to be capable of producing a 6.0 to 7.0 M earthquake if triggered.

Compton Fault

The Compton Fault is a blind thrust fault running through the City of Carson. This fault has an estimated slip rate of 0.2 to 1.0 mm per year and poses a significant threat to urban Los Angeles. Research is pending to determine if this fault remains active (USGS 2017).

Puente Hills Fault

The Puente Hills Fault is a blind thrust fault running from Orange County to Los Angeles. This fault is projected to be capable of producing earthquakes between 7.2 to 7.5 M. Recent studies have indicated that this fault demonstrated an accelerating slip rate, which was recorded at roughly 1.33 mm per year as of most recent data (USGS 2017). This increase in slip rate indicates that the potential magnitude of an earthquake caused by the Puente Hills Fault has likely increased significantly over time.

Susceptible Areas

Due to the expansiveness of the planning area, the intensity of an earthquake will vary significantly across Metropolitan's system. Impacts to facilities can vary based on local soil characteristics, and distance from the earthquake source. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. NEHRP soil classifications in the planning area relative to the water system facilities are shown on Figure 9-3. Risk is similarly increased in areas of mapped liquefaction susceptibility. Metropolitan recently completed a liquefaction susceptibility study which mapped its service area into five categories of liquefaction susceptibility from very high to very low based on soil type and groundwater depth. These respective areas are shown relative to the water system facilities on Figure 9-4.

9.2.3 Frequency

California experiences hundreds of earthquakes each year, most with minimal damage and magnitudes below 3.0. Earthquakes that cause moderate damage to structures occur several times a year. According to the USGS, a strong earthquake measuring greater than 5.0 occurs every two to three years and major earthquakes of more than 7.0 occur once a decade. The State Hazard Mitigation Plan indicates that in the next 30 years there is over a 99 percent probability of a magnitude 6.7 earthquake in California and a 94 percent probability of a magnitude 7.0 earthquake.

The Uniform California Earthquake Rupture Forecast, Version 3 predicts the probability of an earthquake of magnitude 6.7 or greater over the next 30 years as shown in Figure 9-5.

9.2.4 Severity

Potential Earthquake Intensity in the Planning Area

USGS probabilistic mapping is an indication of potential earthquake intensity in an area. Figure 9-1 shows the intensity with a 10-percent exceedance chance in 50 years in Southern California. For the Metropolitan service area, this PGA is in the ranges from of 0.2 g to 1.0 g.

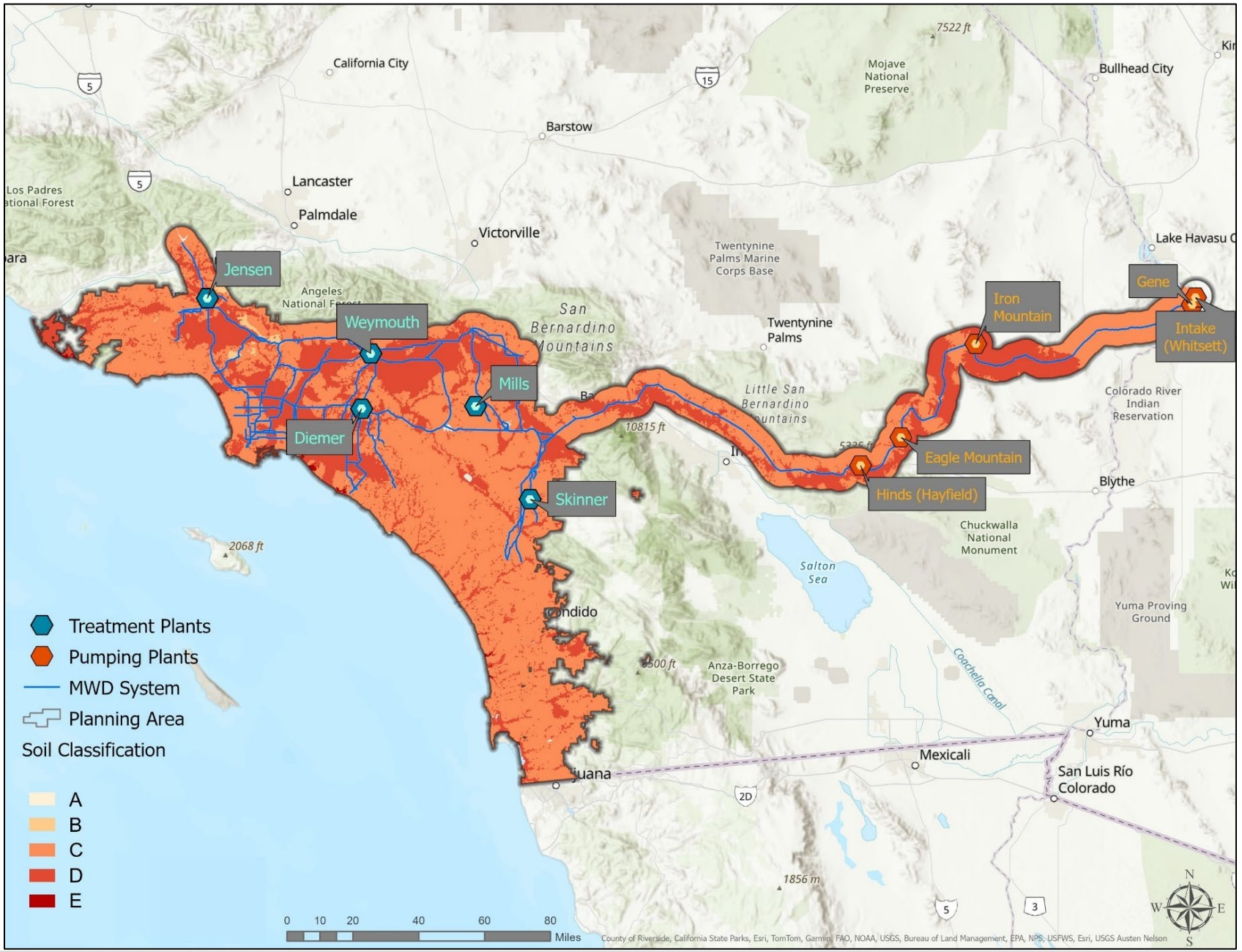


Figure 9-3. Planning Area NEHRP Soil Class

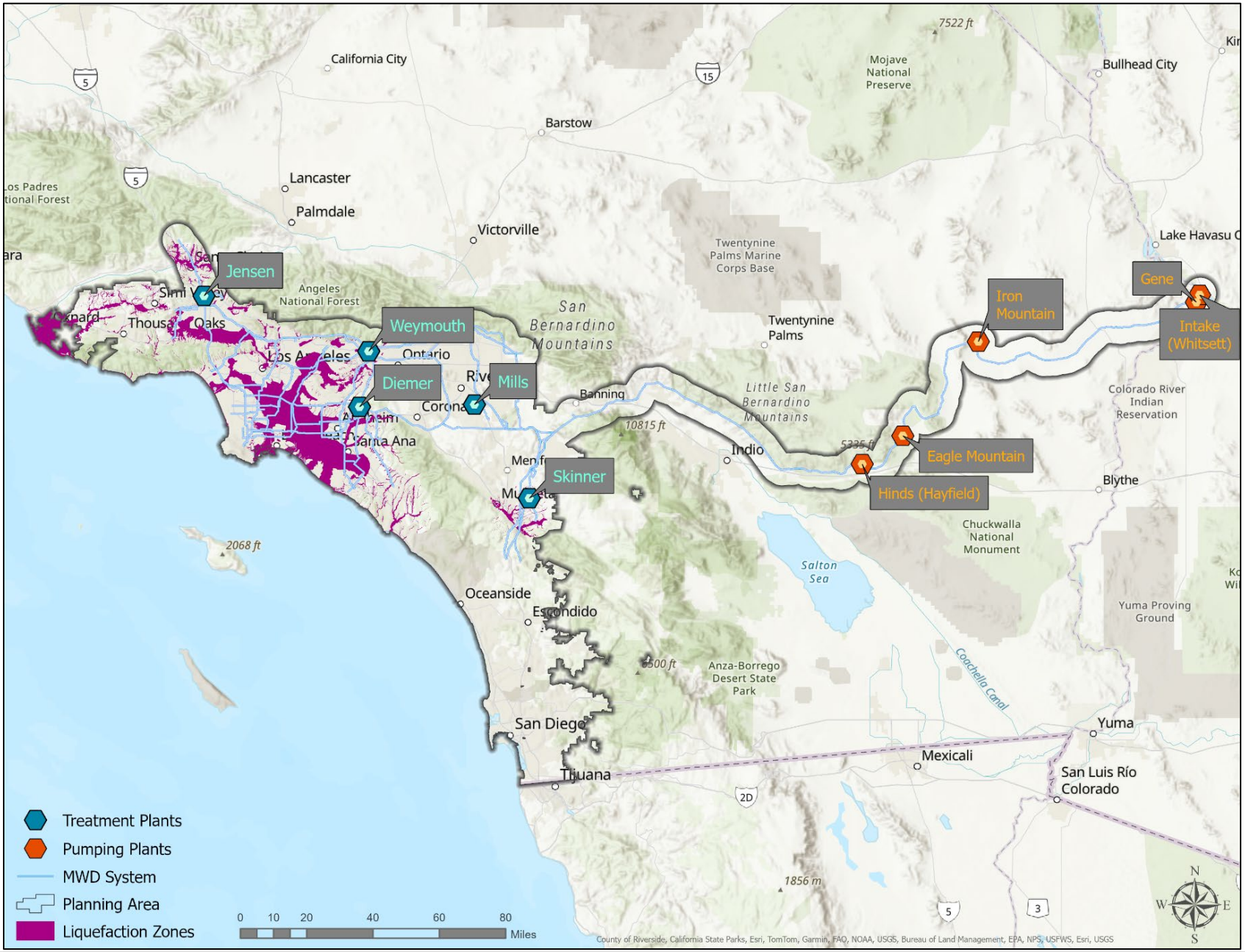


Figure 9-4. Planning Area Liquefaction Zones

Source: (WGCEP 2021)

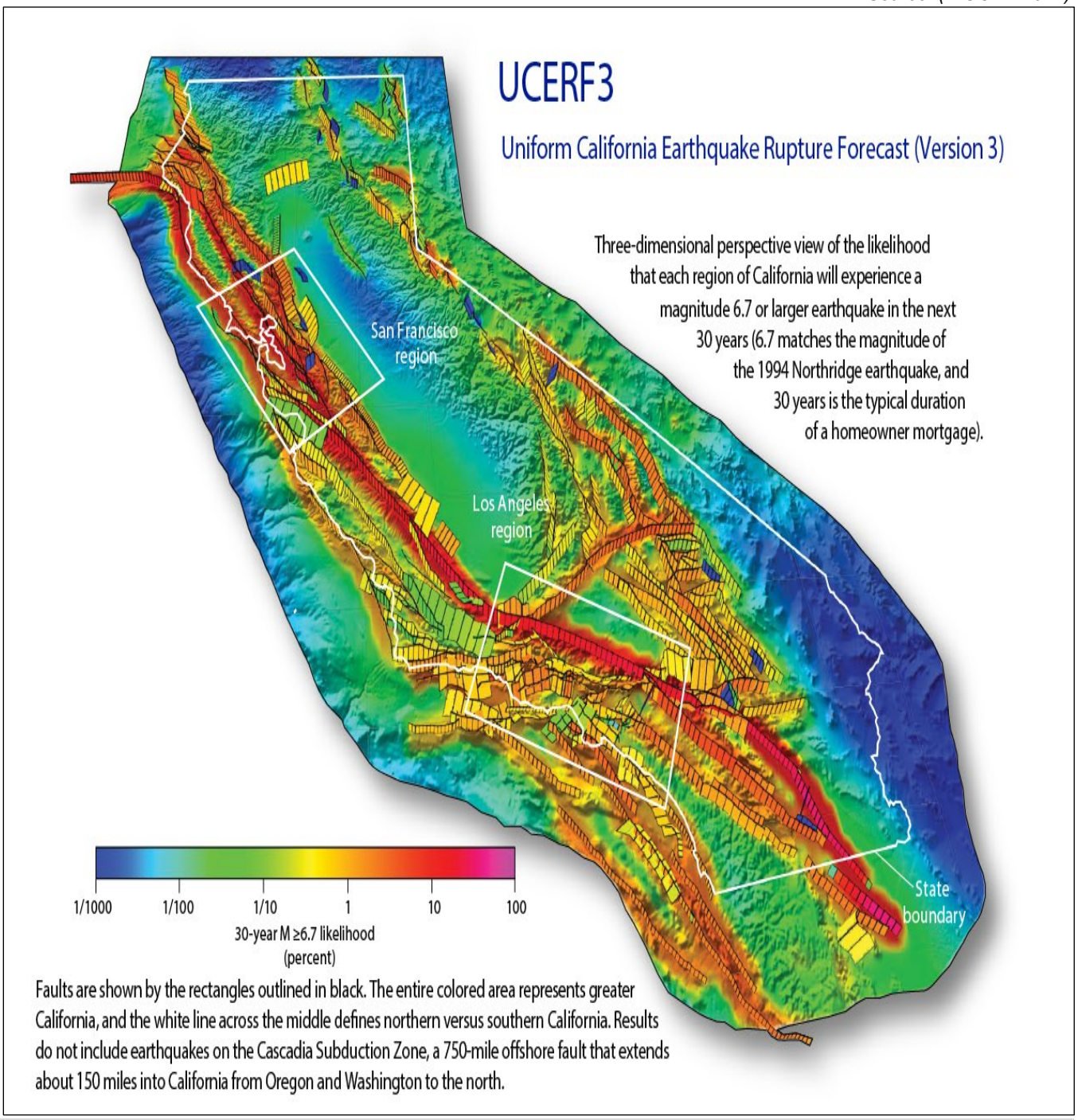


Figure 9-5. Uniform California Earthquake Rupture Forecast for Magnitude 6.7 or Larger Earthquake in the Next 30 Years

With the abundance of fault exposure in southern California, the potential scenarios for earthquake activity are many. Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the planning area. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation.

Potential Damage

Earthquakes can last from a few seconds to over five minutes; they may also occur as a series of tremors over several days. The actual movement of the ground in an earthquake is seldom the direct cause of injury or death. Casualties generally result from falling objects and debris as the shocks shake buildings and other structures. Soil liquefaction can undermine building and road foundations.

Earthquakes of magnitude 6.0 or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts, or gravelly soils.

Disruption of communications, electrical power supplies and gas, sewer and water lines should be expected. Earthquakes may trigger fires, dam failures, landslides, or releases of hazardous material, compounding their disastrous effects. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people.

The severity of a seismic event is directly correlated to the stability of the ground close to the event's epicenter. A poorly built structure on a stable site is far more likely to survive a large earthquake than a well-built structure on an unstable site. Thorough geotechnical site evaluations should be the rule of thumb for new construction in the planning area until creditable soils mapping becomes available.

Metropolitan Water District Seismic Resilience Strategy

Beginning January 2020, all Urban Water Management Plans must include a seismic risk assessment and mitigation plan to assess the vulnerability of each of the various facilities of a water system and mitigate those vulnerabilities. For Metropolitan, the required assessment and plan are accomplished as part of its resilience strategy and are presented in detail in its seismic resiliency reports. Metropolitan's Seismic Resilience Strategy has three primary objectives:

- Provide a diversified water supply portfolio, system flexibility, and emergency storage.
- Prevent damage to water delivery infrastructure in probable seismic events and limit damage in extreme events.
- Minimize water delivery interruptions through dedicated emergency response and business continuity plans.

Metropolitan's Seismic Resilience Strategy is implemented through four components that encompass the various internal functions that promote Metropolitan's seismic resilience objectives.

- **Planning** – Developing and maintaining a diversified water portfolio, system flexibility, and emergency supplies.
- **Engineering** – Evaluation and mitigation of seismic risks of infrastructure and the water system as a whole.
- **Operations** – Maintain effective emergency planning and response capabilities.
- **Reporting** – Increase accountability and transparency of seismic resilience programs.

In addition to the activities conducted under the seismic resilience components, Metropolitan is part of the Seismic Resilient Water Supply Task Force. The task force is a collaboration between Metropolitan, the California Department of Water Resources, and the Los Angeles Department of Water and Power to improve the seismic resilience and coordinate emergency response for the region's imported water supply aqueducts. Figure 9-6 provides a summary of the activities that support Metropolitan's Seismic Resilience Strategy. Additional information on Metropolitan's Seismic Resilience Strategy can be found in Seismic Resilience Report (Metropolitan Water District of Southern California 2021).

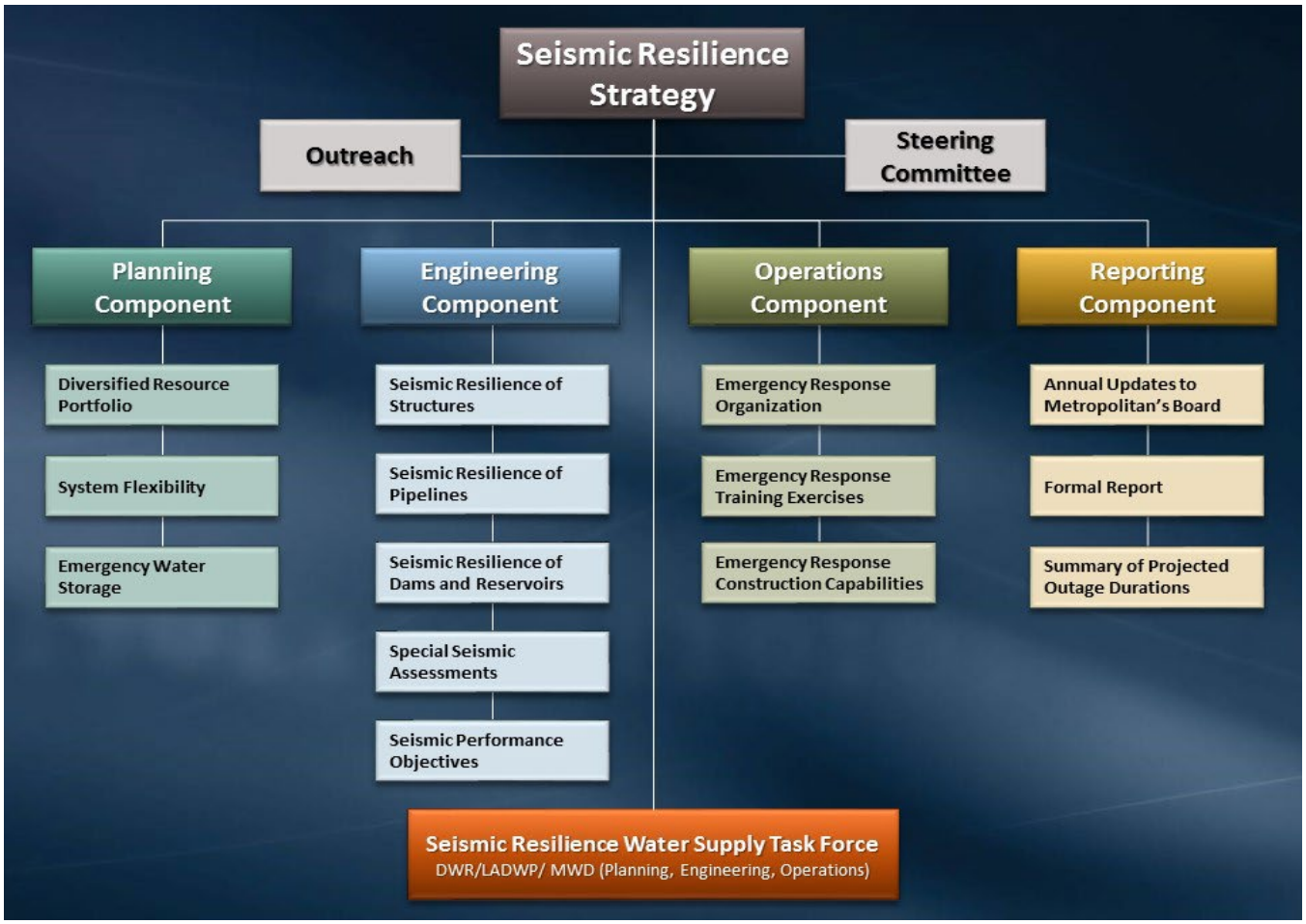


Figure 9-6. Metropolitan's Seismic Resilience Strategy

9.2.5 Warning Time

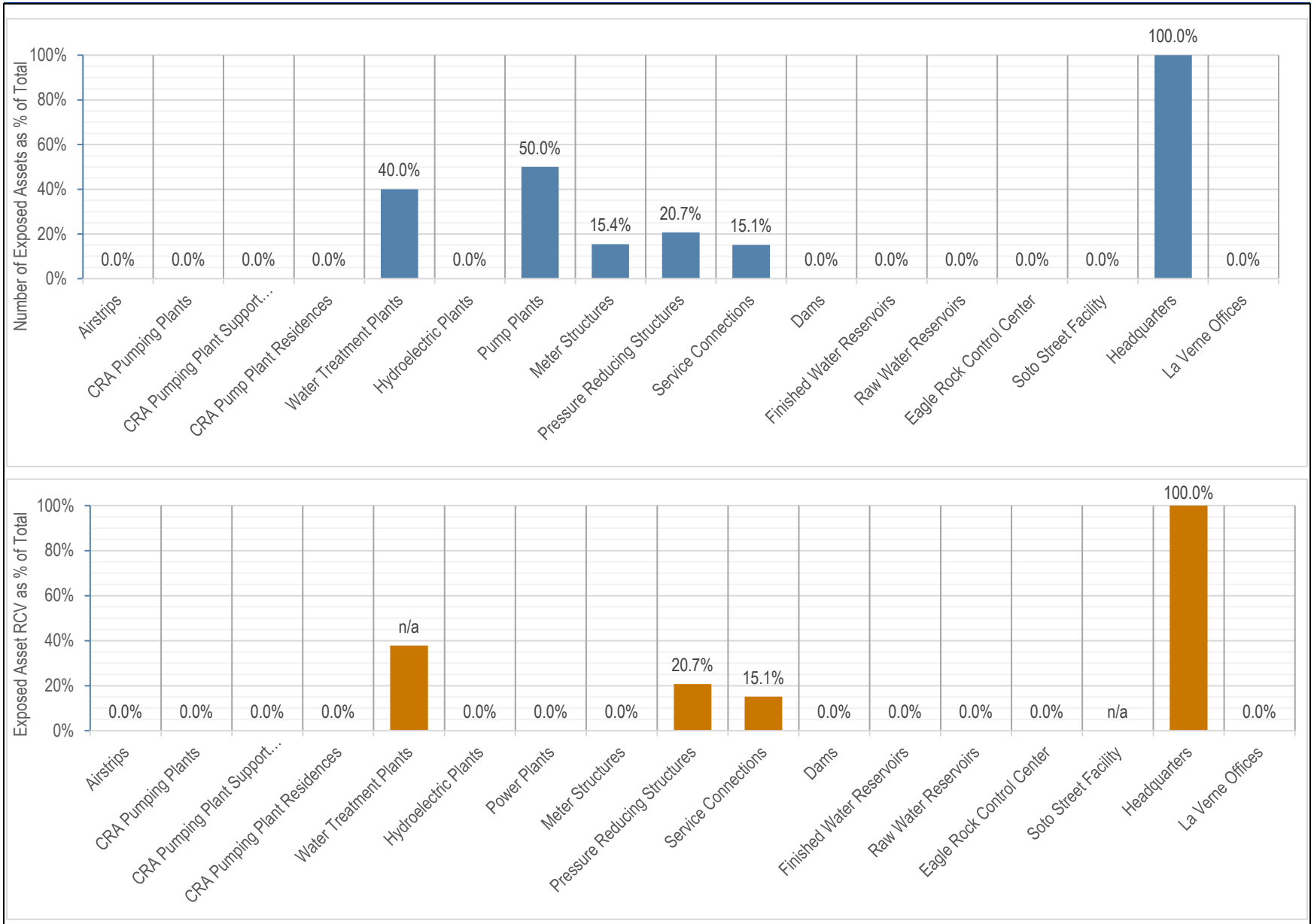
There is no current reliable way to predict the day or month that an earthquake will occur at any given location. Southern California residents are being encouraged to download MyShake, the new statewide cell phone app from Earthquake Early Warning California that is powered by ShakeAlert and builds on lessons learned from the City of Los Angeles's two-year ShakeAlert pilot to deliver earthquake early warning alerts to people across Los Angeles County. The MyShake app—developed by the University at California Berkeley Seismology Lab, sponsored by the State of California Office of Emergency Services—is the first app powered by ShakeAlert® to provide statewide earthquake early warning alerts. The app is one of the delivery modes of the California Earthquake Early Warning System. MyShake is available in both English and Spanish.

9.3 EXPOSURE

The risk assessment for earthquake evaluated Metropolitan above-ground assets that lie within three areas of potential seismic hazard: liquefaction susceptibility areas, NEHRP Class D and E soil areas, and CGS earthquake shaking potential areas (see Figure 9-3 and Figure 9-4). Table 9-3 and 9-4 summarize the number of assets by category within these mapped hazard areas and the total replacement cost value of those assets. Details by type of facility are included in Appendix D. These results are shown as the percent of planning area totals for each asset type in Figure 9-7 through Figure 9-9.

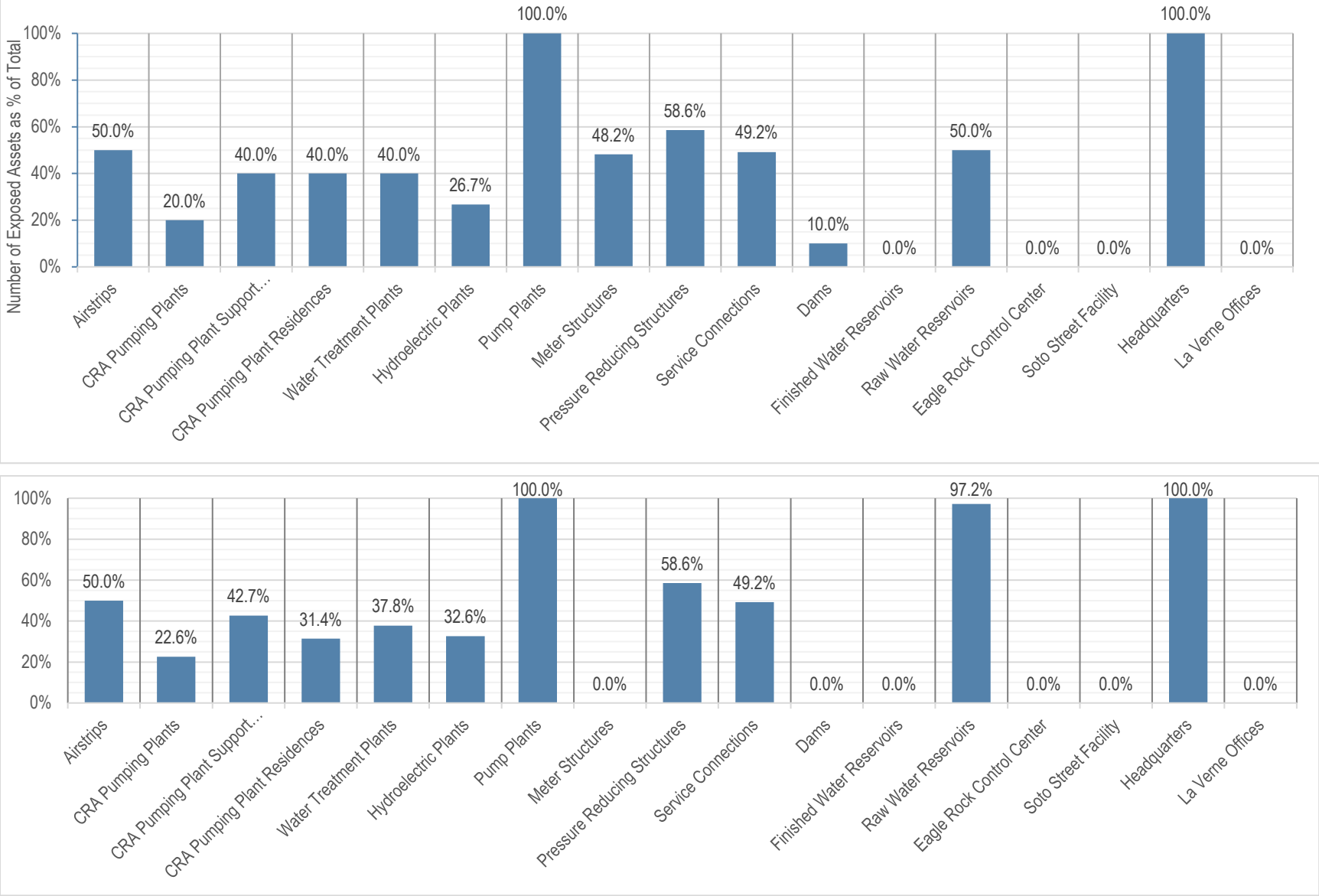
Table 9-3. Metropolitan Non-Linear Assets in the Mapped Seismic Hazard Areas

	Structures Within in the Liquefaction Hazard Area		Structures Within in the NEHRP D & E Hazard Area		Structures Within in the CGS Shaking Potential Hazard Area	
	Number of Structures	Replacement Cost Value	Number of Structures	Replacement Cost Value	Number of Structures	Replacement Cost Value
Colorado River Aqueduct Facilities						
Airstrips	0	$0	2	$372,456	0	$0
Pumping Plants	0	$0	1	$313,287,098	0	$0
Pumping Plant Support Buildings	0	$0	2	$25,407,539	0	$0
Residences	0	$0	2	$15,972,633	0	$0
Conveyance, Treatment and Distribution Facilities						
Water Treatment Plants	2	$1,998,665,135	2	$1,998,665,135	1	$958,894,972
Hydroelectric Plants	0	$0	4	$107,190,636	3	$88,719,186
Pump Plants	2	n/a	4	n/a	3	n/a
Meter Structures	74	n/a	231	n/a	98	n/a
Pressure Reducing Structures	12	$63,857,917	34	$180,930,765	14	$74,500,903
Service Connections	82	$33,390,810	267	$108,723,735	139	$56,601,495
Dams	0	n/a	2	n/a	1	n/a
Building Facilities						
Union Station Headquarters	1	$230,337,632	1	$230,337,632	1	$230,337,632
La Verne Offices	0	$0	0	$0	0	$0
Eagle Rock Control Center	0	$0	0	$0	0	$0
Soto Street	0	$0	0	$0	1	$5,835,176
Reservoirs						
Finished Water Reservoirs	0	$0	0	$0	0	$0
Raw Water Reservoirs	0	$0	3	$3,611,769,823	1	$3,050,701,926



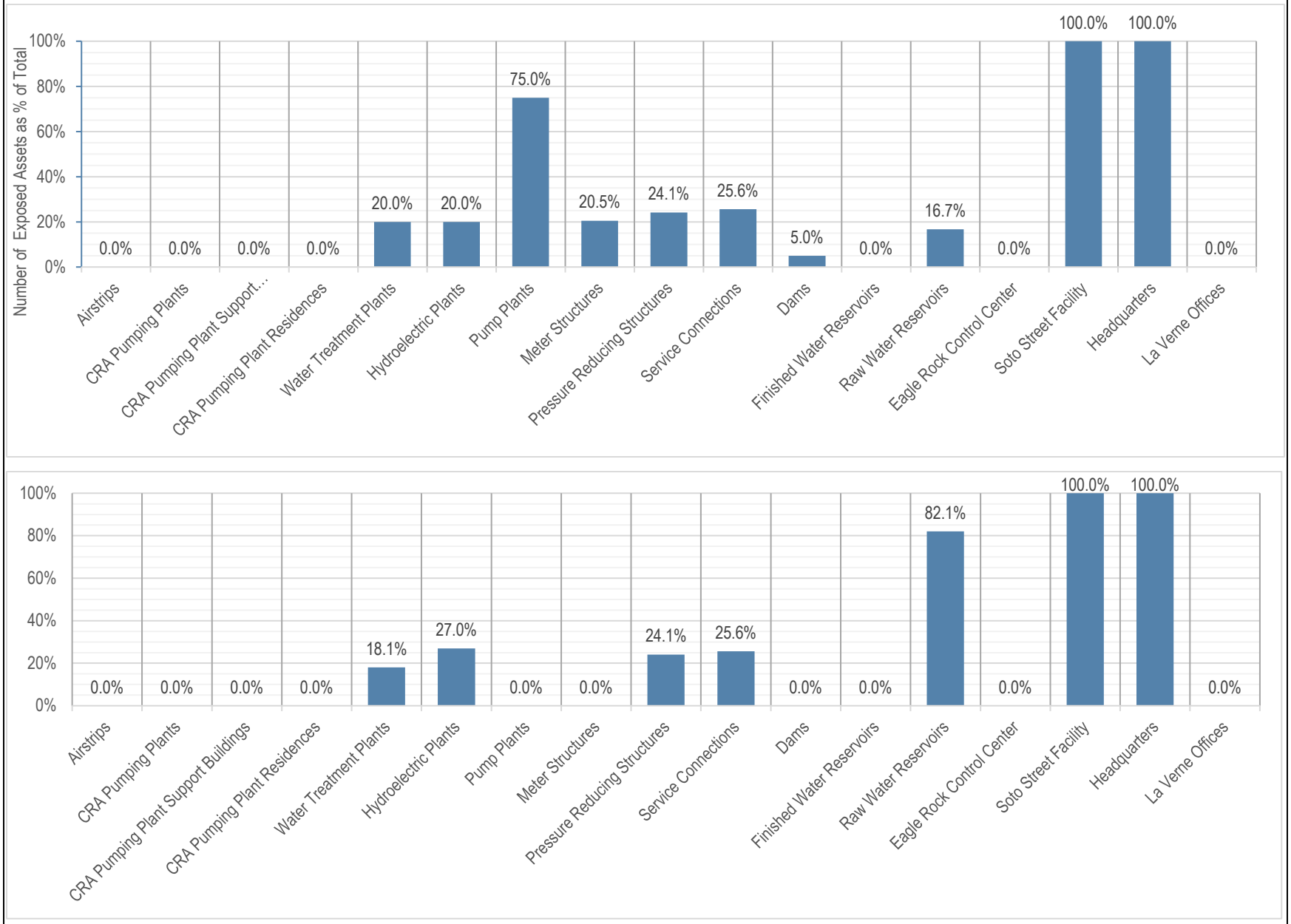
n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 9-7. Percent of Total Assets (Number and Value) in the Liquefaction Susceptibility Hazard Area



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 9-8. Percent of Total Assets (Number and Value) in the NEHRP Class D & E Soil Hazard Area



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 9-9. Percent of Total Assets (Number and Value) in the CGS Earthquake Shaking Potential Hazard Area

9.4 VULNERABILITY

9.4.1 Conditions Evaluated

Metropolitan's previous seismic hazard assessment of its pipelines utilized the RQE model to evaluate earthquake scenarios on 12 faults that span the southern California region (see Section 6.1.3). The Hazus analysis for this plan considered potential impacts from 12 similar earthquake scenarios to assess damage to above-ground Metropolitan assets (see Section 6.2.2).

9.4.2 Seismic Damage to Pipelines

When an earthquake occurs, water pipelines are at risk of being damaged due to ground shaking and permanent ground deformations. Potential damage can range from small leaks to destroyed pipe along ruptured fault zones. Some older Metropolitan systems were constructed using outdated standards or brittle materials, compared to what is used if built today. In recent decades, pipeline systems have become more robust and able to withstand damage from earthquakes.

In 2020, Metropolitan conducted a study to estimate the number of repairs for its underground pipeline system, which is exposed to earthquake shaking, fault displacement, and liquefaction. The analysis used the RQE model (see Section 6.1.3) to examine projected impacts from 12 scenario earthquake events in proximity to Metropolitan pipelines, as well as the estimated time required to complete the repairs for each event (ABS Consulting 2020).

Information from the study was used to develop an estimated timeline to return to service for the 12 earthquake scenarios. Metropolitan staff from Engineering Planning, Engineering Pipeline Design, Construction Management, Operations Conveyance and Distribution, Construction Services Unit, and Manufacturing Services Unit collaborated over a series of meetings to develop the recovery timeframes based on staff experience within their respective fields. The study considered Metropolitan's emergency response program, the type of repair given the pipeline material and size, Metropolitan's fabrication and coating shops capabilities, in-house construction capabilities, and potential for utilizing outside resources (third party contractors and existing mutual aid agreements) for fabrication and construction.

Table 9-4. Pipeline Repairs Required Due to Seismic Damage from Evaluated Earthquake Scenarios

Earthquake Scenario	Estimated Number of Breaks	Estimated Number of Leaks	Time Required to Complete Repairs
Peralta Hills – M6.42	3	2	8 to 10 days
Puente Hills – M6.55	3	2	8 to 10 days
Mission Hills – M6.82	4	3	9 to 12 days
Cucamonga/San Jose – M6.73	5	2	9 to 12 days
San Gabriel – M6.89	6	4	9 to 12 days
Northridge Hills – M6.99	11	6	2 to 3 weeks
Whittier Elsinore – M7.11	12	9	2 to 3 weeks
Elsinore (Glen Canyon/Julian) – M7.27	12	9	2 to 3 weeks
San Jacinto – M7.66	14	8	3 to 4 weeks
Newport-Inglewood – M7.11	17	7	3 to 4 weeks
Compton – M7.8	27	21	6 to 8 weeks
San Andreas – M7.8	30	12	6 to 8 weeks

Source: (ABS Consulting 2020)

9.4.3 Seismic Damage to Above-Ground Facilities

Probability of Level of Damage

Information available for some of Metropolitan's above-ground assets inventoried for this plan was sufficient to conduct a Hazus analysis of potential seismic impacts on those assets. From the complete set of inventoried assets (see Table 6-2), the following groups of assets were defined for the Hazus evaluation:

- **Colorado River Aqueduct**—All inventoried facilities except the airstrips: pump plants, pumping plant support buildings, and residences. Total of 15 assets.
- **Conveyance and Distribution**—A portion of the inventoried pressure-reducing structures. No meter structures or service connections. Total of 33 assets.
- **Facilities and Offices**—All assets at the headquarters, Eagle Rock, and La Verne except for the headquarters Sacramento office. Total of 4 assets.
- **Hydroelectric Plants**—All inventoried plants. Total of 15 assets.
- **Power Plants**—All inventoried plants. Total of four assets.
- **Water Treatment Plants**—All inventoried plants. Total of five assets.

Hazus classifies the vulnerability of structures to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. For each asset, the model estimates the probability of the asset incurring each of the potential levels of damage (adding up to 100 percent across the five damage levels). For the groups of assets evaluated in this assessment, a median probability across all assets included in the group was determined for each damage level. The results for the 12 earthquake scenarios are shown in Figure 9-10 through Figure 9-21. Detailed results for each facility are provided in Appendix D.

Estimated Value of Damage

The Hazus analysis provided estimates of the dollar value of damage to Metropolitan's above-ground assets and their contents from each of the evaluated earthquake scenarios. Table 9-5 shows the total estimated damage for each asset category evaluated from the 12 earthquake scenarios. Detailed results for each facility are provided in Appendix D.

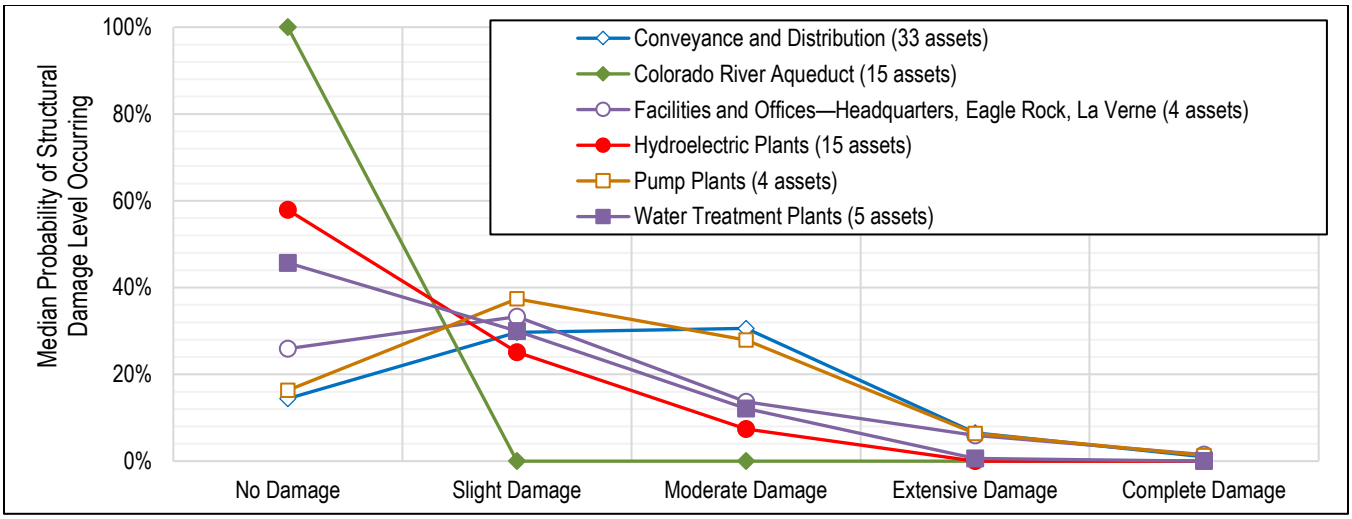


Figure 9-10. Estimated Structural Damage Probability for Compton M7.45 Earthquake Scenario

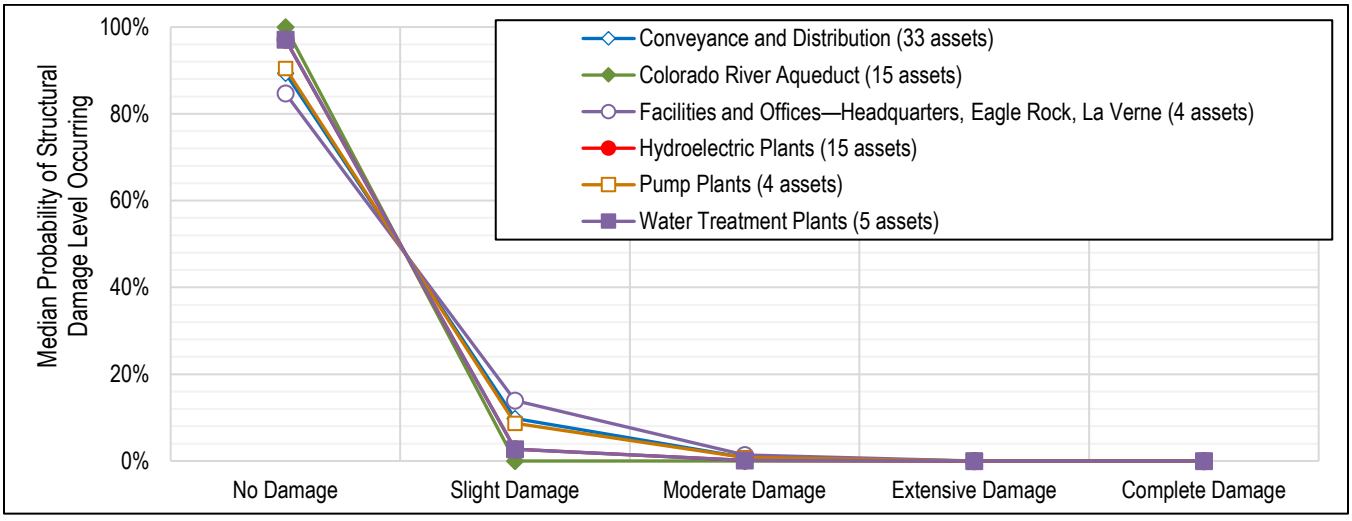


Figure 9-11. Estimated Structural Damage Probability for Cucamonga M6.88 Earthquake Scenario

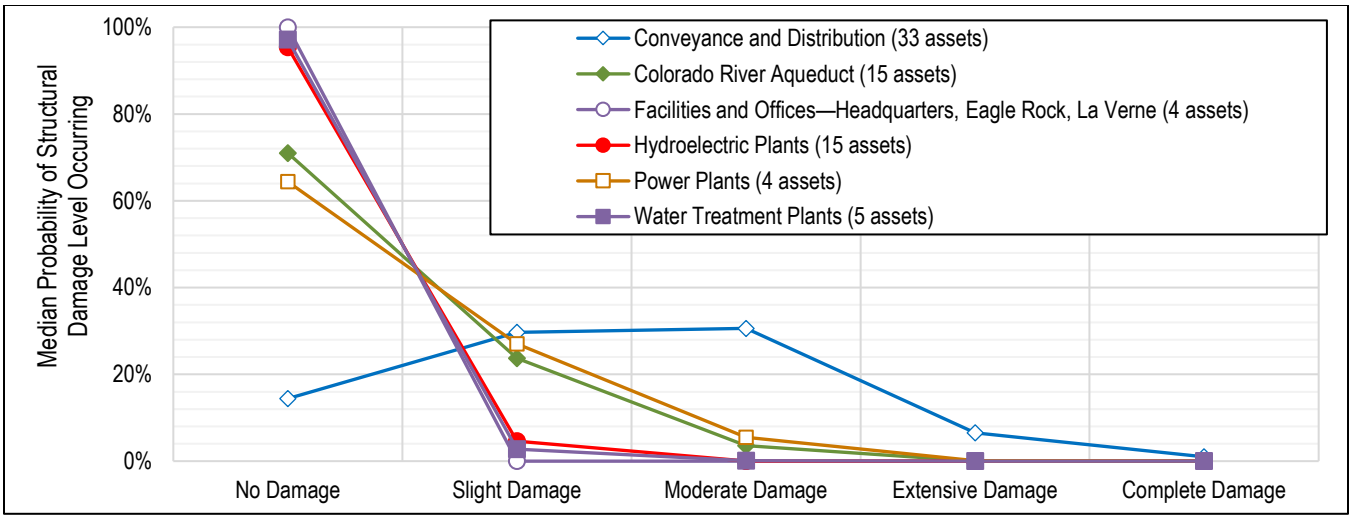


Figure 9-12. Estimated Structural Damage Probability for Elsinore M7.62 Earthquake Scenario

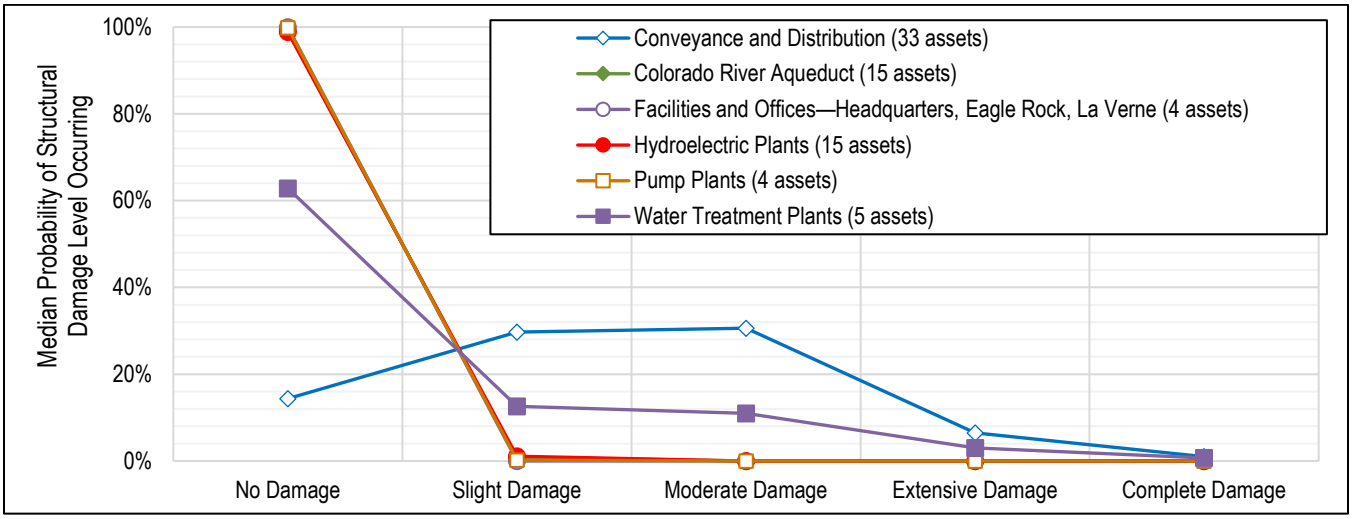


Figure 9-13. Estimated Structural Damage Probability for Mission Hills M6.52 Earthquake Scenario

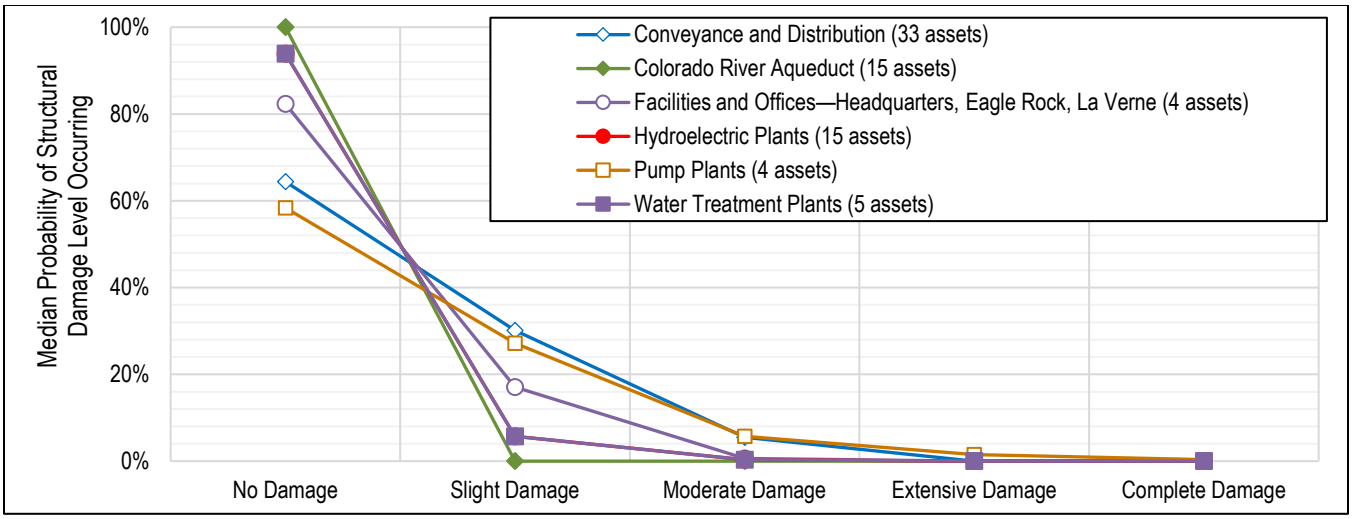


Figure 9-14. Estimated Structural Damage Probability for Newport/Inglewood Alternative 1 M7.2 Earthquake Scenario

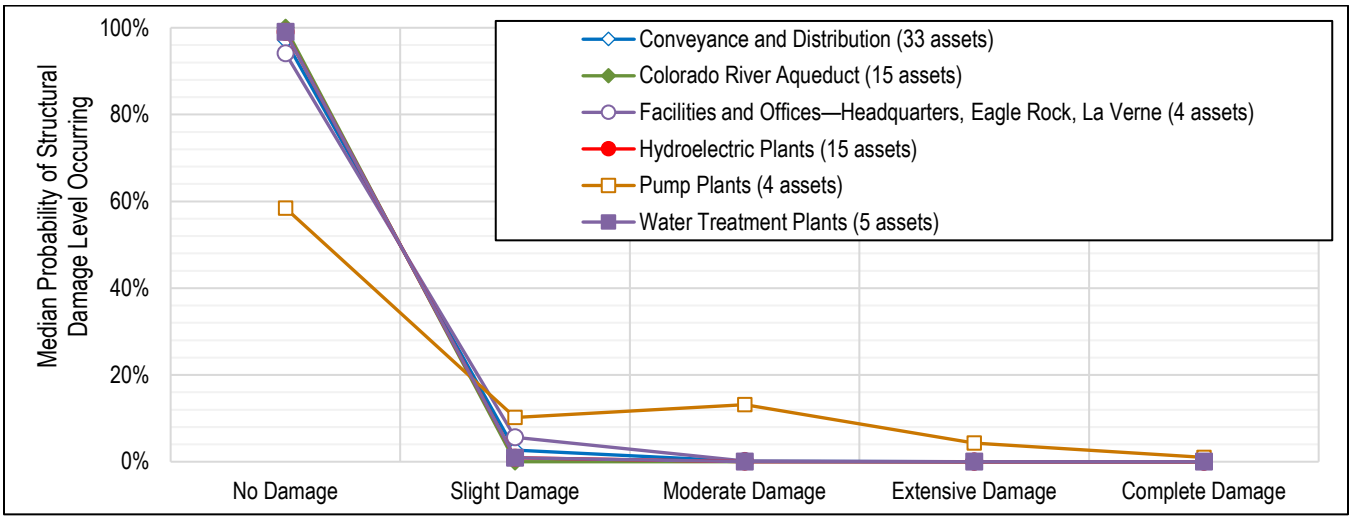


Figure 9-15. Estimated Structural Damage Probability for Northridge Hills M7.01 Earthquake Scenario

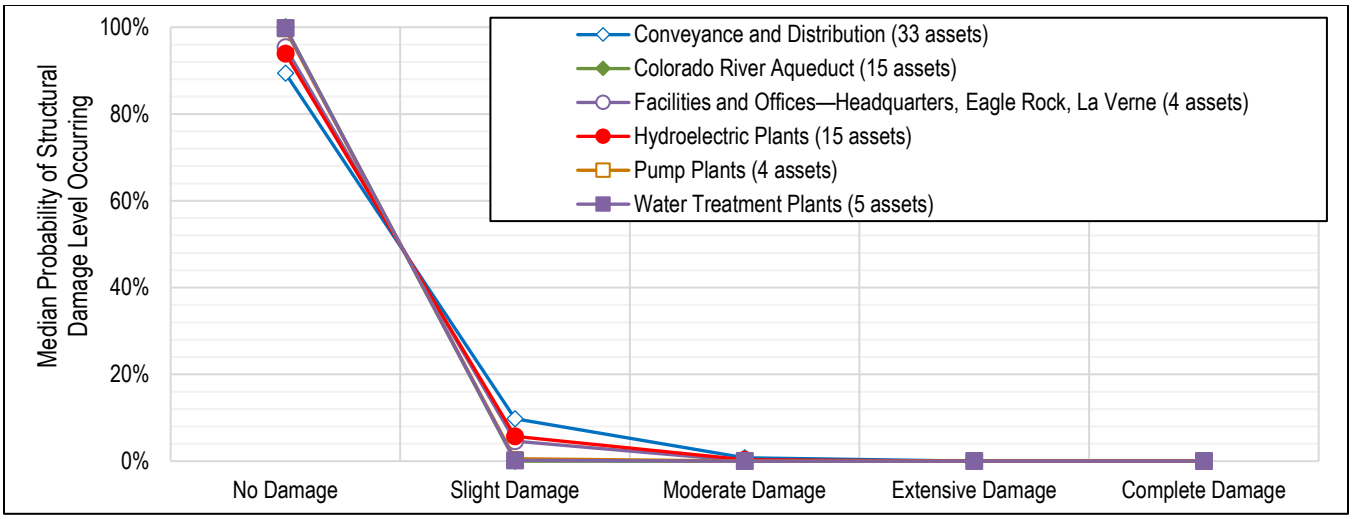


Figure 9-16. Estimated Structural Damage Probability for Peralta Hills M6.55 Earthquake Scenario

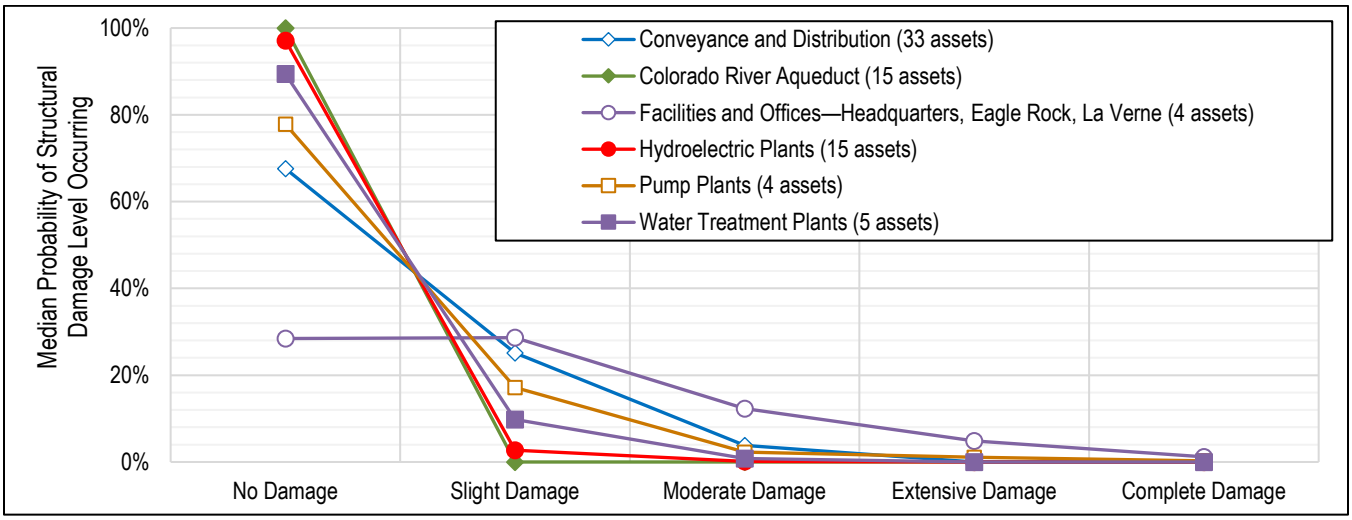


Figure 9-17. Estimated Structural Damage Probability for Puente Hills/Santa Fe Springs M6.61 Earthquake Scenario

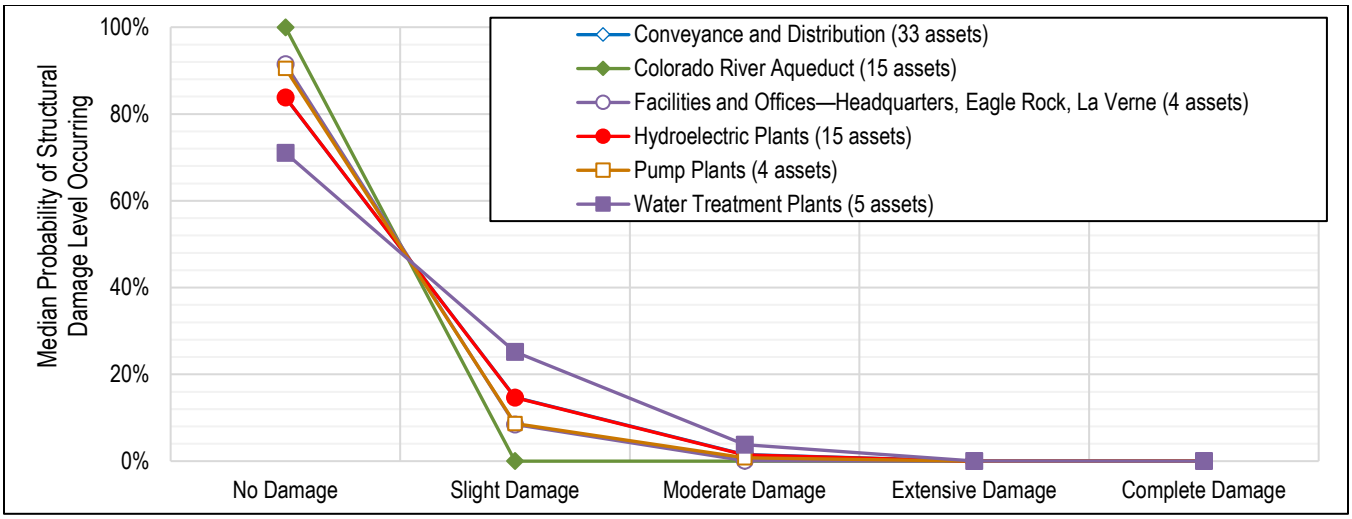


Figure 9-18. Estimated Structural Damage Probability for San Jacinto M7.7 Earthquake Scenario

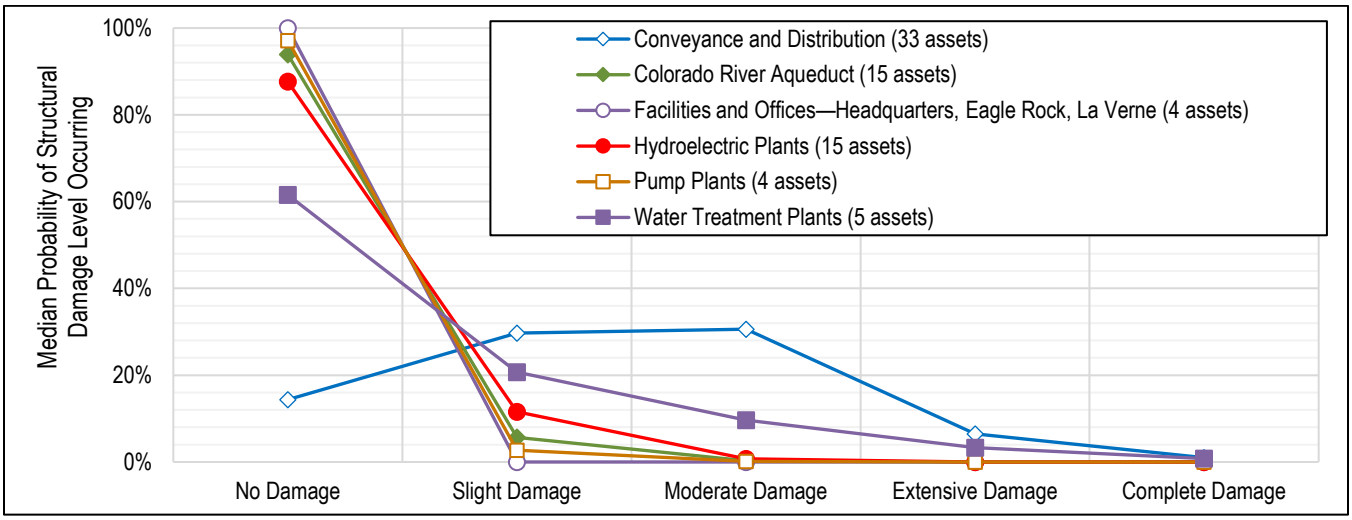


Figure 9-19. Estimated Structural Damage Probability for San Gabriel M7.23 Earthquake Scenario

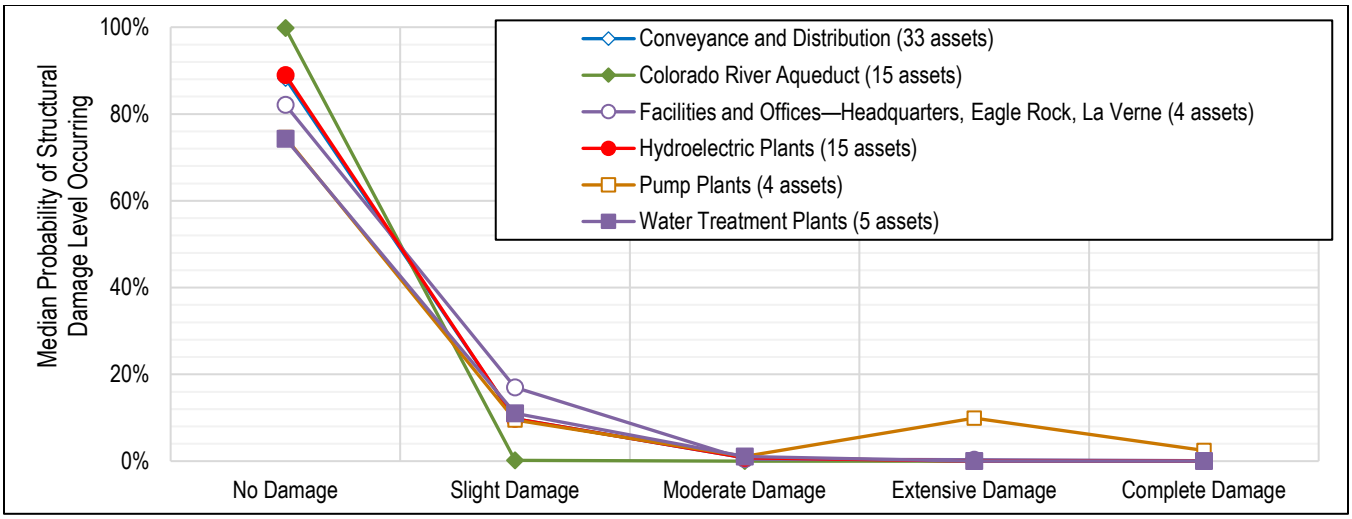


Figure 9-20. Estimated Structural Damage Probability for Southern San Andreas M7.8 Earthquake Scenario

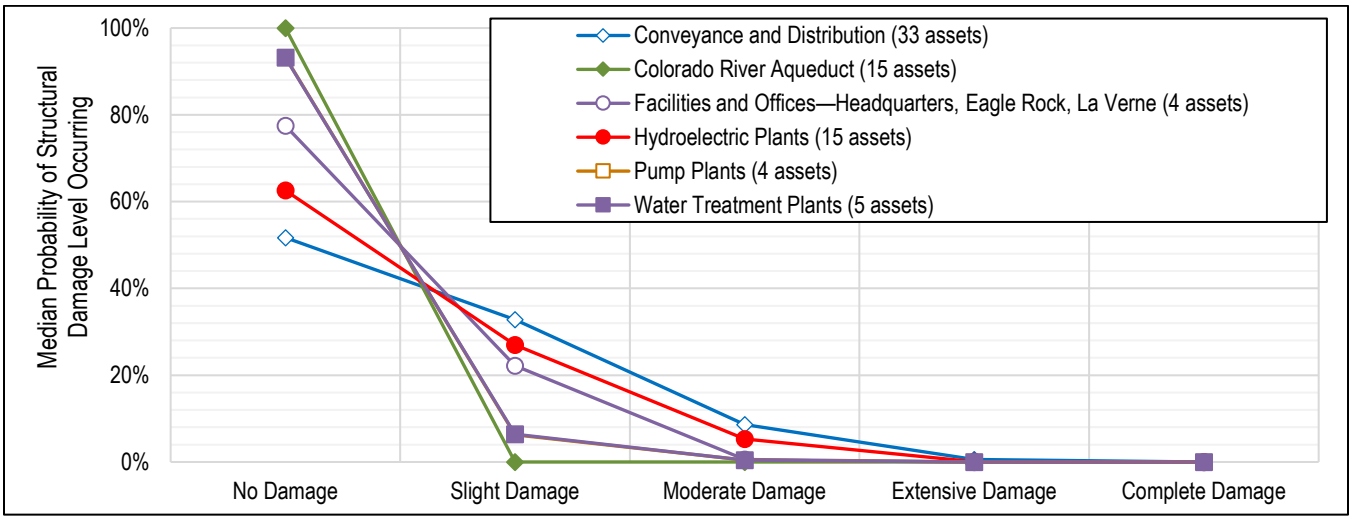


Figure 9-21. Estimated Structural Damage Probability for Whittier Alternative 2 M7.0 Earthquake Scenario

Table 9-5. Estimated Loss Due to Earthquake Damage

Earthquake Scenario	Conveyance and Distribution	Colorado River Aqueduct	Facilities and Offices[a]	Hydro-electric Plants	Water Treatment Plants	Total
Compton M7.45						
Loss Value	$62,919,227	$0	$54,709,813	$41,142,559	$823,165,718	**$981,937,318**
Loss as % of Total Replacement Cost	35.8%	0.0%	12.1%	12.5%	15.6%	**12.7%**
Cucamonga M6.88						
Loss Value	$13,857,091	$0	$15,323,764	$15,936,435	$421,564,014	**$466,681,304**
Loss as % of Total Replacement Cost	7.9%	0.0%	3.4%	4.9%	8.0%	**6.0%**
Elsinore M7.62						
Loss Value	$15,028,789	$30,746	$9,714,963	$22,640,673	$285,270,246	**$332,685,417**
Loss as % of Total Replacement Cost	8.6%	0.0%	2.1%	6.9%	5.4%	**4.3%**
Mission Hills M6.52						
Loss Value	$2,673,095	$0	$7,051,254	$1,415,523	$463,791,336	**$474,931,208**
Loss as % of Total Replacement Cost	1.5%	0.0%	1.6%	0.4%	8.8%	**6.1%**
Newport/Inglewood Alternative 1 M7.2						
Loss Value	$29,020,225	$0	$36,415,370	$12,474,933	$174,572,621	**$252,483,148**
Loss as % of Total Replacement Cost	16.5%	0.0%	8.0%	3.8%	3.3%	**3.3%**
Northridge Hills M7.01						
Loss Value	$8,616,038	$0	$18,386,975	$8,998,554	$502,624,628	**$538,626,195**
Loss as % of Total Replacement Cost	4.9%	0.0%	4.1%	2.7%	9.5%	**7.0%**
Peralta Hills M6.55						
Loss Value	$23,425,417	$0	$1,950,384	$20,892,326	$377,146,877	**$423,415,004**
Loss as % of Total Replacement Cost	13.3%	0.0%	0.4%	6.4%	7.1%	**5.5%**
Puente Hills/Santa Fe Springs M6.61						
Loss Value	$23,063,608	$0	$41,617,074	$11,492,471	$108,428,880	**$184,602,034**
Loss as % of Total Replacement Cost	13.1%	0.0%	9.2%	3.5%	2.1%	**2.4%**
San Gabriel M7.23						
Loss Value	$8,187,571	$0	$20,229,963	$9,718,807	$399,762,787	**$437,899,129**
Loss as % of Total Replacement Cost	4.7%	0.0%	4.5%	3.0%	7.6%	**5.7%**
San Jacinto M7.7						
Loss Value	$9,891,132	$749,975	$2,837,152	$12,943,940	$177,004,862	**$203,427,061**
Loss as % of Total Replacement Cost	5.6%	0.1%	0.6%	3.9%	3.3%	**2.6%**
Southern San Andreas M7.8						
Loss Value	$11,039,064	$58,420,552	$20,135,561	$14,297,958	$376,453,703	**$480,346,838**
Loss as % of Total Replacement Cost	6.3%	3.9%	4.4%	4.4%	7.1%	**6.2%**
Whittier Alternative 2 M7.0						
Loss Value	$31,440,567	$0	$32,208,371	$33,782,584	$444,874,465	**$542,305,988**
Loss as % of Total Replacement Cost	17.9%	0.0%	7.1%	10.3%	8.4%	7.0%

a. Headquarters, Eagle Rock, La Verne

9.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands; this planning considers seismic risks and location of key storage and conveyance and distribution infrastructure in relation to earthquake faults.

Metropolitan's Capital Investment Plan includes a number of programs to improve reliability, which include projects for seismic resiliency. The programs include Colorado River Aqueduct (CRA) Reliability, Distribution System Reliability, System Flexibility/Supply Reliability, System Reliability, and Treatment Plant Reliability.

9.6 CLIMATE CHANGE

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity, according to research into prehistoric earthquakes and volcanic activity. NASA and USGS scientists found that retreating glaciers in southern Alaska may be opening the way for future earthquakes (NASA 2023).

Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction or an increased propensity for slides during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

Because climate impacts on the earthquake hazard are not well understood, increases in exposure and vulnerability of Metropolitan's facilities are not able to be determined.

9.7 ISSUES

Important issues associated with an earthquake include the following:

- Metropolitan has numerous community lifelines at risk to earthquake hazards.
- Based on the modeling of community lifeline facilities performance performed for this plan, several facilities in the planning area are expected to have moderate to extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- The estimated damage to Metropolitan facilities from the scenario earthquakes ranges from $184 million for the Puente Hills/Santa Fe Springs scenario to $981 million for the Compton scenario.
- The estimated number of required pipeline repairs from the scenario earthquakes ranges from 4.5 for the Puente Hills M6.55 scenario to 47.8 for the Compton scenario.
- Metropolitan plans, prepares, and maintains a state of readiness to respond to two simultaneous emergencies. With a significant earthquake event, Metropolitan could experience more than two emergencies and be asked to support requests for assistance from other agencies. Staff and equipment resources would be impacted and there would likely be impacts on material availability. Coordinated regional emergency response planning is critical.
- Metropolitan should consider enhancing business continuity plans to use the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- The risk associated with earthquakes overlaps the risk associated with other hazards such as dam failure, flood, landslide and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

10. EXTREME HEAT

10.1 GENERAL BACKGROUND

Extreme heat can be defined as temperatures that hover 10 ºF or more above the average high temperature for the region, last for prolonged periods of time, and are often accompanied by high humidity. The National Weather Service (NWS) monitors a heat index that takes both temperature and humidity into account (see Figure 10-1).

Source: (NWS 2023)

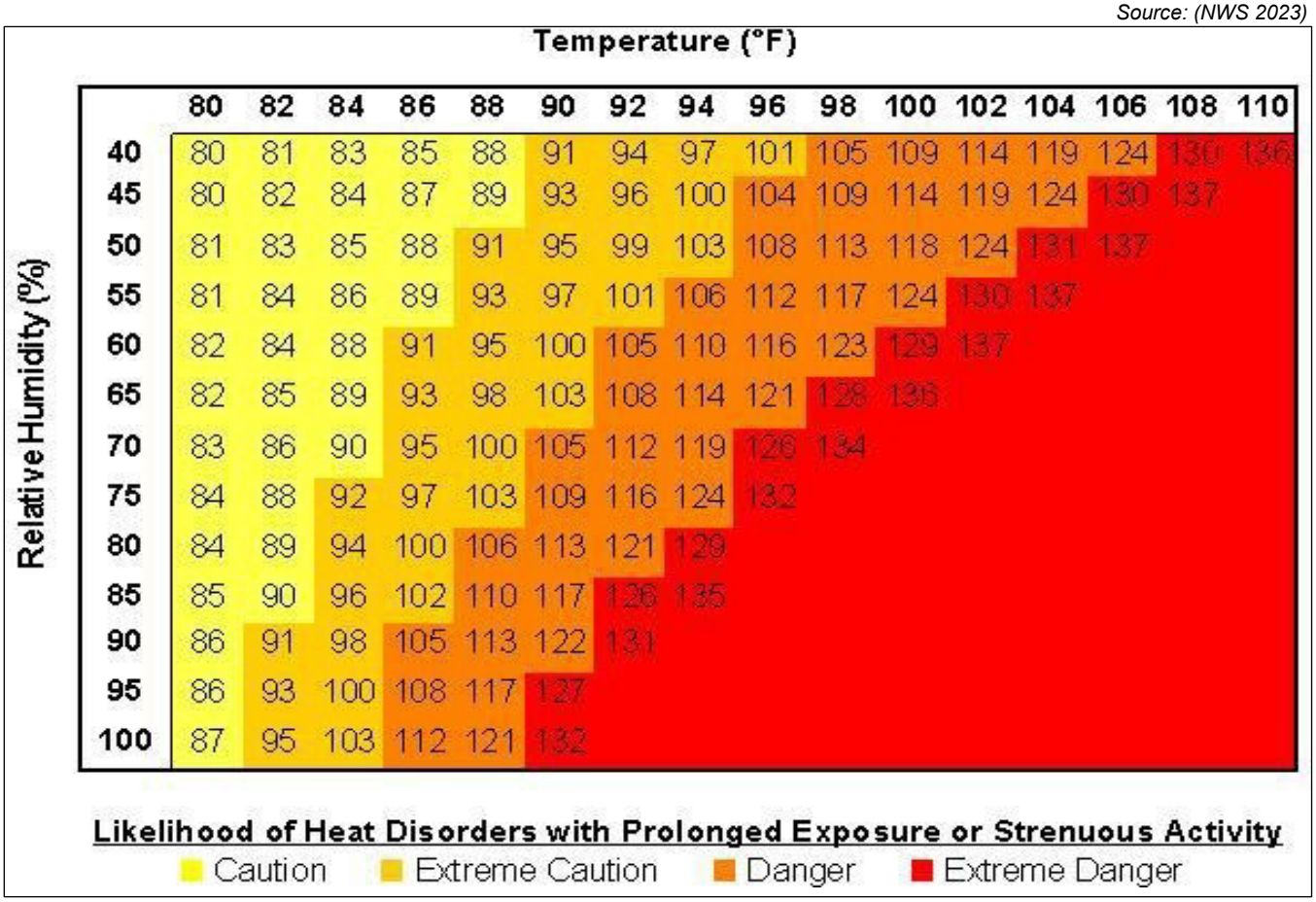


Figure 10-1. Extreme Heat Index

According to the California Climate Adaptation Strategy, heat waves have claimed more lives in California than all other declared disaster events combined (State of California 2021). Heat emergencies are often slow to develop and typically impact vulnerable populations most severely. It can take a number of days of oppressive heat for a heat

wave to have a significant or quantifiable impact. Heat waves do not strike victims immediately, but rather their cumulative effects slowly take the lives of vulnerable populations.

The "urban heat island effect" can produce significantly higher nighttime temperatures where asphalt and concrete (which store heat longer) gradually release heat at night. Urban heat islands develop in urban areas where natural surfaces are paved with asphalt or covered by buildings. Radiation from the sun is absorbed by these surfaces during the day and re-radiated at night, raising ambient temperatures. Urban heat islands have high nighttime minimum temperatures compared to neighboring areas. Waste heat from air conditioners, vehicles, and other equipment contributes to the urban heat island effect (MIT Climate Portal 2021).

Extreme heat events may also impact the electric grid as the demand for energy to operate air conditioning systems may approach or exceed the capacity of the generation, transmission, and distribution systems. The California Independent System Operator (CAISO), which has operational jurisdiction over the majority of Metropolitan's service area, issues alerts as the demand on the grid increases. These alerts include Flex Alerts, which request voluntary demand reduction, and Energy Emergency Alerts (EEA), which range in severity up to and including involuntary load shedding.

Metropolitan's Colorado River Aqueduct, five pumping plants, and related facilities are located in the desert region of Riverside County. This region experiences a wide range of temperatures, from freezing in some areas during the winter months to extremely hot temperatures for long periods of time during the summer. The FEMA National Risk Index (NRI) ranks Heat Wave as a relatively high hazard risk in Riverside County. The risk is indexed at 98.6 out of 100, which is in the 100th national percentile.

10.1.1 Secondary Hazards

Prolonged heat waves can impact the energy grid that supplies power for Southern California and the facilities that move water through the Colorado River Aqueduct. High energy demands and low supply affect energy markets and power purchase costs. This often requires Metropolitan to change its operations and impacts the timing and volume of Colorado River water delivered into the service area.

10.2 HAZARD PROFILE

10.2.1 Past Events

None of Metropolitan's service counties have been included in any federal declarations for extreme heat (FEMA 2025). For California State emergency declarations, all of Metropolitan's service counties have been included in one statewide emergency declaration for extreme heat during the 2021 summer heat wave (FEMA 2025).

According to the 2020 Extreme Heat & Public Health Report by the Southern California Association of Governments (SCAG), the six service counties are expected to see an increase to 35 extreme heat days per year by 2040-2060 (SCAG 2020). A storm event database maintained by NOAA's National Centers for Environmental Information lists the following excessive heat events in the planning area (NOAA 2023):

- **August 28 – 30, 2023**—An upper-level area of high pressure caused very hot daytime temperatures to occur in late August 2023.
- **July 7 – 29, 2023**—A long duration heat wave impacted inland portions of Southern California July 7 to 29 with nearly continuous warnings and advisories. San Diego County public health reported 224 heat

related incidents around their network of 23 hospitals. Numerous record highs were broken in the lower deserts where temperatures topped 115 for many days in a row, as well as across the inland valleys and mountains. Overnight low temperatures remained elevated in the lower deserts as lows only fell into the mid-80s to mid-90s, exacerbating the extreme heat risk. July 2023 was the hottest month on record at Palm Springs.

- **July 1 – 3, 2023**—Strong high pressure over the southwestern US led to increasing heat over Southern California in early July. High heat occurred each afternoon July 1st, 2nd, and 3rd, after which temperatures slowly cooled down.
- **August 31 – September 9, 2022**—From August 31 through September 9, an extreme heat event occurred across the West. The California Independent System Operator's (CAISO) peak load during the heat event was 52,061 megawatts (MW) on September 6, exceeding the previous record demand by 2,000 MW and the 2020 peak by over 5,000 MW. CAISO issued an Energy Emergency Alert EEA-3 (firm load shed imminent or in progress) and came within about 500 MW of curtailing firm load through rolling blackouts. Multiple wildfires occurred across the state, some threatening transmission or generation. The Governor declared an emergency similar to the 2020 energy crisis, allowing emergency generators to run without penalty.
- In response to a direct CAISO request, Metropolitan voluntarily reduced pumping load at its Gene and Intake Pumping Plants during critical load hours (5 pm –9 pm on 9/5 and 9/6 during the heat event). Gene and Intake reduced pumping by 4 pumps at both plants for four hours, which reduced CRA pumping demand by 50 MW, or ~20%. Metropolitan also coordinated with the San Diego County Water Authority, a member agency, to increase deliveries from Metropolitan's Skinner Treatment Plant, allowing the Carlsbad desalination plant to ramp down during peak load hours. Metropolitan adjusted flows on its San Diego Pipeline 5 to allow the Red Mountain hydropower plant to operate, adding 4 MW of generation. Further, Metropolitan increased peaking flows on its Rialto Feeder by using its Live Oak reservoir, allowing CA DWR to increase peak generation at Devil Canyon by about 4 MW.
- **September 21, 2021**—Very warm temperatures occurred inland on September 20-22, with highs reaching 95 to 105 °F. Weak Santa Ana winds brought breezy conditions to the mountains and Inland Empire. Multiple wildfires started in the Inland Empire, with fires exacerbated by hot conditions and dry vegetation.
- **April 1 – August 25, 2021**—An area of upper-level high pressure centered over the southwestern U.S. led to well-above average temperatures across Southern California, as well as elevated thunderstorm convection. Fog along the coast caused travel disruptions. This long-lasting heat wave persisted through the summer, breaking a number of local records and igniting wildfires. Isolated thunderstorms produced gusty winds.
- **October 12, 2020**—Some areas recorded temperatures near 100 °F during this heat wave.
- **September 29, 2020**—High temperatures from the 90s at the beaches to just over 100 °F readings were reported a few miles inland during this heat wave.
- **September 17, 2020**—Temperatures climbed into the upper 90s and low 100s °F in some spots during this heat wave.
- **August 14, 2020**—On August 14 and 15, 2020, the CAISO was forced to institute rotating electricity outages in California in the midst of a West-wide extreme heat wave. Hundreds of thousands of Californians briefly lost power in rolling blackouts, the first time outages were ordered in the state due to insufficient energy supplies in nearly 20 years.

- **October 21 – 22, 2019**—Upper-level high pressure over the Great Basin ushered in gusty Santa Ana winds, hot temperatures and single digit relative humidity. Many Southern California locations took the nation's high temperature between October 21 – 24. Although it was hot and dry October 21 – 22, winds were not very strong. The stronger winds occurred on October 24 – 25, where widespread wind gusts of 50 – 60 mph winds occurred in the mountains and passes, with isolated gusts of 70+ mph. The highest wind gust was 78 mph at Sill Hill in San Diego County.
- **September 13, 2019**—Heat, high winds and low relative humidity hit Southern California. Many locations in the Inland Empire reached 100 – 105 °F. Orange and San Diego County valleys reached 90 – 99 °F. The Coachella Valley saw the highest temperatures in the region with highs topping out around 110 °F on Friday. A weak Santa Ana event occurred with peak wind gusts ranging from 20 – 40 mph, highest in the mountains. Numerous small wildfires broke out due to the low humidity and gusty winds. One of the largest fires was the Horseshoe Fire near Hemet. It prompted evacuations of a small community near North Warren Road. No injuries or damages were reported.
- **July 6, 2018**—Strong broad upper-level high pressure centered over Nevada and unusual weak offshore flow in July brought extreme hot temperatures and dry conditions to Southern California. Inland Orange County, San Diego Valleys, Inland Empire and the deserts experienced the most extreme temperatures. July 6th was the hottest day during this event, with Thermal and Chino reaching 120 °F, and San Bernardino and Riverside Airport reaching 118 °F. July 7 and 8 remained quite hot. Heat began to subside significantly on July 9.
- **October 23 – 25, 2017**—A strong upper-level ridge settled over the region from October 23 – 25, 2017, before weakening slowly. High pressure over the Great Basin brought weak to moderate Santa Winds that contributed dry air and compressional warming. Afternoon high temperatures over the coast and valleys soared past the century mark on October 23 – 25, breaking numerous records. Overnight temperatures in some wind prone spots failed to drop below 80 °F. The San Diego Unified School District was hit hard, with 85 schools resorting to early releases on October 23 – 25. The 108 °F reported at Miramar Marine Air Station was the hottest temperature recorded so late in the year at any location other than Remote automatic weather station sites. On October 24, record highs and extremes occurred when Vista and Poway both peaked at 107, and 106 occurred at Oceanside Airport. Other readings included 105 °F at El Cajon and 105 °F at Huntington Beach, 106 °F at Fullerton and John Wayne Airports.
- **September 1, 2017**—A strong upper-level ridge of high pressure over the Great Basin and weak offshore flow brought a heat wave to the region during the end of August and early September. The hottest temperatures west of the mountains occurred on September 1 – 3. San Diego Unified School District closed more than 70 schools early due to the excessive heat. A flex alert (requesting electricity conservation) issued in late August continued through September 3.
- **September 2, 2007**—Strong high pressure and easterly flow brought hot, humid weather to much of Southern California. Temperatures exceeded 95 °F along the coast and in the mountains, 105 °F in the Orange and San Diego County valleys, 110 °F in the Inland Empire and high deserts, and 115 °F in the lower deserts. Humidity levels were quite high for the region, especially in the lower deserts where periodic gulf surges would raise the dewpoint into the 70s °F. At least six people died of heat related causes, however the actual number of deaths is probably higher than indicated.

10.2.2 Location

Metropolitan's Colorado River Aqueduct and related assets are located in California's desert region and subject to extreme heat events. In Metropolitan's service area, extreme heat events may be exacerbated in areas where reduced air flow, reduced vegetation and tree canopy, and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding less urbanized areas.

10.2.3 Frequency

The National Climatic Data Center storm events database lists 351 heat events in Metropolitan's service counties since 2001. Heat events are increasingly common along the Colorado River Aqueduct. Climate change is likely to bring hotter temperatures, more hot days, and more frequent heat waves, impacting energy demands and availability, water demands, and Metropolitan's infrastructure and operations. It is also expected to lead to higher rates of heat-related impairments and deaths.

10.2.4 Severity

Extreme heat events can impact staff that live and work in the desert region to operate the Colorado River Aqueduct. Extreme heat can cause heat exhaustion, in which the body becomes dehydrated, resulting in an imbalance of electrolytes. Without intervention, heat exhaustion can lead to collapse and heatstroke. Heatstroke occurs when perspiration cannot occur, and the body overheats. Without intervention, heatstroke can lead to confusion, coma, and death. Extreme heat is the primary weather-related cause of death in the U.S. In a 30-year record of weather fatalities across the nation from (1993 – 2022), excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. The total averaged to 168 heat-related deaths per year (NOAA 2023).

Depending on duration and extent, extreme heat events can also impact energy availability on the grid, which can cause Metropolitan to purchase power elsewhere at higher rates and change operations. Extreme heat events do not typically impact buildings; however, losses may be associated with the urban heat island effect and power outages.

Hot weather also can increase levels of ozone, a major component of smog that is created in the presence of sunlight via reactions between chemicals in gasoline vapors and industrial smokestacks. High ozone levels often cause or worsen respiratory problems. The longer a heat wave lasts and the hotter the temperature is, the greater the risk of adverse impacts on human health or infrastructure.

A worst-case scenario event would be a long-duration extreme heat event that impacts power availability through the regional energy grid and triggers a public safety power shutoff event with power disrupted for a long period of time. This would require operational changes throughout the system and would tax Metropolitan's backup power capability beyond its capacity.

10.2.5 Warning Time

The NWS is producing experimental forecasts called HeatRisk to assess the heat risk to local thresholds in the United States (see Table 10-1). The numeric (0 – 4) and color (green, yellow, orange, red and magenta) scales are similar to the NWS air quality index.

Table 10-1. Heat Risk Categories

Category	Risk of Heat-Related Impacts
Green (0)	Little to no risk from expected heat.
Yellow (1)	Minor—This level of heat affects primarily those individuals extremely sensitive to heat, especially when outdoors without effective cooling and/or adequate hydration.
Orange (2)	Moderate—This level of heat affects most individuals sensitive to heat, especially those without effective cooling and/or adequate hydration. Impacts possible in some health systems and in heat-sensitive industries.
Red (3)	Major—This level of heat affects anyone without effective cooling and/or adequate hydration. Impacts likely in some health systems, heat-sensitive industries and infrastructure.
Magenta (4)	Extreme—This level of rare and/or long-duration extreme heat with little to no overnight relief affects anyone without effective cooling and/or adequate hydration. Impacts likely in most health systems, heat-sensitive industries and infrastructure.

Source: (NWS 2024)

The NWS continues to issue excessive heat watches, excessive heat warnings and heat advisories to warn of an extreme heat event (a "heat wave") within the next 36 hours. If NWS forecasters predict an excessive heat event beyond 36 hours, then the NWS will issue messaging in the form of a special weather statement, partner emails and social media out between the three- to seven-day timeframe.

The NWS will use the HeatRisk output to determine if an excessive heat watch/warning or heat advisory is warranted. The NWS issues the following types of heat-related advisories:

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

These advisories are intended to raise the public's awareness to prevent heat illnesses from occurring. If significantly hot weather is forecasted, the NWS will issue an excessive heat watch generally two to three days in advance. An excessive heat watch is a way to give the public and emergency officials a warning that extreme temperatures are expected. If significantly hot temperatures remain in the forecast for 24 to 28 hours, the excessive heat watch will be upgraded to an excessive heat warning, indicating that extreme heat has either arrived or is expected soon.

10.3 EXPOSURE

It can be assumed that all Metropolitan assets are exposed to some extent to extreme heat events profiled in this chapter. Power outages or rolling blackouts may occur as a result of extreme heat events that strain the energy grid. During a blackout, all community lifelines that rely on electricity for power will be severely impacted unless they are connected to a backup power source.

10.4 VULNERABILITY

All Metropolitan assets are vulnerable to direct and indirect impacts from extreme heat. This vulnerability is tied predominately to the loss of power, as most of Metropolitan's community lifelines are power dependent. It is also tied to the impacts of extreme heat on staff who live and work in the desert region to operate the Colorado River Aqueduct. Currently, there are no available models that can estimate future loss and loss of function due to extreme heat. Therefore, no formal loss estimations are being provided, and this vulnerability assessment is qualitative in its narrative.

Weather induced loss of power for the planning area is prevalent, especially considering the impact of Public Safety Power Shutoff (PSPS) protocols being deployed by electric utility service providers in the state of California. High temperatures and extreme dryness can create conditions in the state where any spark at the wrong time and place can lead to a major wildfire. The PSPS is a procedure under which it may be necessary for a utility service provider to turn off electricity in the interest of public safety if weather conditions threaten a portion of the electric system. A PSPS event can be correlated to extreme heat.

Metropolitan does have backup power to most, but not all of its community lifelines, so there is some degree of vulnerability associated with this capability. There are portable sources for emergency power supply, but these sources are not as efficient as picked place backup power for each facility.

10.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands. In addition, Metropolitan works with local jurisdictions on development projects within the vicinity of existing infrastructure to protect public safety, easements and the integrity of the system.

California's efforts to increase the use of Zero Emission Vehicles and other electrification efforts are increasing demands for clean energy and other power supplies. Extreme heat events increase power demands for all users.

Metropolitan's Capital Investment Plan includes several programs to improve infrastructure and reliability, which may include projects to reduce or avoid risk of extreme heat impacts to facilities and operations. Programs include Climate Adaptation, Colorado River Aqueduct (CRA) Reliability, Distribution System, and Additional Facilities and Systems. For the desert region, the CIP includes projects to refurbish or upgrade Metropolitan workforce housing to enhance living conditions and attract and retain skilled employees. These projects can help address the health impacts of extreme heat.

10.6 CLIMATE CHANGE

Climate change presents a challenge for risk management associated with extreme heat. This increase in average surface temperatures can also lead to more intense heat waves that can be exacerbated in urban areas by what is known as urban heat island effect. Evidence from a number of credible sources, such as the Environmental Protection Agency (EPA), suggests that heat waves are already increasing, especially in western states (EPA 2023).

Metropolitan's exposure and vulnerability would likely increase as a result of climate change impacts on the extreme heat hazard. Metropolitan may experience more frequent disruptions in power service and power supply from the grid. Extreme heat events impact the staff that live in the desert and work on the Colorado River Aqueduct.

10.7 ISSUES

Important issues associated with an extreme heat event in the planning area include the following:

- Power interruption is the biggest impact from this hazard for Metropolitan.
- Prolonged backup power usage during extreme heat events could have regional impacts on air quality.
- The bulk power system to the Colorado River Aqueduct may need improvements to adapt to increasing impacts of extreme heat.
- Metropolitan's backup power capability should be enhanced. Redundant communication systems that are not dependent on network connections or power are needed.

- Extreme heat significantly impacts Metropolitan staff living and working in the desert region to operate the Colorado River Aqueduct. Health and safety are of primary importance, and new facilities, staffing approaches and safety protocols are needed.
- The risk associated with the extreme heat hazard overlaps the risks associated with other hazards such as earthquake, flood, landslide, wind, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- The potential impact of climate change on extreme heat event duration and frequency needs to be better understood. It could have impacts on the state and western regional grids and the power demands they can meet.

11. FLOOD

11.1 GENERAL BACKGROUND

11.1.1 River Flooding

River flooding occurs when a river rises to overflow its natural banks due to causes such as prolonged, general rainfall, locally intense thunderstorms, snowmelt, or ice jams.

Measuring Floods on Rivers

River flooding is measured using a discharge probability, which is the likelihood that a certain river discharge (flow) will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for different discharge levels. The flow that historical data show to have a 1 percent chance of being equaled or exceeded in any given year is called the 1-percent-annual-chance flood (also referred to as the 100-year flood or the "base flood"). This flood event is a regulatory standard used in assessing flood risk, regulating new development, and setting requirements for purchasing flood insurance.

Discharge probabilities have an inverse relationship to river flows—that is, a lower probability indicates a higher flow. The 0.2-percent-annual chance flood (also referred to as the 500-year flood) represents a higher river flow than a 1-percent-annual-chance flood. These probabilities reflect statistical averages only; it is possible for two or more low-probability floods to occur in a short time period. The probabilities also can vary along a single river: the same storm event can cause a 1-percent-annual-chance flood at one location on a river and only a 10-percent-annual-chance flood at a point further upstream or downstream.

River Floodplains

A floodplain is the area adjacent to a river, creek or lake that becomes inundated during a flood. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain unconsolidated sediments (accumulations of sand, gravel, loam, silt, and/or clay), often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce, and residential development.

Connections between a river and its floodplain are most apparent during and after major flood events. These areas form a complex physical and biological system that not only supports a variety of natural resources but also

provides natural flood and erosion control. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced.

Floodplain Mapping

The extent of the floodplain during a 1-percent-annual-chance flood is called the special flood hazard area and is used as a regulatory boundary by many agencies. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage.

FEMA has created Flood Insurance Rate Maps to show areas at risk of flooding during 1- and 0.2-percent annual chance scenarios. Properties within the 100-year floodplain are required to have flood insurance as a prerequisite for federally backed mortgages; properties within the 500-year floodplain are not required to have flood insurance to qualify for federally backed mortgages. Metropolitan is not eligible for the National Flood Insurance Program.

Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. It can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

11.1.2 Urban Flooding

Drainage facilities in urbanized areas consist of a series of pipes, roadside ditches, and channels. Urban flooding occurs when these conveyance systems lack the capacity to convey rainfall runoff to nearby creeks, streams, and rivers and in some areas, wastewater and stormwater treatment plants. As drainage facilities are overwhelmed, roads and transportation corridors become conveyance facilities. The key factors that contribute to urban flooding are rainfall intensity and rainfall duration as well as drainage system design and capacity. Topography, soil conditions, urbanization and groundcover also play an important role.

Urban floods can be a great disturbance of daily life in urban areas. Roads can be blocked, and people may be unable to go to work or school. Economic damage can be high, but the number of casualties is usually limited, because of the nature of the flood. On flat terrain, the flow speed can be low, and people may still be able to drive through the flood. The water may rise relatively slowly and usually does not reach life endangering depths.

Urban floods can occur suddenly as flash floods after a brief but intense downpour. In these cases, they can move rapidly, end suddenly, and occur in areas not generally associated with flooding (such as subdivisions not adjacent to a water body). Although the duration of these events is usually brief, the damage they cause can be severe. It is this type of flooding that provides the greatest risk to Metropolitan facilities.

11.1.3 Secondary Hazards

The most problematic secondary hazard for riverine flooding is bank erosion, which in some cases can be more harmful than actual flooding. This is especially true in the upper courses of rivers with steep gradients, where floodwaters may pass quickly and without much damage, but scour the banks and the riverbed, edging properties closer to the floodplain or causing them to fall in and potentially damaging infrastructure. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers, or storm sewers.

Heavy rains in areas affected by wildfire can result in mud and debris flows. As wildfire season lengthens and extends into California's wet season that begins in October, heavy rains that follow wildfires are becoming more common. These post-wildfire rains may create secondary hazards as debris is washed from damaged and destroyed properties, burnt vegetation, and soil from landscapes down canyons. Mudflows are more likely to occur after wildfires because hillsides are more likely to erode; vegetation roots that held the soil on hillsides in place are no longer present.

Heavy rains can also impact water quality and require a change in operations. In January 2023, heavy rains caused silt and debris to flow into Castaic Lake. The increased turbidity of the water stressed the ability of Metropolitan's water treatment plant to meet water quality compliance standards and increased operation and maintenance costs due to actions taken to reduce flow, repurpose out-of-service basins, increase coagulant dosage, and combine chlorine and ozone disinfection.

11.2 HAZARD PROFILE

Low-lying areas near the coast are prone to flooding. In Los Angeles County, this includes the ports of Los Angeles and Long Beach, as well as Marina del Rey. Other low-lying areas prone to flooding from heavy rains include communities in the Santa Monica Mountains Coastal Zone and the Antelope Valley. Communities in the lower reaches of rivers are also at risk of flooding from breaches in upstream levees during heavy storms. This includes communities near the Los Angeles and San Gabriel Rivers.

In Orange County, the Santa Ana River has experienced much of the historic flooding. Other areas subject to flooding during severe storms include areas adjacent to Bolsa Chica Channel, Anaheim-Barber, Stanton Storm Channel, Santa Ana, Cañada, Paularino, Westminster, Trabuco, Borrego, Serrano, Laguna Canyon, Atwood Channel, Brea Creek Channel, Fullerton Creek Channel, Carbon Creek Channel, San Juan Creek Channel, and East Garden Grove-Wintersburg Channel. Areas adjacent to Santiago Creek and Collins Channel in the central portion of the County and large portions of the San Diego Creek watershed in the City of Irvine and unincorporated areas of the County are also subject to inundation. In the southern portion of the county, canyon areas are subject to flooding (County of Orange & Orange County Fire Authority 2021).

The western portion of Riverside County falls within the South Coast Region and contains portions of the Santa Ana River, San Jacinto River and Santa Margarita River watersheds. The South Coast hydrologic region extends up from the U.S. - Mexico border to the Tehachapi, San Bernardino, San Gabriel, and San Jacinto mountains. Nearly one-third of the area is coastal plain. Much of the flooding that occurs here is sudden and severe, resulting in massive slides, debris flows, and mudflows (County of Riverside Emergency Management Department 2018).

The eastern portion of Riverside County falls within the Desert Region and contains portions of the Whitewater River and Colorado River watersheds. Metropolitan's Colorado River Aqueduct system is within this region. The region is marked by the San Bernardino and San Jacinto mountains. This is generally a sparsely populated agricultural region that experiences sporadic flooding; however, the upper Coachella Valley has a much higher population density. Both common winter storm events and summertime monsoonal flows from Mexico's Pacific Coast can spawn massive rainstorms, general flooding and flash floods (County of Riverside 2023).

In San Bernardino County, flash flooding tends to occur in the summer and early fall because of the monsoon rains and is typified by increased humidity and high summer temperatures. The desert area contains many mountain ranges that are steep and experience summer thunderstorms causing flash floods in many dry washes on the desert floor. The water collects in dry lake beds throughout the desert area. Cities and towns often experience street closures for several days due to sediment transport and road damage. Because of the sheet flow character of the desert, many private properties experience erosion and sediment deposits. The urban valley also can experience flash flooding in its narrow canyons and within the many unimproved creeks and interim channels feeding the Santa Ana River. Three-fourths of the county population lives in the urban valley region which contains the headwaters of the Santa Ana River (County of San Bernardino 2017).

In San Diego County, without extended periods of below-freezing temperatures, floods usually occur during the season of highest precipitations or during heavy rainfalls after long dry spells. The areas surrounding the river valleys in all of San Diego County are susceptible to flooding because of the wide, flat floodplains surrounding the riverbeds, and the numerous structures that are built in the floodplains. The western watershed of the County of San Diego extends about 80 miles north from the Mexican border and approximately 45 miles east of the Pacific Ocean. From west to east, there are about 10 miles of rolling, broken coastal plain, 10 to 15 miles of foothill ranges with elevations of 600 to 1,700 feet; and approximately 20 miles of mountain country where elevations range from 3,000 to 6,000 feet. This western watershed constitutes about 75 percent of the County, with the remaining 25 percent mainly desert country. There are over 3,600 miles of rivers and streams which threaten residents and over 200,000 acres of flood-prone property. Seven major streams originate or traverse through the unincorporated area: the Santa Margarita, San Luis Rey, San Dieguito, San Diego, Sweetwater, Otay, and Tijuana Rivers (County of San Diego 2017).

In Ventura County, floods usually occur during the season of highest precipitation or during heavy rainfalls after prolonged dry periods. In areas where flow contains a high sediment load, such as along the Santa Clara River in Ventura County, the course of a river or stream may shift dramatically during a single flood event. Ventura County is dry during the late spring, summer, and early fall and receives most of its rain during the winter months. The average annual rainfall in Ventura County ranges from less than 8 inches in the Cuyama Valley in northwestern Ventura County to 38 inches in the Ventura River watershed west of the City of Ojai. Along the coast near Oxnard, San Buenaventura, Simi Valley, and Thousand Oaks, the average rainfall is approximately 14 inches (County of Ventura 2015).

Flooding in the planning area is typically caused by high-intensity, short-duration (1 to 3 hours) storms concentrated on a stream reach with already saturated soil. Flooding is predominantly confined within traditional riverine valleys. Locally, some natural or constructed levees separate channels from floodplains and cause independent overland flow paths. Occasionally, railroad, highway, or canal embankments form barriers, resulting in ponding or diversion of flows. Some localized flooding not associated with stream overflow can occur where there are no drainage facilities to control flows or when runoff volumes exceed the design capacity of drainage facilities.

11.2.1 Principal Flooding Sources

In Southern California, most flooding is the result of heavy precipitation over one or two days. Short streams and steep watersheds emptying onto lowlands that may be heavily populated produce large volumes of water in short periods, and damage is often severe. The problem is sometimes compounded by the denuding of large areas of watershed by fire during the previous season. Figure 11-1 shows FEMA mapping of the 100-year and 500-year floodplains in the Metropolitan Water District planning area.

11.2.2 Past Events

Collectively, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura Counties have experienced 19 flooding events since 1965 for which federal disaster declarations were issued, as summarized in Table 11-1. Review of these events helps identify targets for risk reduction and ways to increase a community's capability to avoid large-scale events in the future. Many flood events do not trigger federal disaster declaration protocol but have significant impacts on local communities. These events are also important to consider in establishing recurrence intervals for flooding. The following sections describe significant recent flood events in Metropolitan's service counties as well as recent flood events that impacted the Colorado River Aqueduct.

Table 11-1. History of Flood Events

Date	Declaration #	Type of event
2/4/2024 – 2/5/2024	DR-4758	Severe Storm and Flooding
8/19/2023 – 8/21/2023	DR 4750, DR 4743	Flooding, Hurricane Hilary, Tropical Storm Hilary
12/27/2022 – 1/31/2023	DR-4683	Severe Winter Storms, Flooding, Landslides, and Mudslides
2/13/2019 – 2/19/2019	DR 4431	Severe Winter Storms, Flooding, Landslides, and Mudslides
1/18/2017 – 1/23/2017	DR-4305	Severe Winter Storms, Flooding, and Mudslides
12/4/2014 – 12/6/2014	DR-4206	Severe Storms, Flooding, and Mudslides
12/17/2010 – 1/4/2011	DR-1952	Winter Storms, Flooding, and Debris and Mud Flows
1/5/1993 – 3/20/1993	DR-979	Severe Storm, Winter Storm, Mud & Landslides, Flooding
2/10/1992 – 2/18/1992	DR-935	Snowstorm, Heavy Rain, High Winds, Flooding, and Mudslide
1/17/1988 – 1/22/1988	DR-812	Severe Storms, High Tides, and Flooding
8/15/1983 – 8/18/1983	DR-690	Flash Flooding
6/16/1983 – 2/1/1984	DR-687	Flooding
1/8/1980	DR-615	Severe Storms, Mudslides, and Flooding
7/27/1979	DR-594	Heavy Rains, Flooding, Mud Flows
2/15/1978	DR-547	Coastal Storms, Mudslides, and Flooding
9/21/1976	DR-521	Flooding, Tropical Storm Kathleen
1/26/1969	DR-253	Severe Storms and Flooding
1/2/1967	DR-223	Severe Storms and Flooding
12/7/1965	DR-211	Heavy Rains, Flooding

Source: (FEMA 2025)

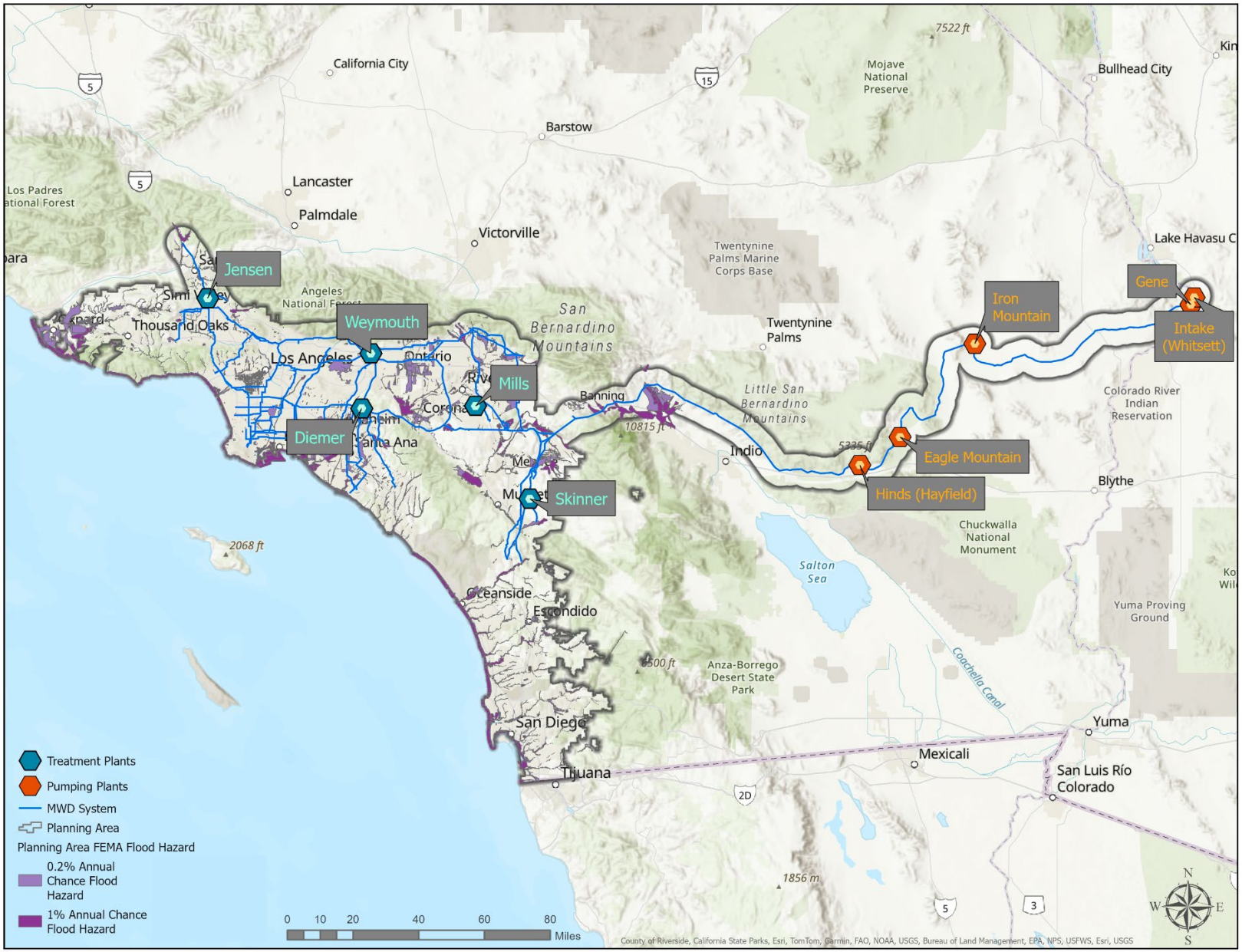


Figure 11-1. FEMA Floodplain Mapping for the Planning Area

February 4 – 6, 2024 Winter Storms

A series of winter storms impacted eight counties across California, bringing high winds, heavy rain, and heavy snowfall (CA.gov 2024). Over 10 inches of rain fell in portions of Los Angeles County, with some areas reaching nearly 1 foot of rainfall. Mountain areas received up to 2 feet of snow, and road closures were reported across the state (Gilbert, et al. 2024).

August 19 – 21, 2023 Tropical Storm Hilary

As it passed over the Whitewater River watershed, the storm released intense heavy rainfall in the mountains and the Coachella Valley. Widespread flooding damaged the water control structures used to deliver water from the Colorado River Aqueduct to groundwater recharge facilities for the Coachella Valley. Metropolitan's water deliveries to Desert Water Agency and Coachella Valley Water District were halted while the facilities were reconstructed.

December 27, 2022 – January 31, 2023, Winter Storms

An atmospheric river impacted Central and Southern California, bringing heavy precipitation and snowfall that caused flooding, landslides, and mudslides to impact the region. Over 40 inches of snow and 10 inches of rain fell in a matter of days in some regions of the State (FEMA 2025).

February 14, 2019, Winter Storm

The Colorado River Aqueduct crosses the Whitewater River in a pair of buried siphons at a location north of the city of Palm Springs. In November 2018, Metropolitan completed construction of an erosion protection structure in the Whitewater River to reduce the risk of damage to the siphons from erosion caused by storm flows. On February 14, 2019, a significant warm-weather rainfall event in the Whitewater watershed area greatly increased river flows across the structure. The velocity and quantity of the flows mobilized very large boulders and debris, which in turn caused significant damage to the recently constructed erosion control structure. Approximately 3,200 cubic yards of gabion cages and riprap were damaged in the event. Repairs were completed before the 2019 – 20 winter storm season.

January 18 – 23, 2017 Winter Storms

A series of storms pounded Southern California, dropping about 4 inches of rain on Los Angeles. Flash flood watches and warnings were in effect across Southern California where multiple roads were closed or blocked by fallen trees. Traffic was diverted off Interstate 110 south of downtown Los Angeles because of water flowing across lanes. The 710 Freeway was also closed because of flooding (Associated Press 2017).

January-March 1993 Winter Storms

From January 6 to February 28, 1993, a series of storms produced 20 to 40 inches of rain over much of the southern California coastal and mountain areas and more than 52 inches at some stations in the San Bernardino Mountains. These storms, which coincided with a reappearance of weak "El Nino" conditions, were driven by an atmospheric low-pressure system off the coast of northern California and Oregon. In Southern California, precipitation intensified because a high-pressure area that extended over Alaska, the Gulf of Alaska, and the Western States concentrated this low-pressure system farther south than usual and held it in place just offshore.

Tropical moisture was supplied to the arriving storms from the southern jet stream, which crossed the coast from the southwest at about the latitude of San Diego (Bowers 1993).

February 10 – 18, 1992 Storm

During February 1992, a series of relatively warm storms passed eastward across southern California, yielding intense precipitation that triggered widespread landslides, flooding, property damage, and loss of life. These storms were triggered by an intense low-pressure system off northern California that deepened as its eastward progress was initially blocked by a high-pressure ridge across western North America. Debris flows occurred where cumulative precipitation exceeded 12 inches and when sustained intensities exceeded an inch per hour. Stream response was rapid, particularly in urban areas where impermeable surfaces and storm drains fed concrete stream channels. Some streams saw recurrence intervals for peak discharge of between 8 and 24 years (Raphael, et al. 2013).

January 17 – 22, 1988 Severe Storms

In January 1988, a winter storm swept away miles of sand, leaving in its place a swath of destruction along the shore. Breakers 25 feet high pounded a 135-mile stretch of coast from Santa Barbara to San Diego counties. High tides combined with 20-foot waves and strong winds to whisk away as much as 10 feet of sand from beachfront homes north of Laguna Beach. The storm was blamed for eight deaths and $68 million in property damage in Southern California, including $16 million in Redondo Beach. Orange, Los Angeles, and San Diego Counties were declared emergency areas (LA Times 1993).

January 8, 1980, Severe Storms

Flooding was caused by two severe storms in January 1980 that soaked soils, decreased unfilled reservoir capacities, and caused extensive damage along coastal streams of Southern California (USGS 1980).

February 15, 1978, Coastal Storms

During February 8 to 10, 1978, heavy rains fell on the southern San Joaquin Valley and Los Angeles Basin and surrounding mountains. The resultant flooding, flash flooding, and mudslides caused widespread damage and 20 deaths. Property damage from the storm totaled $43 million in the Los Angeles area and $40 million in the southern San Joaquin Valley—the latter mostly due to flooding of agricultural lands. Eight counties were declared federal disaster areas.

January 26, 1969, Severe Storms

Intense floods in central and southern California due to storms that occurred between January 18 and February 25 caused severe damage over a large area. The major flood-affected area includes the basins of many streams that have their sources in the central and south-coastal ranges, in the southern part of the San Joaquin Valley, and the southern Sierra Nevada foothills from the Kern River basin on the south to the Mariposa Creek basin north of Fresno (USGS 1975).

11.2.3 Location

Digital Flood Insurance Rate Maps are FEMA's official delineation of special flood hazard areas within all six service counties. While there are occurrences of urban drainage flooding within the service area, there are no

available maps of the extent and/or location of this type of flooding. With no available spatial data on extent and location of the flood hazard, all components of this hazard profile are qualitative. Figure 11-1 shows the FEMA special flood hazard areas within the Metropolitan service area.

11.2.4 Frequency

Metropolitan's six service counties experienced 16 flood events that triggered a federal disaster declaration since 1965, an average of one such flood event every 3.6 years. Records show that Southern California can expect to experience some degree of localized flooding annually.

11.2.5 Severity

The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high velocity flows and transporting debris and sediment. Flood severity is often evaluated by examining peak discharges. For urban drainage flooding, slope (gradient) and impervious surfaces can increase the velocities of surface water flows. As an illustration of the power of water, 6 inches of flood water moving at a velocity of 3 feet per second or greater can move a standard sized passenger vehicle.

The major flooding causes in Metropolitan's service area are short-duration, high-intensity storms that could cause urban stormwater runoff that exceeds the capacity of the stormwater management infrastructure. Water courses in the service area can flood in response to a succession of intense winter rainstorms, usually between early November and late March. A series of such weather events can cause severe flooding due to the large percentage of impervious area and the age and capacity of the drainage system. A worst-case scenario is a series of storms that flood numerous drainage basins in a short time. The debris basins could be overtopped if they are full of debris and sediments, acting like small dam failure events. This could overwhelm response and floodplain management capabilities. Major roads could be blocked, preventing access to Metropolitan facilities by Metropolitan personnel.

For Metropolitan's desert facilities, winter storm events and summertime monsoonal flows can generate massive rainstorms, general flooding and flash floods. Flooding can cause scour and expose pipeline and other subsurface structures, affect erosion control structures, and deposit sand and sediment near open aqueduct reaches.

11.2.6 Warning Time

The warning time that a community has to take action to protect lives and property from a flooding threat is a function of the time between the first predictions of heavy rainfall, the first rainfall, and the first occurrence of flooding.

Each watershed has unique qualities that affect its response to rainfall. A hydrograph, which is a graph or chart of stream flow in relation to time (see Figure 11-2), is a useful tool for examining a stream's response to rainfall. Once rainfall starts falling over a watershed, runoff begins, and the stream begins to rise. Water depth in the stream channel (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. At this peak, the stream stage remains at a constant level until it begins to fall and eventually subside to a level below flooding stage. The length of time that floodwaters remain above flood stage is an important characteristic of the flood hazard.

Serious flooding usually occurs with warning due to the sequential pattern of meteorological conditions needed to cause serious flooding. Warning times for river and stream floods can be between 24 and 48 hours. Flash flooding can be less predictable, but communities can be warned of the potential for flash flooding to occur.

Within the planning area, each County Flood Control District and other agencies share a joint responsibility in managing flood risk. County Flood Control Districts are the main regional agencies able to address large regional drainage needs and use available funds to operate and maintain the existing flood control facilities and systems that transect the various cities and unincorporated areas. During years of heavy rainfall, the existing flood control systems have largely prevented serious flooding.

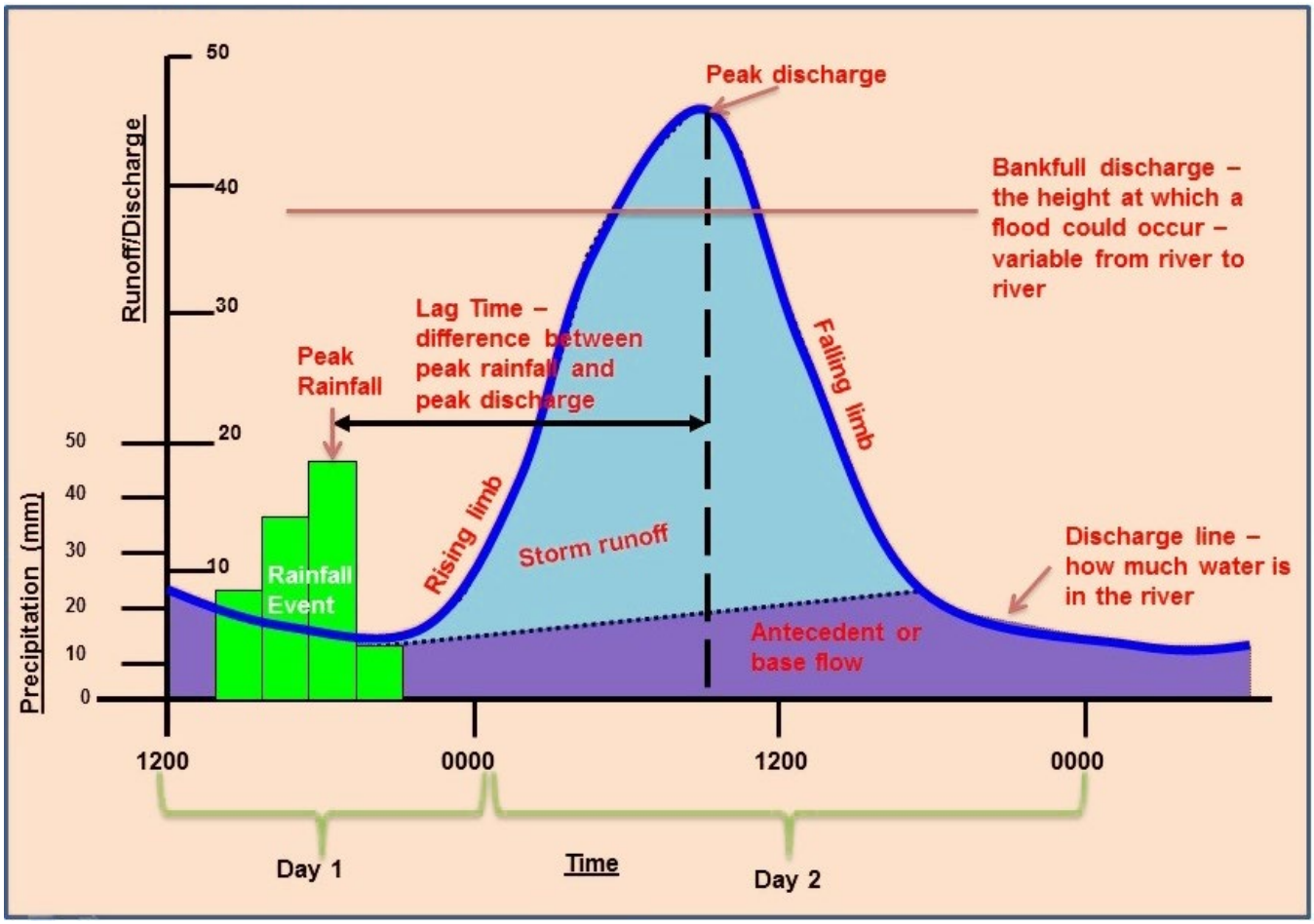


Figure 11-2. Example Hydrograph

11.3 EXPOSURE

The risk assessment for the flood hazard evaluated Metropolitan assets that lie within the mapped 1 percent annual chance and 0.2 percent annual chance flood inundation areas (see Figure 11-1). Table 11-2 and Table 11-3 summarize the number of assets by category within these mapped hazard areas and the total replacement cost value of those assets. For the linear assets, below ground pipelines are assumed to not be at risk from flood; only those linear assets that are above ground and within the mapped flood areas are considered exposed. Details by type of facility are included in Appendix D. These results are shown as the percent of planning area totals for each asset type in Figure 11-3 through Figure 11-5.

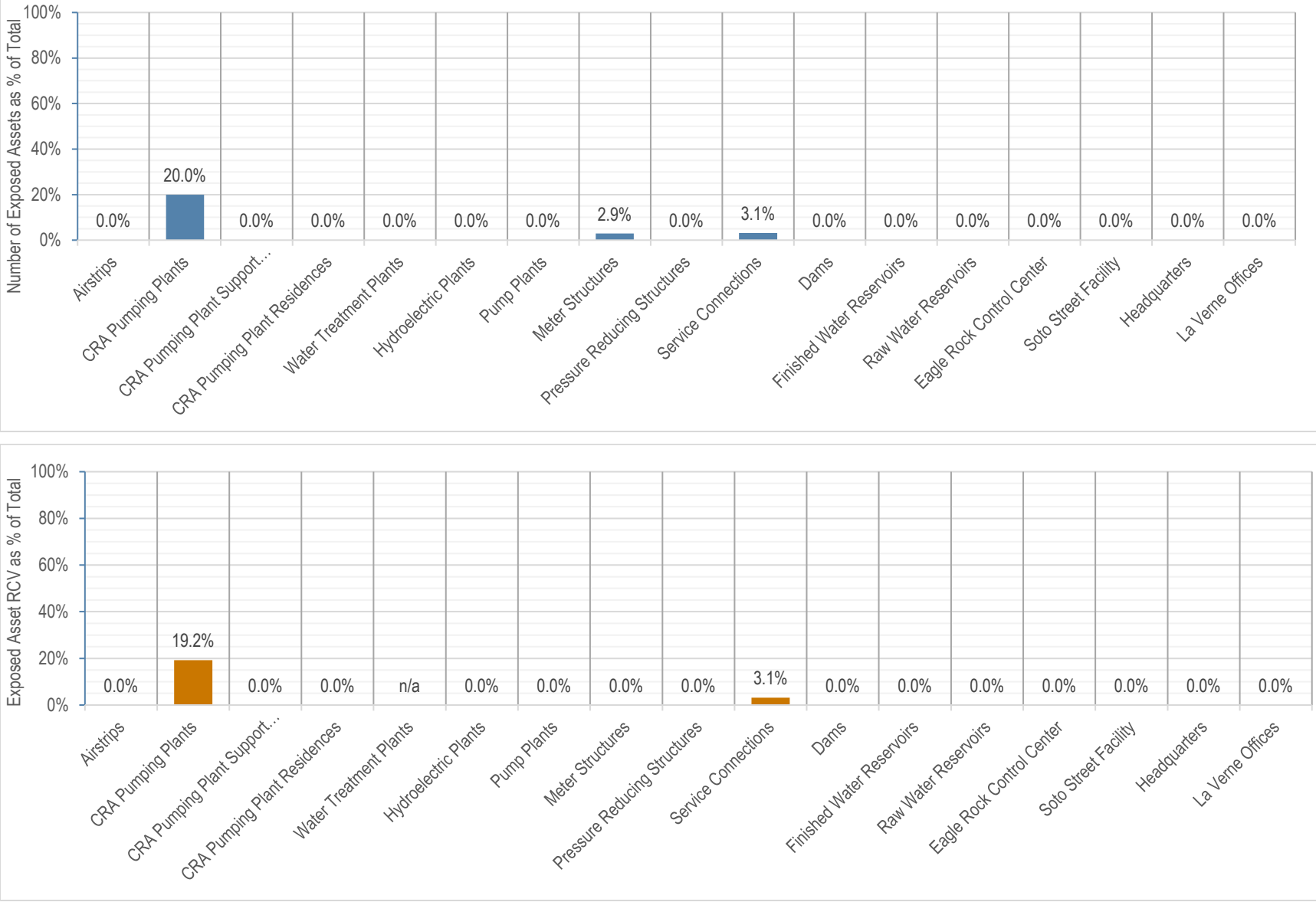
Table 11-2: Metropolitan Non-Linear Assets in the Mapped Flood Area

	Structures within the 1% Annual Chance Flood Zone		Structures within the 0.2% Annual Chance Flood Zone		Structures within the Flood Awareness Zone	
	Number of Structures	Replacement Cost Value	Number of Structures	Replacement Cost Value	Number of Structures	Replacement Cost Value
Colorado River Aqueduct Facilities						
Airstrips	0	$0	0	$0	1	$186,228
Pumping Plants	1	$265,429,246	1	$265,429,246	0	$0
Pumping Plant Support Buildings	0	$0	0	$0	1	$17,127,915
Residences	0	$0	0	$0	1	$8,584,056
Conveyance and Distribution Facilities						
Water Treatment Plants	0	$0	0	$0	1	$1,039,770,163
Hydroelectric Plants	0	$0	0	$0	0	$0
Pump Plants	0	$0	0	$0	0	$0
Meter Structures	14	n/a	52	n/a	18	n/a
Pressure Reducing Structures	0	$0	4	$21,285,972	0	$0
Service Connections	17	$6,922,485	64	$26,061,120	13	$5,293,665
Dams	0	$0	0	$0	0	$0
Building Facilities						
Headquarters	0	$0	0	$0	0	$0
La Verne Offices	0	$0	0	$0	0	$0
Eagle Rock Control Center	0	$0	0	$0	0	$0
Soto Street	0	$0	0	$0	0	$0
Reservoirs						
Finished Water Reservoirs	0	$0	0	$0	0	$0
Raw Water Reservoirs	0	$0	0	$0	0	$0

Table 11-3. Metropolitan Linear Assets in the Mapped Flood Hazard Areas*

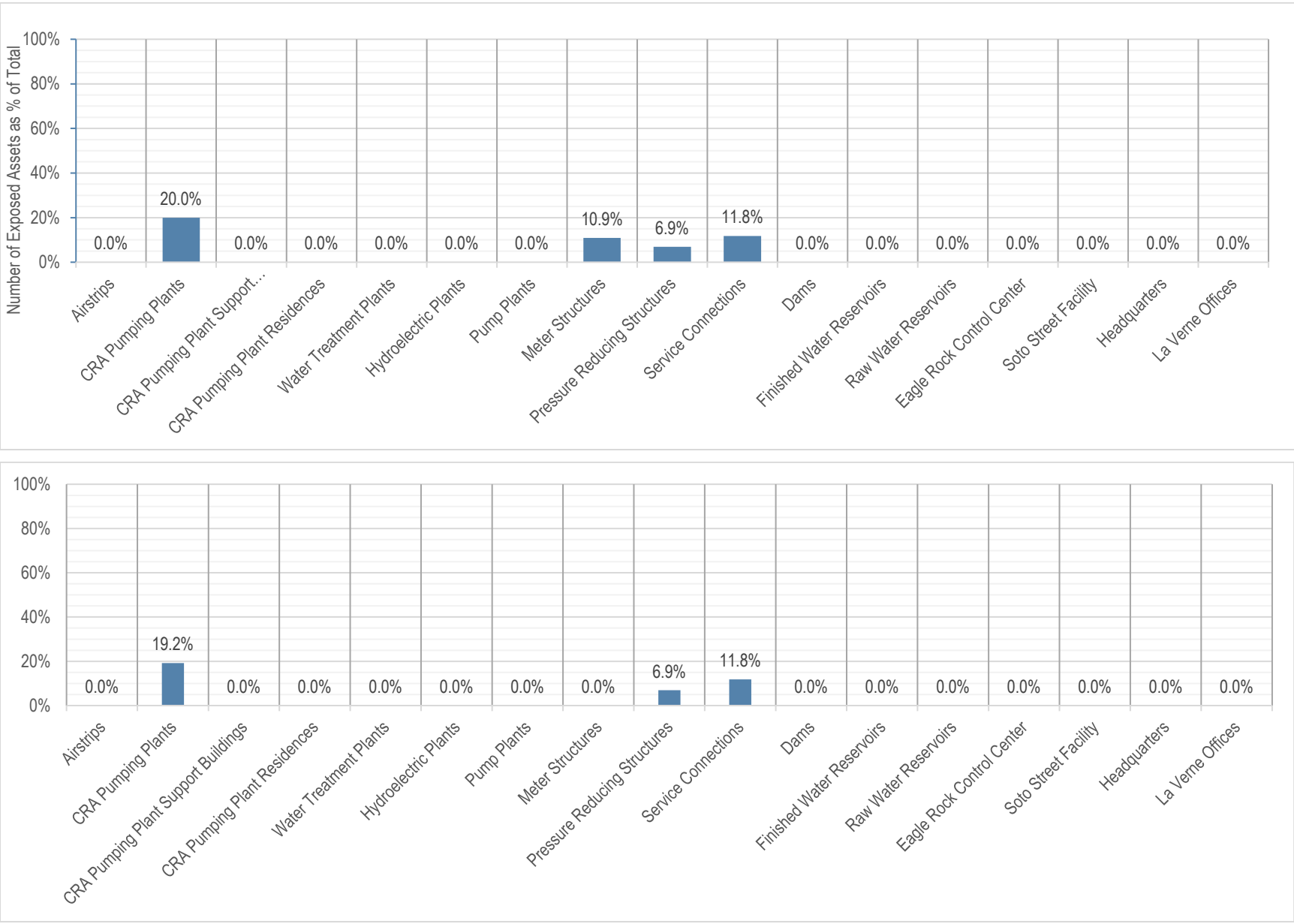
	Length Within in the 1% Annual Chance Flood Zone		Length Within in the 0.2% Annual Chance Flood Zone		Length Within in the Flood Awareness Zone	
	Length (miles)	Replacement Cost Value	Length (miles)	Replacement Cost Value	Length (miles)	Replacement Cost Value
Colorado River	0	$0	0	$0	0.27	$5,932,562
C&D Pipelines	0	$0	0.01	$109,907	2.03	$22,311,135

*Only above ground sections are considered for the flood hazard analysis



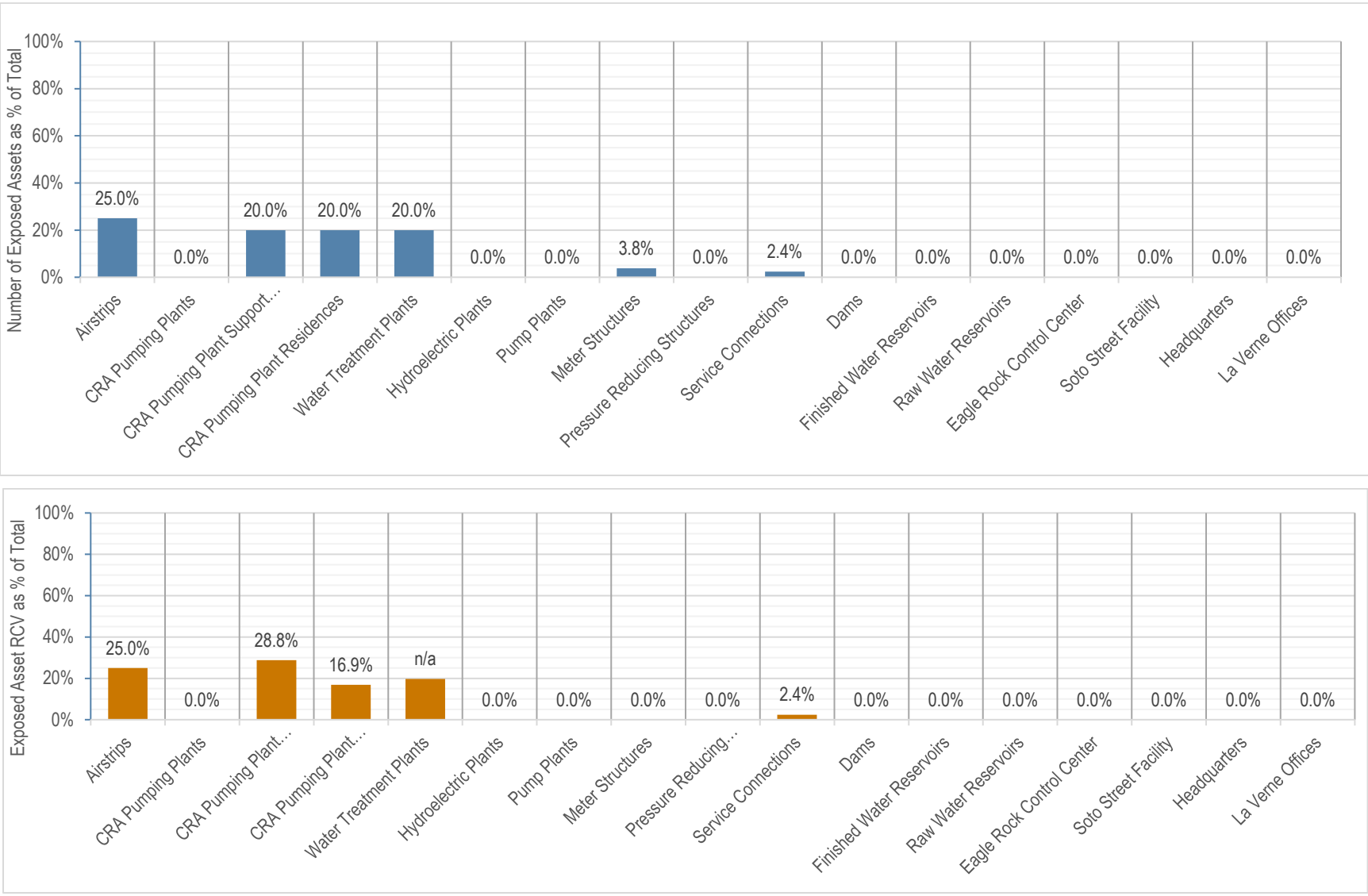
n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 11-3. Percent of Total Assets (Number and Value) in the 1% Annual Chance Flood Hazard Areas



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 11-4. Percent of Total Assets (Number and Value) in the 0.2% Annual Chance Flood Hazard Areas



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 11-5. Percent of Total Assets (Number and Value) in the Flood Awareness Hazard Areas

11.4 VULNERABILITY

In general, flooding from high intensity storms is anticipated to have minimal to no impact on Metropolitan infrastructure or deliveries to member agencies for their retail customers. The exposure analysis shows the flood risk as limited to structures on the distribution system such as service connections. Severe flooding is not expected to impact these structures or buried pipelines within the distribution system. Metropolitan's treatment plants are always manned. If roads are blocked, the staff on hand can continue to operate the plants until roads reopen, and much of Metropolitan's flow regulating facilities can be operated remotely.

Regarding desert facilities, Metropolitan constructed berms as part of the original CRA construction to divert flows from severe storms and protect the aqueduct. However, some CRA locations have experienced scour resulting in exposure of conduit. There were no delivery interruptions resulting from the exposed conduit. If the CRA were to be damaged, Metropolitan maintains a minimum six-month emergency water storage within the region which will provide time for repairs without delivery interruptions.

Other infrastructure and development in flood hazard areas can see significant impacts from flooding; however, this risk assessment does not evaluate infrastructure or buildings that are not part of the regional water system that Metropolitan owns and operates. Metropolitan does not have the responsibility or ownership of the infrastructure that would be at risk, with the exception of its facilities, and does not have land use authority. Metropolitan coordinates with the Office of Emergency Services in the six counties as they are the lead on providing information for public safety on flood protection.

11.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands. In addition, Metropolitan works with local jurisdictions on development projects within the vicinity of existing infrastructure to protect public safety, easements and the integrity of the system.

Metropolitan's Capital Investment Plan includes several programs to improve infrastructure and reliability, which may include projects to reduce or avoid risk of flood. Programs include Colorado River Aqueduct Reliability, Dams & Reservoirs Improvements, Distribution System, Additional Facilities and Systems, and Water Treatment Plants.

11.6 CLIMATE CHANGE

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, the hydrologic record cannot be used to predict changes in frequency and severity of extreme climate events such as floods. Going forward, model calibration or statistical

relation development must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain areas to contribute to peak storm runoff. High frequency flood events (e.g., 10-year floods) in particular will likely increase with a changing climate. Along with reductions in the amount of the snowpack and accelerated snowmelt, scientists project greater storm intensity, resulting in more direct runoff and flooding. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality. With potential increases in the frequency and intensity of wildfires due to climate change, there is potential for more floods following fire, which increase sediment loads and water quality impacts.

As hydrology changes, what is currently considered a 1-percent-annual-chance flood may become more likely, leaving many communities at greater risk. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.

Metropolitan's exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change resulting in risk to facilities that have not historically been at risk from flooding. Additionally, changes in the management and design of community lifelines responsible for flood protection may be needed as additional stress is placed on these systems.

11.7 ISSUES

The following flood-related issues are relevant to the planning area:

- Due to the lack of flood hazard mapping, the understanding of the risk from urban drainage flooding within Metropolitan's service area is low.
- Planning tools whose use depends on flood hazard mapping are less effective due to the deficiencies in the currently available mapping.
- There needs to be a sustained effort to gather historical damage data, such as high-water marks on structures and damage reports, to measure the cost-effectiveness of future mitigation projects.
- Debris basins in Metropolitan's service area could overtop if they become filled with debris and sediment.
- Indirect impacts from flooding outside Metropolitan's service area such as power interruption could impact Metropolitan operations.

- Flooding in the Whitewater River watershed and other desert areas can impact Colorado River Aqueduct operations and impact Metropolitan's ability to bring water into the service area and deliver water to Desert Water Agency and Coachella Valley Water District.
- The potential impact of climate change on flood conditions needs to be better understood.
- The risk associated with the flood hazard overlaps the risk associated with other hazards such as earthquake, landslide, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

12. LANDSLIDE

12.1 GENERAL BACKGROUND

Ground saturation by water, steepening of slopes by erosion or construction, alternate freezing and thawing, and earthquake shaking are all factors that contribute to landslides. These factors can all be exacerbated following wildfires that denature hillsides and bake the soils, making them prone to debris flows. Landslides are typically associated with periods of heavy rainfall or rapid snow melt. Rain-saturated hill slopes and increased groundwater pressure on porous hillsides are triggering agents of slope failure. In areas burned by wildfires, a lower threshold of precipitation may initiate landslides.

12.1.1 Landslide and Debris Flow Types

Landslides are commonly categorized by the type of initial ground failure. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less common than other types.

Debris flows—sometimes referred to as mudslides or mud flows—are rivers of rock, earth, organic matter, and other soil materials saturated with water. Debris flows develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. The consistency of debris flows ranges from watery mud to thick sludge that can carry large items such as boulders, trees, and cars. Debris flows from many sources can combine into channels that, with the addition of water, sand, mud, boulders, trees, and other materials, can become greatly more destructive. The debris carried by a debris flow has the potential to spread over a broad area, wreaking havoc in developed communities.

A debris avalanche is a fast-moving debris flow that travels faster than about 10 miles per hour (mph). Speeds of more than 20 mph are not uncommon, and speeds of more than 100 mph, although rare, can occur. Debris avalanches can travel many miles from their source, picking up large objects in their path and they can have many times the hydraulic force of water due to the mass of material included in them. They can be among the most destructive events in nature.

Landslides also include the following:

- **Rock Falls**—Blocks of rock that fall away from a bedrock unit without a rotational component
- **Rock Topples**—Blocks of rock that fall away from a bedrock unit with a rotational component
- **Rotational Slumps**—Blocks of fine-grained sediment that rotate and move down slope

- **Transitional Slides**—Sediments that move along a flat surface without a rotational component
- **Earth Flows**—Fine-grained sediments that flow downhill and typically form a fan structure
- **Creep**—A slow-moving landslide often only noticed through crooked trees and disturbed structures
- **Block Slides**—Blocks of rock that slide along a slip plane as a unit down a slope

12.1.2 Landslide and Debris Flow Causes

Landslides are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. Although they can be triggered by seismic activity, in general, landslides are most likely during periods of higher-than-average rainfall. The ground must be saturated prior to the onset of a major storm for a significant landslide to occur. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides. The following human-caused factors can contribute to landslide: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes.

Excavation and Grading

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

Drainage and Groundwater Alterations

While permeable soils soak up rain and irrigation water, proper grading and drainage systems can collect water to protect slopes from oversaturation and slippage. Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. Even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems. Drains, gutters, downspouts, and other constructed drainage facilities found on roads or in driveways can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

Following major brushfires, federal or state agencies typically seed denuded slopes with wild plant seeds. This encourages vegetation growth, thereby stabilizing the barren soil and protecting the watershed from erosion. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard.

12.1.3 Landslide and Debris Flow Management

While small landslides and flows are often a result of human activity, the largest are often naturally occurring phenomena with little or no human contribution. The sites of large landslides and debris flows are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. Such naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, stream bank erosion and rapid stream channel migration.

Landslides and debris flows can create immediate, critical threats to public safety. Engineering solutions to protect structures on or near large active landslides are often expensive. In spite of their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to stream channel networks and can contribute to stream complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability through codes and ordinances.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among local, state, and federal agencies, and to provide emergency assistance to affected or at-risk residents
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified as a threat to critical public structures or infrastructure

12.1.4 Secondary Hazards

Landslides are not generally known to result in secondary hazards. A landslide that blocks a river or stream has the potential to cause flooding due to channel relocation.

12.2 HAZARD PROFILE

12.2.1 Past Events

Table 12-1 lists landslide events in the planning area that were included in federal disaster declarations. Table 12-2 lists other known landslide events that occurred in the six Metropolitan Water District service counties between 1970 and December 2023.

Table 12-1. Federally Declared Landslide Events

Date	Declaration #	Type of Event
02/12/2023 – 07/10/2023	DR-4699	Severe Winter Storms, Straight-Line Winds, Flooding, Landslides, and Mudslides
02/12/2019 – 02/15/2019	DR-4431	Severe Winter Storms, Flooding, Landslides, and Mudslides
12/4/2017 – 01/31/2018	DR-4353	Wildfires, Flooding, Mudflows, and Debris Flows
01/18/2017 – 01/23/2017	DR-4305	Severe Winter Storms, Flooding, and Mudslides
12/17/2010 – 01/04/2011	DR-1952	Winter Storms, Flooding, and Debris and Mud Flows
01/17/2010 – 02/06/2010	DR-1884	Severe Winter Storms, Flooding, Debris and Mud Flows
10/21/2007 – 03/31/2008	DR-1731	Wildfires, Flooding, Mud Flows, and Debris Flows
02/16/2005 – 02/23/2005	DR-1585	Severe Storms, Flooding, Landslides, and Mud and Debris Flows
12/27/2004 – 01/11/2005	DR-1577	Severe Storms, Flooding, Debris Flows, and Mudslides
10/21/2003 – 03/31/2004	DR-1498	Wildfires, Flooding, Mudflow, and Debris Flow

Date	Declaration #	Type of Event
02/13/1995 – 04/19/1995	DR-1046	Severe Winter Storms, Flooding, Landslides, Mud Flows
01/03/1995 – 02/10/1995	DR-1044	Severe Winter Storms, Flooding, Landslides, Mud Flows
10/26/1993 – 04/22/1994	DR-1005	Fires, Mud & Landslides, Soil Erosion, Flooding
01/05/1993 – 03/20/1993	DR-979	Severe Storm, Winter Storm, Mud & Landslides, Flooding
02/10/1992 – 02/18/1992	DR-935	Snowstorm, Heavy Rain, High Winds, Flooding, Mudslide
01/21/1983 – 03/30/1983	DR-677	Coastal Storms, Floods, Slides, Tornadoes
01/08/1980	DR-615	Severe Storms, Mudslides, Flooding
07/27/1979	DR-594	Heavy Rains, Flooding, Mud Flows
10/09/1978	DR-566	Landslides
02/15/1978	DR-547	Coastal Storms, Mudslides, Flooding

Source: (FEMA 2025)

Table 12-2. Landslide Events Proximal to Metropolitan's Planning Area

Event Date	Event Type	FEMA Number	County	Description
02/21/2023 – 07/10/2023	Severe Winter Storms, Straight-line Winds, Flooding, Landslides, and Mudslides	4699	Los Angeles, Ventura	Storms brought severe wind and heavy flooding due to increased precipitation that triggered landslides and mudslides. A rare blizzard warning was issued, and snow fell at elevations as low as 1,000 feet. Over 12,000 residents lost power during this storm event.
02/12/2019 – 02/15/2019	Severe Winter Storms, Flooding, Landslides, and Mudslides	4431	Riverside	75 feet of pavement completely collapsed along State Route 243 near the remote community of Idyllwild.
12/4/2017 – 01/31/2018	Wildfires, Flooding, Mudflows, and Debris Flows	4353	Los Angeles, San Diego, Ventura	A winter storm passing over Southern California led to mudslides and debris flows that killed at least 17 people
1/18/2017 – 1/23/2017	Severe winter storms, flooding, and mudslides	4305	Los Angeles, Orange, Riverside, San Diego	Storms flooded roads, triggered mudslides, and submerged vehicles.
12/17/2010 – 01/04/2011	Winter Storms, Flooding, and Debris and Mud Flows	1952	Orange, Riverside, San Bernardino, San Diego	20 homes in San Bernadino County swamped with 3 feet of mud, evacuation orders issued for 200 more homes. Corona airport in Riverside County closed due to flooding. 30 people evacuated from mudslides in Orange County
1/17/2010- 2/6/2010	Severe Winter Storms, Flooding, and Debris and Mud Flows	1884	Los Angeles, Riverside, San Bernardino	A rainstorm triggered a mudslide along Ocean View Boulevard in the La Canada Flintridge burn area and others throughout the region.
10/21/2007 – 3/31/2008	Wildfires, Flooding, Mud Flows, and Debris Flows	1731	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	Heavy rains in Southern California after recent wildfires triggered evacuations due to landslide concerns
2/16/2005 – 2/23/2005	Severe Storms, Flooding, Landslides	1585	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	Heavy rains in Southern California led to several landslides
12/27/2004 – 01/11/2005	Severe Storms, Flooding, Debris Flows, and Mudslides	1577	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	After days of "record or near-record" rainfall, a hill in La Conchita gave way, killing 10 people. Over 400,000 tons of mud inundated the community, thirteen homes were destroyed, and another 23

Event Date	Event Type	FEMA Number	County	Description
				were damaged. Meanwhile, five straight days of heavy rains hit other parts of Southern California, causing other mountain slopes to slide and sewage to spill. The damages were estimated at $100 million, and a state of emergency was declared.
10/21/2003 – 3/31/2004	Wildfires, Flooding, Mud Flow and Debris Flow	1498	Los Angeles, Riverside, San Bernardino, San Diego, Ventura	In October, wildfires ravaged the San Bernadino mountains. On Christmas Day, heavy rains led to mud slides that destroyed property and caused 15 deaths.
2/13/1995 – 4/19/1995	Severe Winter Storms, Flooding, Landslides,	1046	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	A mudslide in La Conchita destroyed nine houses within a few seconds. According to a report by the U.S. Geological Survey, despite the destruction, no lives were lost.
1/3/1995 – 2/10/1995	Severe Winter Storms, Flooding, Landslides, Mudflows	1044	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	
1/17/1994	Northridge Earthquake	1008	Los Angeles, Orange, Ventura	The earthquake caused more than 11,000 landslides throughout the region. The landslides led to several deaths.
10/26/1993 – 4/22/1994	Fires, Mud/Landslides, Flooding, Soil Erosion	1005	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	Amid torrential rains that led to a disaster declaration for much of Southern California, city officials learned that the saturated Anaheim Hills bluff was sliding about an inch a day and evacuated 46 families.
1/5/1993 – 3/20/1993	Severe Winter Storm, Landslides, & Flooding	979	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	
2/10/1992 – 2/18/1992	Rain/Snow/Windstorms, Flooding, Mudslides	935	Los Angeles, Orange, San Bernardino, Ventura	One of southern California's heaviest winter storms triggered floods and mudslides in suburban Ventura County, killing at least six people and carrying large motor homes in a trailer park out to sea. The Ventura River, clogged by trees and debris, poured over its banks, covering streets and homes with mud. The Los Angeles River also overflowed twice in three days.
1/21/1983 – 3/30/1983	Coastal Storms, Floods, Slides and Tornadoes	677	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	
1/08/1980 – 02/21/1980	Severe Storms, Mudslides, Flooding	615	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	Six different storms hit Southern California in just over a week, and 30 people were killed by both floods and mudslides. "Post-fire flooding" caused a basin in Harrison Canyon to overflow four times, and

Event Date	Event Type	FEMA Number	County	Description
				hundreds of homes were either destroyed or damaged.
2/15/1978	Coastal Storms, Mudslides and Flooding	547	Los Angeles, Orange, Riverside, San Bernardino, San Diego, Ventura	Water and debris flowing down canyons led to 21 deaths and $50 million in damage.

Sources: (FEMA 2025) (Martichoux 2019), (Lindsey 2018), (Javier 2018), (NPR Staff and Wires 2010), (Associated Press 2007) (L.A. Times 1999) (Cannon 1992)

12.2.2 Location

The best predictor of where landslides might occur is the location of past landslides. These can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small portion of them may become active in any given year. Ancient dormant landslide sites can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding. As development has spread into the hillsides, unstable soil and erosion often contributes to landslides.

Factors that characterize landslide hazard areas include significant slope, weak rocks, and heavy rains. California's state geologist maps hazardous landslide areas for use by municipalities in planning and decision-making on grading and building permits. This program focuses on urban areas that experience heavy rainfall and that exhibit significant slopes and weak rocks. Figure 12-1 shows mapped landslide hazard areas.

12.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods, or wildfires, so landslide frequency is often related to the frequency of these other hazards. According to the National Centers for Environmental Information storm events database and the Southern California Earthquake Data Center, the planning area has been impacted by earthquakes, wildfires, and/or severe storms at least once every other year since 1960, representing an annual probability of 50 percent. Given the preponderance of steep slopes and the frequency of contributory sources to landslides in the planning area, the probability of future occurrence can be considered equal to this 50-percent annual probability. Until better data is generated specifically for landslide hazards, this frequency is appropriate for the purpose of ranking risk.

12.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. They can pose a serious hazard to properties on or below hillsides. Landslides directly damage structures in two ways: disruption of structural foundations caused by differential movement/deformation of the ground upon which the structure sits, and the physical impact of debris moving down-slope against structures located in the debris flow's path. As a landslide breaks away from a slope, it deforms the ground into an undulating surface broken up by fissures and scarps. This deformation distresses foundations and structures situated on top of a landslide by settlement, cracking, and tilting. This can occur slowly, over years, or rapidly within days or hours. A water-saturated, fast-moving debris flow can destroy all in its path, collapsing walls and shifting structures off their foundations.

Major landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater, wildfires, or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain isolated over a watershed denatured by wildfire in the vicinity of a structure or pipeline in Metropolitan's regional water system. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, soils become saturated with water. Soils in watersheds impacted by wildfires tend to become impermeable due to the extreme heat exposure, which can lead to debris flows. This is especially true for soils with high clay content. Weakness and destabilization in the slope can occur when water seeps downward through the upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

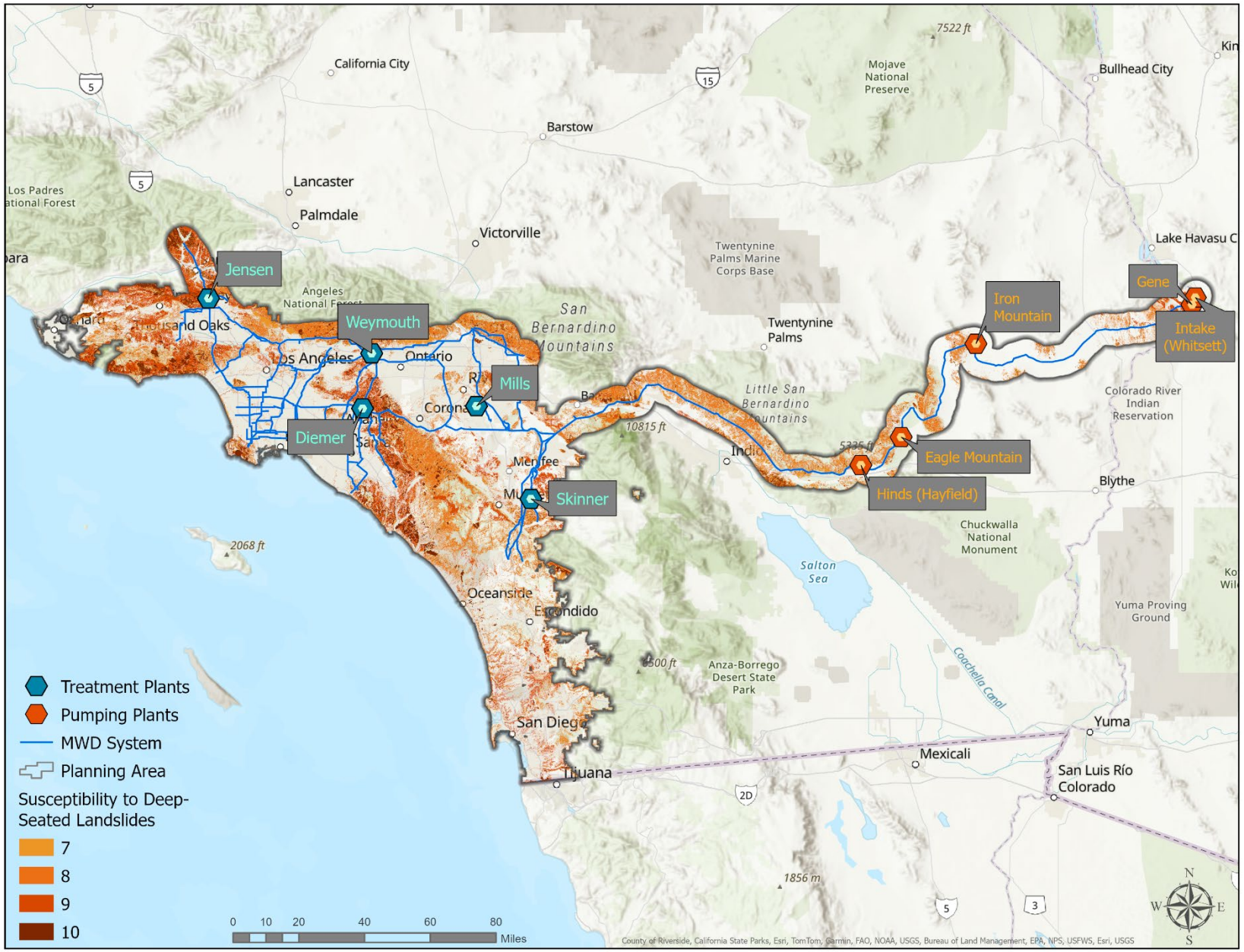


Figure 12-1. Regional Water System - Susceptibility to Deep-Seated Landslides

12.2.5 Warning Time

Landslides can be initiated by severe storms, earthquakes, wildfires, or human modification of the land. The velocity of landslide movement may range from inches per year to many feet per second, depending on slope angle, material, and water content. They can move rapidly down slopes or through channels and can strike with little or no warning. Some methods used to monitor landslides can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation, and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis and respond after the event has occurred.

When atmospheric river weather patterns occur, the risk of landslides increases. Improved forecasting of such events could allow advanced warning to better prepare for and respond to potential slope failures. According to the USGS, landslide warning signs can include but are not limited to the following (USGS 2023):

- Springs, seeps, or saturated ground in areas that have not typically been wet before.
- New cracks or unusual bulges in the ground, street pavements or sidewalks.
- Soil moving away from foundations.
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house.
- Tilting or cracking of concrete floors and foundations.
- Broken water lines and other underground utilities.
- Leaning telephone poles, trees, retaining walls or fences.
- Offset fence lines.
- Sunken or down-dropped roadbeds.
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content).
- Sudden decrease in creek water levels though rain is still falling or just recently stopped.
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb.
- A faint rumbling sound that increases in volume is noticeable as the landslide nears.
- Unusual sounds, such as trees cracking or boulders knocking together, might indicate moving debris.

12.3 EXPOSURE

The risk assessment for landslide evaluated Metropolitan assets that lie within the mapped deep-seated landslide area (Figure 12-1). Table 12-3 and 12-4 summarizes the number of assets by category within the mapped landslide area and the total replacement cost value of those assets. Details by type of facility are included in Appendix D. Figure 12-2 shows these results as the percent of planning area totals for each asset type. Transportation infrastructure and other development in landslide susceptibility areas can see significant impacts from landside activity; however, this risk assessment does not evaluate infrastructure or buildings that are not part of the regional water system that Metropolitan owns and operates. Metropolitan does not have the responsibility or ownership of the infrastructure that would be exposed, with the exception of access to its facilities, and does

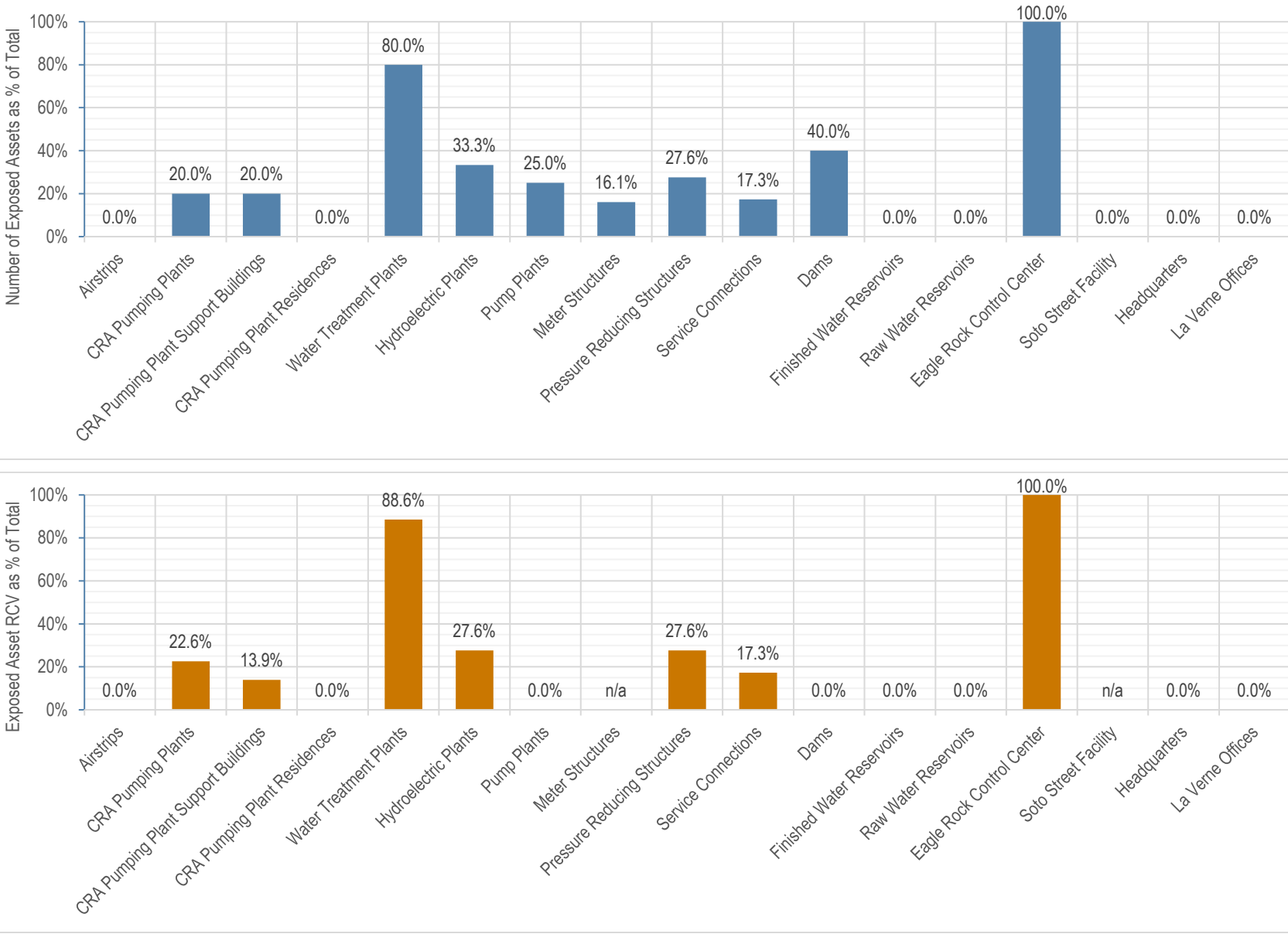
not have land use authority. Metropolitan coordinates with the emergency services agencies in the six counties as they are the lead on providing information for public safety during a major landslide event.

Table 12-3. Metropolitan Non-Linear Assets in the High or Very High Deep-Seated Landslide Hazard Areas

	Structures Within in the Hazard Area	
	Number of Structures	Replacement Cost Value
Colorado River Aqueduct Facilities		
Airstrips	0	$0
Pumping Plants	1	$313,287,098
Pumping Plant Support Buildings	1	$8,279,624
Residences	0	$0
Conveyance and Distribution Facilities		
Water Treatment Plants	4	$4,686,945,492
Hydroelectric Plants	5	$90,743,160
Pump Plants	1	n/a
Meter Structures	77	n/a
Pressure Reducing Structures	16	$85,143,890
Service Connections	94	$38,277,270
Dams	8	n/a
Building Facilities		
Headquarters	0	$0
La Verne Offices	0	$0
Eagle Rock	1	$15,733,961
Facility (Soto Street)	0	$0
Reservoirs		
Finished Water Reservoirs	0	$0
Raw Water Reservoirs	0	$0

Table 12-4: Metropolitan Linear Assets in the High or Very High Deep-Seated Landslide Hazard Areas

	Length (miles)	Replacement Cost Value
Colorado River Aqueduct	99.4	$2,184,061,633
C&D Pipelines	191.6	$2,107,242,190



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 12-2. Percent of Total Assets (Number and Value) in the High or Very High Deep-Seated Landslide Hazard Areas

12.4 VULNERABILITY

Loss estimation modeling is not available for the landslide hazard. Although complete historical documentation of the landslide threat in the planning area is lacking, the available history of landslides in the region suggests a significant vulnerability to such hazards. Mapping of the deep-seated landslide areas reveals portions of Metropolitan's distribution system within the highest risk areas. These are primarily pipelines that run along the foothills or mountainous terrain such as the Upper Feeder, Allen-McColloch Pipeline, Yorba Linda Feeder, and Inland Feeder. Many of these lines are deep tunnel sections that are not expected to be impacted by a landslide event. However, some of the shallower pipeline segments could become damaged if a landside were to occur. For example, damage to the Allen-McColloch Pipeline would result in loss of delivery to service connections downstream of the nearest isolation points. The pipeline serves Metropolitan member agency Municipal Water District of Orange County who conveys that water from the Allen McColloch Pipeline to populations within the cities of Tustin, Irvine, Mission Viejo, and Laguna Hills. If damage to the pipeline were to occur, these areas would be required to rely on local supplies such as groundwater or surface storage while Metropolitan repairs the pipeline.

The mapping also shows four of Metropolitan's treatment plants exposed to landslide. Metropolitan has been proactive in identifying and mitigating these hazards. Consequently, limited impacts to the service area are expected at the treatment plants.

12.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands. In addition, Metropolitan works with local jurisdictions on development projects within the vicinity of existing infrastructure to protect public safety, easements and the integrity of the system.

Metropolitan's Capital Investment Plan includes several programs to improve infrastructure and reliability, which may include projects to reduce or avoid risk of landslide impacts to facilities and operations. Programs include Colorado River Aqueduct Reliability, Distribution System, Additional Facilities and Systems, and Water Treatment Plants.

12.6 CLIMATE CHANGE

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability of landslides.

Metropolitan's exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard; however, Metropolitan may experience more frequent disruption to operations as a result of landslide hazards. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as debris basins and river and stream courses that protect Metropolitan's facilities.

12.7 ISSUES

Important issues associated with landslides in the planning area include the following:

- More than 200 of Metropolitan's community lifelines assets are located in a very high or high landslide susceptibility zone.
- Landslide activity within the planning area could impact access to Metropolitan's assets and operations.
- The high occurrence of wildfire activity within the planning area increases the probability for future debris flow and landslide potential.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.
- The potential impact of climate change on landslide risk needs to be better understood.
- Landslides may cause negative environmental consequences, including water quality degradation.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.

13. WILDFIRE

13.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. The potential for significant damage to life and property exists in areas designated as "wildland-urban interface areas," where development is adjacent to densely vegetated areas. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson. Fire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure. Vulnerability to flooding increases due to the destruction of vegetation and watersheds.

13.1.1 Secondary Hazards

Wildfires can have a significant impact on air quality, especially with prolonged periods of burning combined with climatic conditions. Wildfires strip slopes of vegetation, exposing them to greater amounts of runoff and debris flow. This in turn can weaken soils and cause failures on slopes. Major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This increases the runoff generated by storm events, thus increasing the chance of flooding.

Wildfires also trigger public safety power shutoff (PSPS) outages where utility service providers plan to de-energize parts of their system to help prevent the spread of wildfire and keep communities safe. Due to the grid nature of electrical power distribution systems, this can impact areas beyond where a wildfire is burning. Power outages can impact Metropolitan's operations and some communication systems.

Wildfires can impact the source watersheds for Metropolitan's imported water supplies. Wildfires in the Northern Sierra and along the Colorado River can increase runoff in the near term, decrease runoff as more moisture is absorbed and used by vegetation regrowth, and decrease the longevity of the snowpack through ash deposition.

13.2 HAZARD PROFILE

13.2.1 Past Events

Metropolitan's service area includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. Incident information from the California Department of Forestry and Fire Protection (CAL FIRE) identifies 299 wildfires throughout all six counties since 2005. In total, all six service counties have been included in 16 federal wildfire disaster declarations and another 104 federal fire management declaration events,

for a combined total of 120 federal declaration since 1956. Table 13-1 lists some of the most damaging urban-wildland interface fires that have affected Metropolitan's service counties since 2005 (as reported by CAL FIRE).

Table 13-1. Damaging Urban-Wildland Interface Fires in Metropolitan Service Counties Since 2005

Name	County	Dates	Area Burned (acres)
Eaton Fire	Los Angeles	January 7 – January 31, 2025	14,021
Palisades Fire	Los Angeles	January 7 – January 31, 2025	23,448
Airport Fire	Orange, Riverside	September 9 – October 5, 2024	23,526
Bridge Fire	Los Angeles, San Bernardino	September 8 – October 28, 2024	56,030
Line Fire	San Bernardino	September 5 – October 31, 2024	43,978
Rabbit Fire	Riverside	July 14 – 22, 2023	8,283
Fairview Fire	Riverside	September 5 – October 3, 2022	28,307
Apple Fire	Riverside	July 31 – November 16, 2020	33,424
Lake Fire	Los Angeles	August 12 – September 29, 2020	31,089
Woolsey Fire	Los Angeles, Ventura	November 8, 2018 – January 4, 2019	96,949
Saddleridge Fire	Los Angeles	October 10 – 31, 2019	8,799
Thomas Fire	Ventura, Santa Barbara	December 4, 2017 – January 12, 2018	281,893
Blue Cut Fire	San Bernardino	August 16 – 23, 2016	36,274
Station Fire	Los Angeles	August 26 – October 16, 2009,	160,577
Freeway Complex	Orange, Riverside	November 15 – 19, 2008	30,305
Witch Fire	San Diego	October 21 – November 6, 2007	197,990
Harris Fire	San Diego	October 21 – November 5, 2007	90,440
Ranch Fire	Los Angeles	October 20 – November 1, 2007	58,401
Poomacha Fire	San Diego	October 23 – November 9, 2007	49,410
Buckweed (Agua Dulce) Fire	Los Angeles	October 21 – November 1, 2007	38,000
Sawtooth Complex	San Bernardino	July 9 – 19, 2006	61,700

Source: (CAL FIRE 2025)
Notes: The 2008 Freeway Complex Fire directly impacted the Diemer Plant; the 2019 Saddleridge Fire directly impacted the Jensen Plant.

Within the planning area, the two most destructive fires have been the Eaton Fire and the Palisades Fire. Both wildfires, which occurred within Los Angeles County, ignited on January 7, 2025 and were exacerbated by severe winds that pushed the fires into neighboring communities. The Eaton Fire burned over 14,000 acres before being fully contained on January 31, 2025. The fire destroyed 9,414 structures, damaged an additional 1,074 structures and caused 19 deaths. The Palisades Fire burned over 23,000 acres, destroyed 6,837 structures, damaged another 973 structures and caused 12 deaths before full containment, also on January 31, 2025. The combined wildfires resulted in an estimated $28 billion to $53 billion in property damage and economic impacts between $4.6 billion and $8.9 billion (Los Angeles County Economic Development Corporation 2025).

In response to the Eaton and Palisades fires, Metropolitan activated its Emergency Operations Center coordinating with member agencies and emergency responders. Metropolitan provided logistical support and engineering support to the member agencies. The fires directly impacted Metropolitan member agency water systems damaging or destroying storage and distribution infrastructure. Additionally, several Metropolitan employees were directly impacted.

The largest wildfires within the planning area counties since 2005 have been the Thomas Fire, the Witch Fire, and the Station Fire. The Thomas Fire was a massive wildfire that affected Ventura and Santa Barbara Counties, and one of multiple wildfires that ignited in southern California in December 2017. It burned over 281,000 acres before being fully contained on January 12, 2018, making it the largest wildfire in modern California history at the time. The Thomas Fire destroyed at least 1,063 structures, while damaging 280 others; and the fire caused

over $2.2 billion in damages, including $230 million in suppression costs, becoming the seventh-most destructive wildfire in state history at the time.

The Witch Fire was the second-largest wildfire of the 2007 California wildfire season, and the largest one of the October 2007 California wildfires. Although the Witch Creek Fire was initially smaller, burning 197,990 acres alone, after merging with the Poomacha and McCoy Fires, the Witch–Guejito–Poomacha Complex Fire had a total burn area of 247,800 acres. The Witch Fire led to the evacuations of 500,000 people, 200,000 of whom lived within the City of San Diego. This evacuation came almost four years to the day after the Cedar Fire of 2003. The Witch Fire was a major contributor to the mass evacuations across much of Southern California at that time, which saw 1,000,000 residents evacuate, becoming the largest evacuation in California history. The Witch–Guejito–Poomacha Fire caused at least $1.3 billion in insured damages alone.

The Station Fire was the largest wildfire in the history of Los Angeles County, igniting on August 26, 2009, near the U.S. Forest Service ranger station on the Angeles Crest Highway in the Angeles National Forest. The blaze threatened 12,000 structures in the National Forest and the nearby communities of La Cañada Flintridge, Pasadena, Glendale, Acton, La Crescenta, Juniper Hills, Littlerock, and Altadena, as well as the Sunland and Tujunga neighborhoods of the City of Los Angeles. By the time the fire was extinguished on October 16, over 160,000 acres had burned, 106 structures were destroyed, 10 people were injured, and two firefighters died.

13.2.2 Location

CAL FIRE's Fire and Resource Assessment Program has modeled and mapped wildfire hazard zones using a science-based and field-tested computer model that assigns a fire hazard severity zone (FHSZ) of moderate, high, or very high. The FHSZ model is built from existing CAL FIRE data and hazard information based on factors such as the following:

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. Of particular importance for wildfire activity are wind and thunderstorms:
    - Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
    - The thunderstorm season typically begins in June with wet storms and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of landforms (fire spreads more easily uphill than downhill).
- **Probability of Future Occurrence**—The likelihood of an area burning over a 30- to 50-year time period, based on history and other factors.

The model also is based on frequency of fire weather, ignition patterns, and expected rate of spread. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires

within the urban area and spread to adjacent structures. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates. FHSZ mapping for Metropolitan is shown in Figure 13-1.

13.2.3 Frequency

Wildfire frequency can be assessed through review of the number of previous wildfire events and the area burned over a defined period. CAL FIRE records of fires indicate that, from 1878 to 2016, 53.5 percent of the total area within the very-high FHSZ was burned by wildfire (50,782 acres out of 94,904 acres). This record includes wildland fires that exceed 10 acres, all prescribed fires, and those that destroyed three or more residential or commercial structures. Based on these data, this averages 0.4 percent of the very-high FHSZ area burned per year over that 139-year period. However, those records are incomplete prior to 1950, so the annual average is likely higher than that. CAL FIRE records indicate that there were 299 fires in the service counties since 2005, which comes to an average of nearly 19 fires per year.

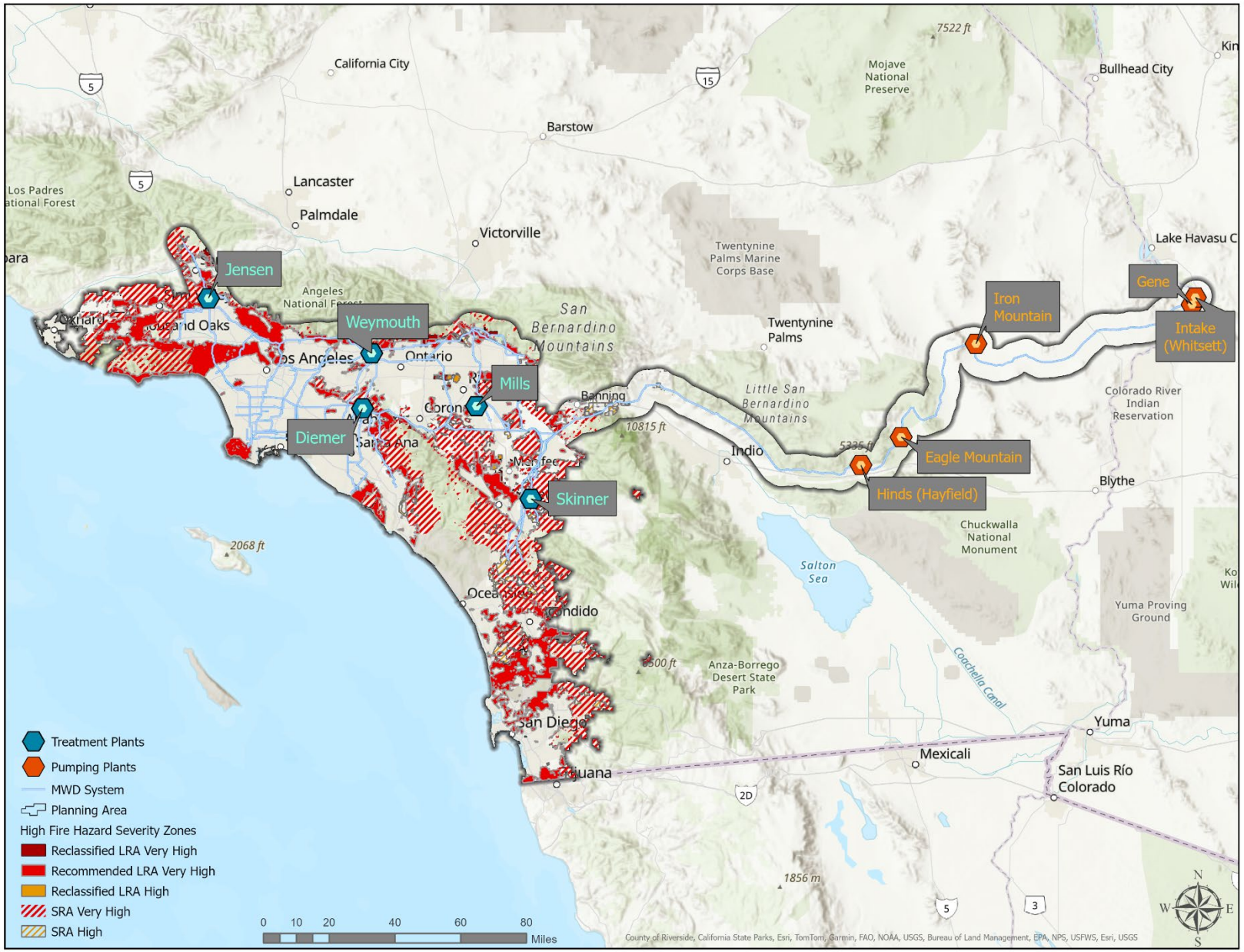


Figure 13-1. Regional Water System - Wildfire Hazard Severity Zones

13.2.4 Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. As of October 2023, four wildfire-related fatalities have taken place in 2023. The deadliest year for wildfire fatalities was 2018, where 100 civilians and firefighters lost their lives during wildfire incidents (CalMatters 2023). Wildfires can limit accessibility and impact operations if in the vicinity of Metropolitan's treatment plants and create health risks for staff due to poor air quality. Wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to increased runoff from loss of vegetation in local watersheds.

A major wildfire in the planning area might begin with a high rainfall spring season, adding to fuels already present in open areas, hillsides, and forested areas. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Human activities or a sudden lighting storm could trigger a multitude of small, isolated fires. The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers could be deep in the forests and interface zones. These new small fires would most likely merge.

The worst-case scenario would include an active fire season throughout the West, spreading resources thin. Many federal assets would be responding to other fires that started earlier in the season. Additional resources could be unavailable. Even though the existence and spread of the fire is known, it may not be possible to respond to it adequately, so an initially manageable fire can become out of control.

13.2.5 Warning Time

Wildfires are often caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Dry seasons, droughts and high winds or Santa Ana winds are factors that greatly increase fire likelihood. Dry lightning may ignite wildfires. Adverse weather can be predicted, so special attention can be paid during weather events that may include high winds, Santa Ana winds, or lightning. Reliable National Weather Service warnings are available on average 24 to 48 hours prior to a weather event.

A fire that breaks out and spreads rapidly can require evacuation within hours or days. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications and social media in recent years has further contributed to a significant improvement in warning time. Metropolitan has developed online communication and mapping tools to notify the district-wide emergency response organization when a wildfire has started. Metropolitan also uses an employee alert system to notify staff of hazardous conditions such as wildfire and poor air quality within a local area. Metropolitan coordinates closely on emergency preparation and response with the member agencies and other public agencies and receives direct communications from the emergency managers for the six operational areas within Metropolitan's service area.

13.3 EXPOSURE

The risk assessment for wildfire evaluated Metropolitan assets that lie within the mapped fire hazard severity zone Figure 13-1). Table 13-2 summarizes the number of assets by category within the mapped fire hazard severity zone and the total replacement cost value of those assets. Details by type of facility are included in Appendix D. Figure 13-2 shows these results as the percent of planning area totals for each asset type.

13.4 VULNERABILITY

Structures, above-ground infrastructure, power systems, communication systems, and community lifelines are all vulnerable to the wildfire hazard. There is currently no validated damage model available to support wildfire mitigation planning.

Metropolitan's buried pipelines and tunnels located within wildfire risk areas are not expected to be impacted if a wildfire were to occur due to the depth of cover that is typical of Metropolitan pipelines. However, three of Metropolitan's treatment plants, the Diemer, Jensen, and Skinner plants, are located within high or very high-risk wildfire areas. A wildfire impacting any of these three treatment plants could impact deliveries in areas reliant on the individual plants. Consequently, Metropolitan has implemented various mitigation measures to limit potential wildfire impacts at each of these facilities such as maintaining defensible space and installation of fire hydrants. At the Diemer plant, Metropolitan constructed a secondary access road to ensure emergency access to the plant.

Previously, the Jensen plant was impacted by the Saddleridge fire in 2019, and the Diemer plant was impacted by the Freeway Complex Fire in 2008. In both instances, the fires extended to the plant boundaries. Based on lessons-learned from the Freeway Complex Fire, the air circulation system in the Diemer Plant Control Room was upgraded to protect staff from external smoke. In 2025, a heli-hydrant was installed at that plant to provide immediate water access to local firefighting helicopters. Following the Saddleridge Fire, Metropolitan implemented a 24/7 Duty Officer program to provide immediate communications link between Metropolitan and outside first-responders. Metropolitan agency-representatives now regularly respond to fire command posts for any fires that could threaten Metropolitan staff and/or facility.

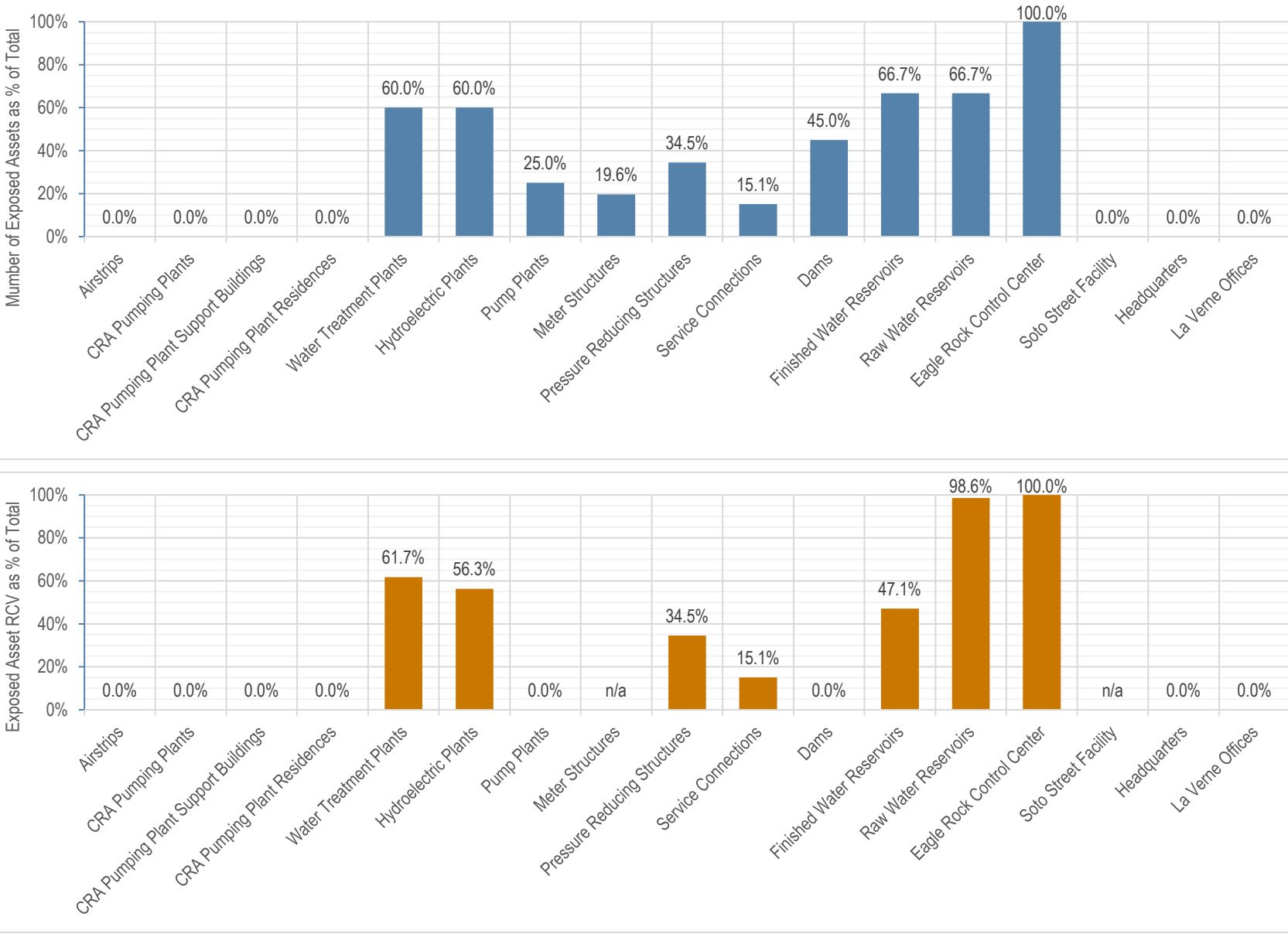
Table 13-2. Metropolitan Non-Linear Assets in the High or Very High Wildfire Hazard Severity Zones

	Structures Within the Hazard Area	
	Number of Structures	Replacement Cost Value
Colorado River Aqueduct Facilities		
Airstrips	0	$0
Pumping Plants	0	$0
Pumping Plant Support Buildings	0	$0
Residences	0	$0
Conveyance and Distribution Facilities		
Water Treatment Plants	3	$3,265,183,517
Hydroelectric Plants	9	$184,852,179
Power Plants	1	n/a
Meter Structures	94	n/a
Pressure Reducing Structures	20	$106,429,862
Service Connections	82	$33,390,810
Dams	9	n/a
Building Facilities		
Headquarters	0	$0
La Verne	0	$0
Eagle Rock	1	$15,733,961
Soto Street	0	$0
Reservoirs		
Finished Water Reservoirs	2	$106,694,744
Raw Water Reservoirs	4	$3,664,219,843

Table 13-3. Metropolitan Linear Assets in the High or Very High Wildfire Hazard Severity Zones*

	Length (miles)	Replacement Cost Value
Colorado River Aqueduct	0	$0
C&D Pipelines	6.9	$75,835,876

*Only above ground sections are considered for the wildfire hazard exposure analysis.



n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

Figure 13-2. Percent of Total Assets Within the High or Very High Wildfire Hazard Severity Zones

13.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands. In addition, Metropolitan works with local jurisdictions on development projects within the vicinity of existing infrastructure to protect public safety, easements and the integrity of the system.

Metropolitan's Capital Investment Plan includes several programs to improve infrastructure and reliability, which may include projects to reduce or avoid risk of wildfire to facilities and operations. Programs include Distribution System, Additional Facilities and Systems, and Water Treatment Plant. In addition, Metropolitan is preparing Fire Management Plans for facilities to reduce risk and liability to the District, create defensible space, and keep employees and firefighting personnel safe and facilities operational during wildfire emergencies.

13.6 CLIMATE CHANGE

Wildfire is determined by climate variability, local topography, and human intervention. Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. Additionally, changes in climate patterns may impact the distribution and perseverance of insect outbreaks that can cause tree mortality and increase fuel loads. When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain and thus are more likely to cause more damage to urban and wildland areas.

Metropolitan's exposure and vulnerability would likely increase as a result of climate change impacts on wildfire. Larger, more severe, more frequent fires may impact people, property, and community lifelines by increasing the risk of ignition from nearby fire sources. The five treatment plants and other facilities for the conveyance system, along with the power system that supplies them, are in areas that can be impacted by nearby wildfires. Additionally, secondary impacts such as air quality issues may increase.

13.7 ISSUES

The major issues for wildfire are the following:

- Public Safety Power Shutoff (PSPS) events for "fire weather" and wildfires could impact Metropolitan operations.
- Backup power is needed for community lifelines exposed to the wildfire hazard.
- Metropolitan's landscape conservation programs can be enhanced to further promote firesafe landscapes and defensible space.
- Increased water storage and access to Metropolitan's stored water can enhance firefighting capability.

- There is a need for coordination with local fire departments and increased training of Metropolitan personnel.
- There is a need for coordination with local planning authorities to ensure awareness of new development planned for urban-wildland interface zones.
- The risk associated with wildfire overlaps the risks associated with other hazards such as earthquake, flood, landslide, wind, and extreme heat. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- Wildfires can affect Metropolitan's imported water supplies through impacts to the source watersheds for the State Water Project and Colorado River, increasing dependence on local water resources.
- The potential impact of climate change on wildfire patterns needs to be better understood.

14. WIND

14.1 GENERAL BACKGROUND

High winds are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage. High winds or a windstorm are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, manufactured housing units, major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial, and community lifelines, and leave tons of debris in its wake.

14.1.1 Types of Damaging Winds

Damaging winds are classified as those exceeding 60 mph. Damage from such winds is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. NOAA identifies seven types of damaging winds (NOAA 2023):

- **Straight-line winds—**Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- **Downdrafts—**A small-scale column of air that rapidly sinks toward the ground.
- **Downbursts—**A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- **Microbursts—**A small, concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph.
- **Gust front**—A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.
- **Derecho—**A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word “derecho” is of Spanish origin and means “straight ahead.” Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.

- **Bow Echo—**A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

For Southern California, Santa Ana winds can cause significant damage, increase wildfire risk, and impact Metropolitan's operations if a Public Safety Power Shutoff (PSPS) occurs. Santa Anas are a principal feature of Southern California weather. These are offshore winds, usually warm, blowing from the mountains to the coast, and occurring principally in fall and winter, with a frequency peaking in December. Santa Ana winds are marked by light coastal winds, clean air, and low humidity. They may last from a day to over a week. The Santa Ana condition is usually one of warm temperatures when the rest of the United States is in the grip of winter. High pressure builds over the Great Basin in fall and winter as cold air travels into that region from Canada. When the surface pressure gradient reaches or exceeds 10 millibars, as measured from Tonopah, Nevada, to Los Angeles, wind gusts can reach 70 mph in the mountains and below passes and canyons near the Southern California coast (Erdman 2018).

Santa Ana winds broadly affect Metropolitan's service area. Winds tend to channel below specific passes and canyons, coming in gust clusters. High winds may blow in one neighborhood, while a few blocks away there are only gentle warm breezes. Offshore winds from the northeast or east must reach 30 mph or more below passes and canyons to reach minimum criteria for Santa Ana wind advisories. Typical wind speeds are in the 40 to 55 mph range; in extreme cases, winds can gust locally to over 100 mph.

14.1.2 Rating Wind Strength

As shown in Table 14-1 the Beaufort Wind Scale is an empirical measure that relates wind speed to observed conditions at sea or on land.

Table 14-1. Beaufort Wind Scale

Force	Wind (knots)	Classification	Appearance of Wind Effects on Land
0	< 1	Calm	Calm, smoke rises vertically
1	1 – 3	Light Air	Smoke drift indicates wind direction, still wind vanes
2	4 – 6	Light Breeze	Wind felt on face, leaves rustle, vanes begin to move
3	7 – 10	Gentle Breeze	Leaves and small twigs constantly moving, light flags extended
4	11 – 16	Moderate Breeze	Dust, leaves, and loose paper lifted; small tree branches move
5	17 – 21	Fresh Breeze	Small trees in leaf begin to sway
6	22 – 27	Strong Breeze	Larger tree branches moving, whistling in wires
7	28 – 33	Near Gale	Whole trees moving, resistance felt walking against wind
8	34 – 40	Gale	Twigs breaking off trees, generally impedes progress
9	41 – 47	Strong Gale	Slight structural damage occurs, slate blows off roofs
10	48 – 55	Storm	Seldom experienced on land, trees broken or uprooted, considerable structural damage
11	56 – 63	Violent Storm	Seldom experienced on land
12	64+	Hurricane	Seldom experienced on land

Source: (NOAA 2023)

14.1.3 Tornadoes

A tornado is a violently rotating column of air extending between, and in contact with, a cloud and the surface of the earth. Tornadoes are often (but not always) visible as a funnel cloud. On a local-scale, tornadoes are the most intense of all atmospheric circulations and wind can reach destructive speeds of more than 300 mph. In general, a tornado's vortex is typically a few hundred meters in diameter, and damage paths can be up to 2 miles wide and 50 miles long (NOAA n.d.). Tornadoes can occur throughout the year.

In 2007, NWS replaced the Fujita Scale (F-scale) tornado rating system with the Enhanced Fujita Scale (EF-scale). The EF-scale is a set of wind estimates (not measurements) based on damage. It uses 3-second gusts estimated at the point of damage based on a judgment of 8 levels of damage to 28 indicators. These estimates vary with height and exposure. Standard measurements are taken by weather stations in openly exposed area. Table 14-2 describes the F-scale and EF-scale ratings (NOAA 2023).

Table 14-2. The Fujita Scale and Enhanced Fujita Scale

Fujita (F) Scale			Operational Enhanced Fujita (EF) Scale	
F Number	Fastest ¼ mile (mph)	3-second gust (mph)	EF Number	3-second gusts (mph)
F0	40 – 72	45 – 78	EF-0	65 – 85
F1	73 – 112	79 – 117	EF-1	86 – 110
F2	113 – 157	118 – 161	EF-2	111 – 135
F3	158 – 207	162 – 209	EF-3	136 – 165
F4	208 – 260	210 – 261	EF-4	166 – 200
F5	261 – 318	262 – 317	EF-5	Over 200

The south coastal region of California has the greatest incidence of tornadoes in the state, due to the natural curvature of the shoreline and the location of the coastal mountains. Tornadoes in the region are typically less severe than those in other parts of the country. They are typically not high in intensity and are short-lived. Although the state has never proclaimed a state of emergency or had a federal disaster declared as the result of a tornado, the frequency of tornadoes and the density of the region's urban areas make tornadoes a relevant hazard for Metropolitan's service area.

14.1.4 Secondary Hazards

Under certain weather conditions, particularly Santa Ana and high wind events, utility service providers plan to de-energize parts of their system to help prevent wildfire and keep communities safe. A combination of dry vegetation and high winds can uproot trees, blow branches onto power lines or create sparks if power lines contact one another. Public safety power shutoff (PSPS) outages can occur across the state. Due to the grid nature of electrical power distribution systems, they can impact areas beyond where weather conditions present a direct hazard. Power outages impact Metropolitan's operations and some communication systems. Table 14-3 shows some of the weather conditions that are monitored by utility service providers that trigger PSPS events.

Table 14-3. Triggers for Public Safety Power Shutoff Events

Monitor Factor	Metrics
Red Flag Warning	A warning declared by the National Weather Service that weather conditions could lead to fire and rapid spread.
Low Humidity	20% or lower humidity. Low humidity creates dry vegetation, which fuels fire.
High Winds	Sustained wind speeds above 25 miles per hour and wind gusts above 45 miles per hour can cause fire to spread.
Utility Observations	On-the-ground findings from utility crews.

14.2 HAZARD PROFILE

14.2.1 Past Events

None of Metropolitan's service counties have been included in any federal or state declarations for high winds or tornadoes (FEMA 2025).

High Winds and Thunderstorm Winds

The planning area has experienced both high wind and thunderstorm wind events. The National Centers for Environmental Information storm events database lists the following wind events from 2001 to 2021:

- 1,793 high wind events, with 267 considered as damaging wind events.
- 320 thunderstorm events, with 12 events resulting in death or injury.

Tornadoes

According to the National Centers for Environmental Information storm events database, the six service counties experienced 148 tornadoes from 1970 through 2021, with 54 injuries and over $94.8 million in property damage.

14.2.2 Location

Wind events have the potential to happen anywhere in the planning area. High wind events can affect the entire region or be more localized, such as with Santa Ana winds that are strongest below canyons and in interior areas. Tornadoes occur within a limited local area.

14.2.3 Frequency

The wind events for the planning area are often related to high winds associated with severe storms and Santa Ana winds. Based on a record of 267 damaging wind events (over 60 mph) in 20 years, the planning area will continue to experience these on an annual basis.

Tornadoes may occur in any month and at any hour of the day, but they occur with the greatest frequency from November through March. There were only seven recorded tornado events above F2 magnitude from 1970 to 2021, therefore on average, a considerable tornado may occur every six years. There is a 68 percent chance of a light to moderate tornado occurring in any year.

14.2.4 Severity

For Metropolitan, the most common issue associated with high wind and Santa Ana wind events is impacts to operations due to power outages. Outages may be planned, such as with PSPS events, or unplanned when power lines are downed. Physical damage to facilities can be caused by wind induced falling objects such as trees.

A worst-case scenario event would be a severe windstorm event that impacts power availability through the regional energy grid and triggers a PSPS event with power disrupted for a long period of time. This would require operational changes throughout the system and would tax Metropolitan's backup power capability beyond its capacity.

Tornadoes generally have low intensity in the planning area, but if a major tornado were to strike the dense planning area, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. According to FEMA's National Risk Index, one county in the planning area faces a relatively high risk of the tornado hazard (Los Angeles), four counties in the planning area face a moderate risk of tornadoes (Orange, Riverside, San

Bernardino, San Diego), and one county (Ventura) is ranked as facing low risk of the tornado hazard (FEMA 2023).

14.2.5 Warning Time

Meteorologists can often predict the likelihood of potentially damaging winds. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity. Energy utilities have modeling tools to identify the need, timing and extent for a PSPS event. This information is communicated to Metropolitan and their other customers in advance to allow for preparation. The NWS issues the following advance messages when potentially damaging winds are in the forecast:

- **Advisory**—Strong winds are occurring or will occur within 12 to 24 hours but are not so strong as to warrant a high wind warning
- **Watch**—Strong sustained winds for one hour or longer, or wind gusts for any duration that are not associated with thunderstorms are occurring or will occur within 12 to 48 hours
- **Warning**—Strong sustained winds for one hour or longer, or wind gusts for any duration that are not associated with thunderstorms are occurring or will occur within six to 12 hours

14.3 EXPOSURE

It can be assumed that all Metropolitan assets are exposed to some extent to the wind events profiled in this chapter. Power outages or rolling blackouts may occur as a result of wind events that damage portions of the grid. During a blackout, all community lifelines that rely on electricity for power will be severely impacted unless they are connected to a backup power source. Facilities on higher ground may face more exposure to wind damage or damage from falling trees. Thunderstorms can result in significant precipitation over a short period, causing erosion and damage to access roads and other facilities. This can be particularly significant for the Colorado River Aqueduct due to the severity and intensity of desert storms.

14.4 VULNERABILITY

All Metropolitan assets are vulnerable to direct and indirect impacts from the wind events profiled in this chapter. This vulnerability is tied predominately to the loss of power, as most of Metropolitan's community lifelines are power dependent. Therefore, no formal loss estimations are being provided, and this vulnerability assessment is qualitative in its narrative. However, claims for recent past events can serve as a reference. Metropolitan is seeking FEMA assistance for the following: DR 4431 2019 Storms- $4,804,196; DR 4683 January 2023 Storms - $968,825; and DR 4750 October 2023 Tropical Storm - $900,000.

Weather induced loss of power for the planning area is prevalent, especially considering the impact of Public Safety Power Shutoff protocols being deployed by electric utility service providers in the state of California. High temperatures, extreme dryness and record-high winds can create conditions in the state where any spark at the wrong time and place can lead to a major wildfire. The Public Safety Power Shutoff is a procedure in which it may be necessary for a utility service provider to turn off electricity in the interest of public safety if weather conditions threaten a portion of the electric system. A PSPS event can be correlated to high winds.

Metropolitan does have backup power to most, but not all of its community lifelines, so there is some degree of vulnerability associated with this capability. There are portable sources for emergency power supply, but these sources are not as efficient as picked place backup power for each facility.

14.5 DEVELOPMENT TRENDS

As discussed in Chapter 3, SCAG and SANDAG estimate the population in Metropolitan's service area will reach 20.1 million in 2025 and 22.0 million by 2045. While Los Angeles County leads in total population, the inland areas of Riverside and San Bernardino counties are projected to grow at the fastest rates over the next ten years. Metropolitan provides critical lifeline services of water supply, treatment and delivery to its member agencies throughout its six-county service area. Metropolitan and the member agencies collaborate on regional planning for water supply and infrastructure to meet future demands. In addition, Metropolitan works with local jurisdictions on development projects within the vicinity of existing infrastructure to protect public safety, easements and the integrity of the system.

Metropolitan's Capital Investment Plan includes several programs to improve infrastructure and reliability, which may include projects to reduce or avoid risk of wind event impacts on facilities and operations. Programs include Colorado River Aqueduct Reliability, Distribution System, Additional Facilities and Systems, and Water Treatment Plants. For the desert region, the CIP includes projects to refurbish or upgrade Metropolitan workforce housing to enhance living conditions and attract and retain skilled employees.

14.6 CLIMATE CHANGE

Climate change presents a challenge for risk management associated with high winds associated with storms. The frequency of storm events has increased steadily in recent decades. Historical data shows that the probability for such events increases in a warmer climate. Metropolitan's exposure and vulnerability would likely increase as a result of climate change impacts on the wind hazard as storms become more frequent and intense. Metropolitan may experience more frequent disruptions in power service and power supply from the grid.

14.7 ISSUES

Important issues associated with a wind event in the planning area include the following:

- Power interruption is the biggest impact from this hazard for Metropolitan.
- The bulk power system to the Colorado River Aqueduct may need improvements to adapt to increasing impacts of high winds and associated storms.
- Metropolitan's backup power capability should be enhanced. Redundant communication systems that are not dependent on network connections or power are needed.
- The risk associated with the wind hazard overlaps the risks associated with other hazards such as earthquake, extreme heat, flood, landslide, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- The potential impact of climate change on wind patterns and associated storm duration and frequency needs to be better understood. It could have impacts on the state and western regional energy grids.

15. RISK RANKING

FEMA requires all hazard mitigation planning to have jurisdiction-specific mitigation actions based on local risk, vulnerability, and community priorities (FEMA 2023). This plan includes a risk ranking protocol for Metropolitan, in which "risk" was calculated by multiplying probability by impact on people, property and Metropolitan's continuity of operations following the hazard events assessed. The risk estimates were generated using methodologies promoted by FEMA. The Planning Committee reviewed, discussed, and approved the methodology and results.

Numerical ratings of probability and impact were based on the hazard profiles and exposure and vulnerability evaluations presented in Chapters 7 through 14. Using that data, the Planning Committee ranked the risk of all the natural hazards of concern described in this plan. When available, estimates of risk were generated with data from Hazus or GIS. For hazards of concern with less specific data available, qualitative assessments were used. As appropriate, results were adjusted based on local knowledge and other information not captured in the quantitative assessments.

Risk ranking results are used to help establish mitigation priorities. Metropolitan used these rankings to inform the identification and prioritization of actions for the plan and identify actions for all hazards of concern, in accordance with FEMA and state guidance.

15.1 PROBABILITY OF OCCURRENCE

A probability factor is assigned based on how often a hazard is likely to occur. The probability of occurrence of a hazard event is generally based on past hazard events in an area, although weight can be given to expected future probability of occurrence based on established return intervals, changing climate conditions, and knowledge of local conditions. For example, if a jurisdiction has experienced two damaging floods in the last 25 years, the probability of occurrence is high for flooding and assigned a probability factor of 3 under this category. If a jurisdiction has experienced no damage from landslides in the last 100 years, the probability of occurrence for landslide is low and assigned a probability factor of 1 under this category. Each hazard was assigned a probability factor as follows:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor = 2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor = 1)
- None—If there is no exposure to a hazard, there is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past hazard events in the area. Table 15-1 summarizes the probability assessment for each hazard of concern for this plan.

Table 15-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Low	1
Drought	High	3
Earthquake	High	3
Extreme Heat	High	3
Flood	High	3
Landslide	Medium	2
Wildfire	High	3
Wind	High	3

15.2 IMPACT

The impact of each hazard is divided into three categories: impacts on people, impacts on Metropolitan Water District property and assets, and impacts on the continuity of Metropolitan operations. These categories are also assigned weighted values. Impact on people was assigned a weighting factor of 3, impact on property was assigned a weighting factor of 2 and impact on the continuity of operations was assigned a weighting factor of 1.

People—Values are assigned based on the percentage of the total population exposed in Metropolitan's planning area to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. Impact factors were assigned as follows:

- High—25 percent or more of the population is exposed to a hazard (Impact Factor = 3)
- Medium—10 percent to 24 percent of the population is exposed to a hazard (Impact Factor = 2)
- Low—9 percent or less of the population is exposed to the hazard (Impact Factor = 1)
- No impact—None of the population is exposed to a hazard (Impact Factor = 0)

Property—Values are assigned based on the percentage of the total Metropolitan assets exposed to the hazard event:

- High—25 percent or more of the total replacement value of assets is exposed to a hazard (Impact Factor = 3)
- Medium—10 percent to 24 percent of the total replacement value of assets is exposed to a hazard (Impact Factor = 2)
- Low—9 percent or less of the total replacement value of assets is exposed to the hazard (Impact Factor = 1)
- No impact—None of the total replacement value is exposed to a hazard (Impact Factor = 0)

Continuity of Operations—Impacts on water operations are assessed based on estimates of how long it will take Metropolitan to become 100-percent operable after a hazard event. The estimated functional downtime for community lifelines has been subjectively assigned an impact as follows:

- High—Functional downtime of 365 days or more (Impact Factor = 3)
- Medium—Functional downtime of 180 to 364 days (Impact Factor = 2)
- Low—Functional downtime of 180 days or less (Impact Factor = 1)
- No impact—No functional downtime is estimated from the hazard (Impact Factor = 0).

After preliminary impact scores for each hazard were determined based on the categories above, Metropolitan staff adjusted the scores based on institutional understanding of past experiences of each hazard's impacts on Metropolitan assets. The final impact scores identified through this process are shown in Table 15-2.

Table 15-2. Hazard Impact on People, Property and Operations

	People (Weighting Factor = 3)		Property (Weighting Factor = 2)		Operations (Weighting Factor = 1)	
Hazard Event	Impact Score	Weighted Score	Impact Score	Weighted Score	Impact Score	Weighted Score
Dam Failure	1	3	1	2	3	3
Drought	3	9	0	0	3	3
Earthquake	3	9	3	6	2	2
Extreme Heat	3	9	0	0	1	1
Flood	2	6	1	2	1	1
Landslide	2	6	2	4	2	2
Wildfire	2	6	3	6	1	1
Wind	3	9	2	4	1	1

15.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property, and continuity of operations, as summarized in Table 15-3.

Table 15-3. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)	Rating
Dam Failure	1	8	8	Low
Drought	3	12	36	High
Earthquake	3	17	51	High
Extreme Heat	3	10	30	Medium
Flood	3	9	27	Medium
Landslide	2	12	24	Medium
Wildfire	3	13	39	High
Wind	3	14	42	High

Based on these ratings, a priority of high, medium, or low was assigned to each hazard. Generally, a score of 31 or greater receive a “high” rating, between 16 and 30 receive a “medium” rating, and less than 15 receives a “low” rating. Hazards ranked as being of highest concern include earthquake, drought, wildfire, and wind. Hazards ranked as being of medium concern include extreme heat, flood and landslide. The risk ranked as being of lowest concern is dam failure.

Part 3. Mitigation Plan

16. GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Planning Committee established a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The goals, objectives and actions in this plan all support each other. Objectives were selected that meet multiple goals. Actions were prioritized based on ability to accomplish multiple objectives.

16.1 GOALS

The following goals were set for this hazard mitigation plan:

1. Protect life and property
2. Increase public awareness of risk and loss of water service
3. Protect Metropolitan's community lifelines
4. Facilitate partnerships with member agencies and coordinate implementation of mitigation actions
5. Maintain continuity of essential services
6. Enhance resilience, sustainability, and reliability

16.2 OBJECTIVES

The Planning Committee members identified the following plan objectives to support these goals:

1. Implement activities that assist in protecting lives by making infrastructure, community lifelines, and other property more resistant to hazards
2. Assess vulnerability of key resources and critical infrastructure
3. Mitigate vulnerable infrastructure to reduce/minimize future hazards and disasters
4. Raise awareness and communicate risk to Metropolitan's stakeholders
5. Preserve, rehabilitate, and enhance natural systems to serve natural hazard mitigation functions
6. Diversify Metropolitan's water supply portfolio
7. Increase flexibility of Metropolitan's water supply and distribution system
8. Leverage grant funding and low-interest loan programs for hazard mitigation capital projects
9. Establish procedures and programs to ensure mitigation projects for community lifelines, services, and infrastructure

17. MITIGATION BEST PRACTICES

Catalogs of hazard mitigation alternatives presented below offer a broad range of alternatives to be considered for use in the planning area, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

One catalog is shown for each natural hazard of concern evaluated in this plan, except for dam failure. The catalogs present alternatives that are categorized in the following two ways:

- Who would have responsibility for implementation?
  - Individuals (personal scale)
  - Businesses (corporate scale)
  - Government (government scale)
- What would the alternative do?
  - Manipulate the hazard
  - Reduce exposure to the hazard
  - Reduce vulnerability to the hazard
  - Increase the ability to respond to or be prepared for the hazard

The catalogs list mitigation actions that might be able to reduce the risk of hazards in the planning area. They show a baseline set of alternatives that could be considered by individuals, businesses and organizations, and other government agencies. Mitigation actions recommended in this plan (see Chapter 18) were selected based on their support for the plan's goals and objectives and ability to effectively mitigate the hazards. Actions would generally not be selected as recommended mitigations for this plan for any combination of the following reasons:

- Any action that is not feasible.
- Any action that is already being implemented.
- Any action for which there is an apparently more cost-effective alternative.
- Any government action that is beyond the capabilities of Metropolitan to implement (government actions in the catalogs are generic to all forms of government and may not fall within the responsibilities of a water district).
- Any government action that does not have public or political support.

The catalogs for each hazard of concern are presented in Table 17-1 through Table 17-8.

Table 17-1. Alternatives to Mitigate the Dam Failure Hazard

Personal Scale	Organizational Scale	Government Scale
A. Reduce the probability of hazard events: ❖ None	**E. Reduce the probability of hazard events:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams.	**I. Reduce the probability of hazard events:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams.
B. Limit risk to new/redeveloped structures: ❖ Relocate out of dam failure inundation areas.	**F. Limit risk to new/redeveloped structures:** ❖ Replace earthen dams with hardened structures.	**J. Limit risk to new/redeveloped structures:** ❖ Replace earthen dams with hardened structures ❖ Relocate community lifelines out of dam failure inundation areas. ❖ Consider open space land use in designated dam failure inundation areas.
C. Reduce risk to existing structures: ❖ Elevate home to appropriate levels.	**G. Reduce risk to existing structures:** ❖ Flood-proof facilities in dam failure inundation areas.	**K. Reduce risk to existing structures:** ❖ Adopt higher floodplain standards in mapped dam failure inundation areas. ❖ Retrofit community lifelines in dam failure inundation areas.
D. Increase ability to respond to or be prepared for hazard: ❖ Learn about risk reduction for the dam failure hazard. ❖ Learn the evacuation routes for a dam failure. ❖ Educate yourself on early warning systems. ❖ Know evacuation routes ❖ Educate yourself on where the inundation areas are and if you are located within them.	**H. Increase ability to respond to or be prepared for hazard:** ❖ Educate employees on the probable effects of a dam failure. ❖ Develop a continuity of operations plan.	**L. Increase ability to respond to or be prepared for hazard:** ❖ Map dam failure inundation areas. ❖ Enhance emergency operations plan to include a dam failure component. ❖ Institute monthly communications checks with dam operators. ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the sale of property located in dam failure inundation areas. ❖ Consider the probable effects of climate in assessing the risk associated with dam failure. ❖ Establish early warning capability downstream of listed high hazard dams. ❖ Consider the residual risk associated with protection provided by dams in future land use decisions. ❖ Develop non-English and culturally sensitive educational materials.

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-2. Alternatives to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale[a]
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce private water system losses • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	• **Manipulate the hazard:** ❖ Groundwater recharge through stormwater management • **Reduce exposure to the hazard:** ❖ Identify and create groundwater backup sources • **Reduce vulnerability to the hazard:** ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits • **Increase the ability to respond to or be prepared for the hazard:** ❖ Public education on drought resistance ❖ Encourage recycling ❖ Identify alternative water supplies for times of drought, mutual aid agreements with alternative suppliers ❖ Develop drought contingency plan ❖ Develop criteria "triggers" for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques ❖ Increase emergency storage capacity

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-3. Alternatives to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale[a]
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area (off soft soils) • **Reduce vulnerability to the hazard:** ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design • **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice "drop, cover, and hold" ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate or relocate mission-critical functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions • **Increase the ability to respond to or be prepared for the hazard:** ❖ Adopt higher standard for new construction; consider "performance-based design" when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ Locate community lifelines or functions outside hazard area where possible • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards ❖ Perform seismic retrofits for vulnerable critical buildings and areas • **Increase the ability to respond to or be prepared for the hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, spare well pumps, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components.

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-4. Alternatives to Mitigate the Extreme Heat Hazard

Personal Scale	Organizational Scale	Government Scale
Reduce the probability of hazard events: ❖ Plant trees to create shade in urban areas ❖ Remove concrete and other hard surfaces and replace them with native vegetation **Limit risk to new/redeveloped structures:** ❖ None **Reduce risk to existing structures:** ❖ Insulate residential and non-residential structures to provide greater thermal efficiency ❖ Provide redundant power sources ❖ Get air conditioning installed ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) **Increase ability to respond to or be prepared for hazard:** ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio ❖ Obtain an emergency generator or community microgrid	**Reduce the probability of hazard events:** ❖ Plant trees in urban areas experiencing urban heat island effects or with below average tree canopy coverage* ❖ Remove concrete and other hard surfaces and replace them with native vegetation **Limit risk to new/redeveloped structures:** ❖ None **Reduce risk to existing structures:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines meet resiliency expectations against all-hazard impacts ❖ Install tree wire ❖ Provide cooling centers for employees ❖ Install "cool roofs" and "green roofs." **Increase ability to respond to or be prepared for hazard:** ❖ Create redundancy in power supply ❖ Equip facilities with a NOAA weather radio ❖ Equip vital facilities with emergency power sources	**Reduce the probability of hazard events:** ❖ Plant trees in urban areas experiencing urban heat island effects or with below average tree canopy coverage ❖ Remove concrete and other hard surfaces and replace them with native vegetation **Limit risk to new/redeveloped structures:** ❖ None **Reduce risk to existing structures:** ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines ❖ Install "cool roofs," "green roofs," and other green infrastructure ❖ Use the best available technology to enhance warning systems for all extreme heat events **Increase ability to respond to or be prepared for hazard:** ❖ Increase communication alternatives ❖ Enhance public awareness campaigns to address actions to take during extreme heat events ❖ Coordinate extreme-heat warning capabilities and the dissemination of warning among agencies with the highest degree of capability ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Provide NOAA weather radios to the public ❖ Review and update heat response plan in light of climate change projections ❖ Promote programs that support community-scale microgrids ❖ Evaluate and revise, as needed, building codes to address and mitigate extreme heat impacts on residents ❖ Develop non-English and culturally sensitive educational materials.

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-5. Alternatives to Mitigate the Flood Hazard

Personal-Scale	Corporate-Scale	Government-Scale[a]
• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development • **Reduce exposure to the hazard:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures • **Increase the ability to respond to or be prepared for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication, 72-hour self-sufficiency during and after an event	• **Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development • **Reduce exposure to the hazard:** ❖ Locate community lifelines outside hazard area ❖ Use low-impact development techniques • **Reduce vulnerability to the hazard:** ❖ Build critical function redundancy or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains • **Increase the ability to respond to or be prepared for the hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing through partnerships on projects with multiple benefits.	• **Manipulate the hazard:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • **Reduce exposure to the hazard:** ❖ Locate or relocate community lifelines outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in high hazard areas via techniques such as planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulations for freeboard, cumulative substantial improvement, substantial damage, compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt “no-adverse impact” floodplain management policies that strive to not increase the flood risk on downstream communities. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider climate change impacts on the risk associated with the flood hazard ❖ Consider the residual risk associated with structural flood control in future land use decisions ❖ Enforce National Flood Insurance Program ❖ Adopt a Stormwater Management Master Plan

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-6. Alternatives to Mitigate the Landslide Hazard

Personal-Scale	Corporate-Scale	Government-Scale[a]
• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit home • **Increase the ability to respond to or be prepared for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) • **Reduce vulnerability to the hazard:** ❖ Retrofit at-risk facilities • **Increase the ability to respond to or be prepared for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	• **Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope • **Reduce exposure to the hazard:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. • **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives.

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-7. Alternatives to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale[a]
• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-retardant building materials ❖ Create defensible spaces around home • **Increase the ability to respond to or be prepared for the hazard:** ❖ Employ techniques from the National Fire Protection Association's Firewise Communities program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. • **Increase the ability to respond to or be prepared for the hazard:** ❖ Support Firewise community initiatives. ❖ Create /establish stored water supplies to be utilized for firefighting.	• **Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands. • **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. • **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-retardant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. ❖ Consider higher regulatory standards (such as Class A roofing) ❖ Establish biomass reclamation activities • **Increase the ability to respond to or be prepared for the hazard:** ❖ More public outreach and education efforts, including an active Firewise program ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes ❖ Seek alternative water supplies ❖ Become a Firewise community ❖ Use academia to study impacts/solutions to wildfire risk ❖ Establish/maintain mutual aid agreements between fire service agencies. ❖ Create/implement fire plans ❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

Table 17-8. Alternatives to Mitigate the Wind Hazard

Personal-Scale	Corporate-Scale	Government-Scale[a]
• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Insulate house ❖ Provide redundant heat and power ❖ Insulate structure ❖ Plant appropriate trees near home and power lines (“Right tree, right place” National Arbor Day Foundation Program) • **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ❖ Install tree wire • **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Create redundancy ❖ Equip facilities with a NOAA weather radio ❖ Equip vital facilities with emergency power sources.	• **Manipulate the hazard:** ❖ None • **Reduce exposure to the hazard:** ❖ None • **Reduce vulnerability to the hazard:** ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines ❖ Consider “cool roofs” and “green roofs” • **Increase the ability to respond to or be prepared for the hazard:** ❖ Support programs such as “Tree Watch” that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ Establish and enforce building codes that require all roofs to withstand snow loads ❖ Increase communication alternatives ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Provide NOAA weather radios to the public

a. These catalogs are generic and are not specific to Metropolitan. Many of the government-scale alternatives listed are beyond the range of responsibilities of a water district.

18. MITIGATION ACTIONS

18.1 RECOMMENDED MITIGATION ACTIONS

The Planning Committee selected actions to be included in a hazard mitigation action plan based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives.

Table 18-1 lists the recommended hazard mitigation actions that make up the action plan (actions are not listed by priority in this table; prioritization is described below). The timeframe indicated in the table is defined as follows:

- Near-term = Completion within 5 years
- Long-term = Completion within 10 years

18.2 ACTION PLAN PRIORITIZATION

The actions recommended in the action plan were prioritized based on the following factors:

- Cost and availability of funding
- Benefit, based on likely risk reduction to be achieved
- Number of plan objectives achieved
- Timeframe for project implementation
- Eligibility for grand funding programs

Two priorities were assigned for each action:

- A high, medium, or low priority for implementing the action
- A high, medium, or low priority for pursuing grant funding for the action.

The following sections describe the analysis of benefits and costs and the assignment of the two priority ratings.

Table 18-1. Hazard Mitigation Action Plan Matrix

Number	Action	Project Lead for Metropolitan	Potential Partner Agency	Timeline	Estimated Cost	Funding Sources	Potential Grant Programs
MWD-01-2024	Complete East Orange County Feeder No. 2 Seismic Retrofit	Engineering Services Group		Long-Term	Medium	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD- 02-2024	Construct Burbank Pump Station for Delivery to Connection B5A	Engineering Services Group	City of Burbank	Near-Term	Medium	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-03-2024	Construct Hayfield Groundwater Storage and Extraction	Engineering Services Group		Long-Term	Medium	CIP: PAYGO, Debt Financing; grants	USEPA DWSIRS
MWD-04-2024	Implement San Gabriel Tower and Spillway Improvements	Engineering Services Group		Long-Term	Medium	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD-05-2024	Complete Diemer Treatment Plant Slope Stabilization and Drainage Improvements Project	Engineering Services Group		Near-Term	Medium	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-06-2024	Implement Sepulveda Canyon Control Facility Water Storage Tanks Seismic Upgrades	Engineering Services Group		Long-Term	Medium	CIP: PAYGO, Debt Financing; grants	USEPA DWSIRS
MWD-07-2024	Complete Colorado River Aqueduct Erosion Protection Project	Engineering Services Group		Near-Term	Medium	CIP: PAYGO, Debt Financing; grants	USDA NRCS WSP
MWD-08-2024	Install Inland Feeder to San Bernardino Valley Municipal Water District Foothill Pump Station Intertie	Engineering Services Group	San Bernardino Valley Municipal Water District	Near-Term	Medium	CIP: PAYGO, Debt Financing; grants	FEMA BRIC
MWD- 09-2024	Implement Weymouth Treatment Plant Administration and Control Buildings Seismic Upgrades	Engineering Services Group		Near-Term	Medium	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD-10-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 5	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-11-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 4	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	USEPA DWSIRS
MWD-12-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 3	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-13-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 2	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD-14-2024	Implement Sepulveda Feeder Prestressed Concrete Cylinder Pipe Rehabilitation - Reach 1	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-15-2024	Implement Perris Control Facility Bypass & Pressure Control Structure Upgrades	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	USEPA DWSIRS
MWD-16-2024	Implement Weymouth Treatment Plant Finished Water Reservoir Rehabilitation	Engineering Services Group		Near-Term	High	CIP: PAYGO, Debt Financing; grants	USDA NRCS EWP
MWD-17-2024	Implement La Verne Water Quality Laboratory and Field Engineering Building Seismic Upgrades and Building Improvements	Engineering Services Group		Near-Term	High	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA
MWD-18-2024	Implement Lake Mathews Forebay Pressure Control Structure and Bypass Improvements	Engineering Services Group		Near-Term	High	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD-19-2024	Construct Inglewood Lateral Improvements	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-20-2024	Construct Sepulveda Feeder Pump Station Phase 2	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	USEPA DWSIRS
MWD-21-2024	Implement Pure Water Southern California program for advanced water treatment, new conveyance, potable reuse	Engineering Services Group	Los Angeles County Sanitation Districts	Long-Term	High	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD-22-2024	Complete Colorado River Aqueduct Ancillary Erosion and Drainage Control Project	Engineering Services Group		Long-Term	Medium	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP
MWD-23-2024	Install Diemer Treatment Plant Fire Hydrants	Engineering Services Group		Near-Term	Medium	CIP: PAYGO, Debt Financing; grants	USEPA DWSIRS
MWD-24-2024	Implement Sepulveda Canyon Control Facility Reliability Improvements	Engineering Services Group		Long-Term	High	CIP: PAYGO, Debt Financing; grants	CalEPA DWSRF Parts A & B
MWD-25-2024	Construct Sepulveda Feeder Pump Station Phase 1	Engineering Services Group		Near-Term	High	CIP: PAYGO, Debt Financing; grants	FEMA BRIC, HMA, NEHRP

Number	Action	Project Lead for Metropolitan	Potential Partner Agency	Timeline	Estimated Cost	Funding Sources	Potential Grant Programs
MWD-26-2024	Update Integrated Water Resources Plan Needs Assessment	Water Resources Management		Near-Term	Low	O&M Budget	USEPA DWSIRS
MWD-27-2024	Update Business Continuity Plan	Finance Group		Near-Term	Low	O&M Budget	CalEPA DWSRF Parts A & B
MWD-28-2024	Update Risk and Resilience Assessment/Emergency Response Plan as part of America's Water Infrastructure Act	Office of Safety, Security Protection		Near-Term	Low	O&M Budget; grants	FEMA BRIC, HMA, NEHRP
MWD-29-2024	Update Information Technology Disaster Recovery Plans	Information Technology Group		Near-Term	Low	O&M Budget	USEPA DWSIRS
MWD-30-2024	Update Metropolitan Regional Water System Flexibility Study	Engineering Services Group		Near-Term	Low	O&M Budget	CalEPA DWSRF Parts A & B
MWD-31-2024	Update Seismic Resilience Report	Engineering Services Group		Near-Term	Low	O&M Budget	FEMA BRIC, HMA, NEHRP
MWD-32-2024	Update Dam Emergency Action Plans	Engineering Services Group		Near-Term	Medium	O&M Budget	USEPA DWSIRS
MWD-33-2024	Provide public outreach and education for socially vulnerable communities to improve water literacy and advocacy capabilities	External Affairs Group	26 Metropolitan member agencies	Near-Term	Low	O&M Budget	CalEPA DWSRF Parts A & B
MWD-34-2024	Provide targeted water efficiency programs for socially vulnerable communities	Water Resources Management	26 Metropolitan member agencies; subagencies serving socially vulnerable communities	Near-Term	Medium	O&M Budget; grants	FEMA BRIC, HMA, NEHRP

CIP - Capital Investment Plan
PAYGO - Pay- as-You-Go with operating revenue
Debt Financing - bond financed
O&M budget - operating revenue
CalEPA DWSRF Part A - Drinking Water State Revolving Fund (Part A): Construction Financing
CalEPA DWSRF Part B- Drinking Water State Revolving Fund (Part B): Planning/Design Financing
FEMA BRIC - Building Resilient Infrastructure and Communities
FEMA HMA – Hazard Mitigation Assistance
FEMA NEHRP- National Earthquake Hazards Reduction Program
USEPA DWSIRS – Midsize and Large Drinking Water System Infrastructure Resilience and Sustainability
USDA NRCS WSP- Natural Resources Conservation Service Watershed Surveys and Planning
USDA NRCS EWP- Emergency Watershed Protection

18.2.1 Benefit/Cost Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). For this hazard mitigation plan, a qualitative benefit-cost review was performed for each action by assigning ratings for benefit and cost as follows:

- **Cost**
  - High—Existing funding will not cover the cost of the action; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee or water rate increases).
  - Medium—The action could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
  - Low—The action could be funded under the existing budget. The action is part of or can be part of an ongoing existing program.
- **Benefit**
  - High—Action will provide an immediate reduction of risk exposure for life and property.
  - Medium—Action will have a long-term impact on the reduction of risk exposure for life and property, or action will provide an immediate reduction in the risk exposure for property.
  - Low—Long-term benefits of the action are difficult to quantify in the short term.

To assign priorities, each action with a benefit rating equal to or higher than its cost rating (such as high benefit/medium cost, medium benefit/medium cost, medium benefit/low cost, etc.) was considered to be cost-beneficial. This is not the detailed level of benefit/cost analysis required for some FEMA hazard-related grant programs. Such analysis would be performed at the time a given action is being submitted for grant funding.

18.2.2 Implementation Priority

Implementation priority ratings were assigned as follows:

- **High Priority**—An action that meets multiple objectives, has benefits that exceed costs, and has a secured source of funding. Action can be completed in the short term (1 to 5 years).
- **Medium Priority**—An action that meets multiple objectives, has benefits that exceed costs, and is eligible for funding though no funding has yet been secured for it. Action can be completed in the short term (1 to 5 years) once funding is secured. Medium-priority actions become high-priority actions once funding is secured.
- **Low Priority**—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no secured source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions may be eligible for grant funding from programs that have not yet been identified.

18.2.3 Grant Pursuit Priority

Grant pursuit priority ratings were assigned as follows:

- **High Priority**—An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium implementation priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.

- **Medium Priority**—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low implementation priority; local funding options are unavailable.
- **Low Priority**—An action that has not been identified as meeting any grant eligibility requirements.

18.2.4 Overall Priority

Overall priority ratings were assigned by Metropolitan based on a combination of the benefits and costs, implementation feasibility and priority, grant pursuit feasibility and priority, and Metropolitan-specific needs and goals.

18.2.5 Prioritization Summary for Mitigation Actions

Table 18-2 lists the priority of each recommended action.

18.3 CLASSIFICATION OF MITIGATION ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 18-3 shows these classifications. Mitigation types used for this categorization are as follows:

- **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 customers and local officials about hazards and ways to mitigate them. Includes outreach projects, 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, wetland restoration and preservation, and green infrastructure.
- **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, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resiliency**—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea level rise or urban heat island effect.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

Table 18-2. Mitigation Action Priority

Action #	Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority	Grant Pursuit Priority	Overall Priority
MWD-01-2024	1, 3, 5	Low	Medium	No	Yes	No	Low	Low	Low
MWD- 02-2024	1, 3, 5	High	Medium	Yes	Yes	No	Medium	High	High
MWD-03-2024	1, 3, 5	Low	Medium	No	Yes	No	Low	Low	Low
MWD-04-2024	1, 3, 5	Low	Medium	No	Yes	No	Low	Low	Low
MWD-05-2024	1, 3, 5	High	Medium	Yes	Yes	No	Medium	High	High
MWD-06-2024	1, 3, 5	Low	Medium	No	Yes	No	Low	Low	Low
MWD-07-2024	1, 3, 5	High	Medium	Yes	Yes	No	Medium	High	High
MWD-08-2024	1, 3, 5	High	Medium	Yes	Yes	No	Medium	High	High
MWD- 09-2024	1, 3, 5	High	Medium	Yes	Yes	No	Medium	High	High
MWD-10-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-11-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-12-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-13-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-14-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-15-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-16-2024	1, 3, 5	High	High	No	Yes	No	Low	Medium	High
MWD-17-2024	1, 3, 5	High	High	No	Yes	No	Low	Medium	High
MWD-18-2024	1, 3, 5	High	High	No	Yes	No	Low	Medium	High
MWD-19-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-20-2024	1, 3, 5	Low	High	No	Yes	No	Low	Low	Low
MWD-21-2024	1, 3, 5	Medium	High	No	Yes	No	Low	Low	Medium
MWD-22-2024	1, 3, 5	Medium	Medium	No	Yes	No	Low	Low	Low
MWD-23-2024	1, 3, 5	Medium	Medium	No	Yes	No	Low	Low	High
MWD-24-2024	1, 3, 5	Medium	High	No	Yes	No	Low	Low	Low
MWD-25-2024	1, 3, 5	Medium	High	No	Yes	No	Low	Low	High
MWD-26-2024	2, 4, 6	Medium	Low	Yes	Yes	Yes	High	Low	High
MWD-27-2024	2, 4, 6	Medium	Low	Yes	Yes	Yes	High	Low	High
MWD-28-2024	2, 3, 4, 6	Low	Low	No	Yes	No	Low	Low	High
MWD-29-2024	2, 3, 4, 6	Low	Low	No	Yes	Yes	Low	Low	High
MWD-30-2024	2, 4, 5	Low	Low	No	Yes	Yes	Low	Low	High
MWD-31-2024	2, 4, 6	Low	Low	No	Yes	Yes	Low	Low	High
MWD-32-2024	2, 3, 4, 6	Low	Medium	No	Yes	Yes	Low	Low	High
MWD-33-2024	2, 4	Low	Low	No	Yes	Yes	Low	Low	High
MWD-34-2024	2, 3, 4, 5, 6	Low	Medium	No	Yes	No	Low	Low	High

Table 18-3. Analysis of Mitigation Action

Action Addressing Hazard, by Mitigation Type							
Hazard Type	**Property Protection**	**Public Education & Awareness**	**Natural Resource Protection**	**Emergency Services**	**Structural Projects**	**Climate Resilient**	**Community Capacity Building**
High-Risk Hazards							
Earthquake	1, 4, 5, 6, 9, 10, 11, 12, 13, 14, 16, 17, 18, 31	30, 31	5	8, 27, 28, 29, 30	1, 4, 6, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 20, 25	30	8, 20, 24, 25, 27, 28, 29, 30, 31
Drought	10, 11, 12, 13, 14, 15	30, 34		3, 8, 21, 28, 30	2, 3, 8, 10, 11, 12, 13, 14, 15, 19, 20, 21, 25,	3, 21, 26, 30, 34	3, 8, 19, 20, 21, 25, 26, 28, 30, 34
Wildfire	23			27, 29			27, 29
Wind				27, 29			27, 29
Medium-Risk Hazards							
Extreme Heat				27, 29			27, 29
Flood	5, 7, 16, 22, 32		5, 7, 22, 32	28, 32	16		28
Landslide	5		5				
Low-Risk Hazards							
Dam Failure	16, 32		32	32	16		

19. PLAN ADOPTION AND MAINTENANCE

19.1 PLAN ADOPTION

The governing body of the jurisdiction requesting federal approval of the hazard mitigation plan must formally adopt the plan and document the action (44 CFR Section 201.6(c)(5)). This plan will be submitted for a pre-adoption review to Cal OES and FEMA Region 9 prior to adoption. Once pre-adoption approval has been provided, Metropolitan will formally adopt the plan. DMA compliance and its benefits cannot be achieved until the plan is adopted. The Metropolitan Water District Board resolution adopting this plan is provided in Appendix E.

19.2 PLAN MAINTENANCE STRATEGY

Plan maintenance is the formal process for achieving the following:

- Ensuring that the hazard mitigation plan remains an active and relevant document, and that the adopting jurisdiction maintains its eligibility for applicable funding sources
- Monitoring and evaluating the plan annually and producing an updated plan every 5 years
- Integrating public participation throughout the plan maintenance and implementation process
- Incorporating the mitigation actions outlined in the plan into existing planning mechanisms and programs
- To achieve these ends, a hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):
- A method and schedule for monitoring, evaluating, and updating the mitigation plan within a 5-year cycle
- An approach for how the community will continue public participation in the plan maintenance process.
- A process by which local governments will incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate

Table 19-1 summarizes the plan maintenance strategy. The following sections further describe each element.

19.2.1 Plan Implementation and Monitoring

The mitigation action plan presents a range of action items for reducing loss from hazard events. Some action items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. The effectiveness of the hazard mitigation plan depends on monitoring, implementation, and incorporation of its action items into existing Metropolitan plans, policies,

and programs. Together, the action items in the plan provide a framework for activities that Metropolitan can implement over the next 5 years. By Board adoption, Metropolitan has established goals and objectives and has prioritized mitigation actions that will be implemented through existing plans, policies, and programs. The Facilities Design Team within Engineering Services will have responsibility for overseeing the plan monitoring and implementation strategy as summarized in Table 19-1.

Table 19-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Biennial Progress Report.	Biennial after the adoption and final approval of the plan by FEMA. Reporting period Biennial	Albert Rodriguez
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support the assessment of the effectiveness of the plan; compile the Biennial Progress Report; assess appropriate action for preparing next hazard mitigation plan update.	Biennial after final plan approval by FEMA, or following a major disaster that significantly impacts Metropolitan	Albert Rodriguez
Update	Complete a comprehensive update to this plan every 5 years. Plan update to be facilitated through oversight of the Planning Committee	Every 5 years or after a major disaster that significantly impacts Metropolitan	Albert Rodriguez
Continuing Public Involvement	Provide the public access to implementation of this plan through the Hazard Mitigation Plan webpage on www.mwdh2o.com.	Biennial	Carolyn Schaffer
Plan Integration	Integrate relevant information from Hazard Mitigation Plan into other plans and programs where viable and opportunities arise	Ongoing	Albert Rodriguez

19.2.2 Plan Evaluation

The plan will be evaluated by how successfully the implementation of identified actions has helped to achieve the goals and objectives identified in this plan. This will be assessed by a review of the changes in risk that occur over the performance period and by the degree to which mitigation goals and objectives are incorporated into existing plans, policies, and programs. The minimum task of Metropolitan will be the evaluation of the progress of its action plan during a 24-month performance period. This review will include the following:

- Summary of any 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)
- Impact of any other planning programs or initiatives that involve hazard mitigation

The evaluation will be summarized in a biennial progress report. This report will be available through two means:

- Posted on Metropolitan's Hazard Mitigation Plan webpage on www.mwdh2o.com
- Provided to the Metropolitan Board to inform them of the progress of actions implemented

Biennial progress reporting is not a requirement specified under 44 CFR. However, it may enhance Metropolitan's opportunities for funding. While failure to implement this component of the plan maintenance strategy will not jeopardize Metropolitan's compliance under the DMA, it may jeopardize its opportunity to partner and leverage funding opportunities with the other stakeholders in the planning area.

An oversight committee with representation similar to the Steering Committee that oversaw the development of this plan should have an active role in the plan evaluation. The new steering committee will review the annual progress report and provide input to Metropolitan on possible enhancements to be considered for the next update.

19.2.3 Plan Update

Federal regulations require that local hazard mitigation plans be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under the Disaster Mitigation Act (44 CFR Section 201.6.d(3)). This plan's format allows Metropolitan to review and update sections when new data become available. New data can be easily incorporated, resulting in a plan that will remain current and relevant. Metropolitan intends to update the plan on a 5-year cycle from the date of plan approval. This cycle may be accelerated to less than 5 years based on the following triggers:

- A presidential disaster declaration that impacts the planning area
- A hazard event that causes loss of life
- Other hazard events that significantly alter Metropolitan's exposure or vulnerability to a natural hazard

It will not be the intent of the update process to develop a completely new hazard mitigation plan. Based on needs identified by the Planning Committee, the update will, at a minimum, include the following elements:

- The update process will be convened through a new Steering Committee.
- The hazard risk assessment will be reviewed and, if necessary, updated using 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 the risk assessment or Metropolitan policies identified under other planning mechanisms.
- 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 Board of Directors will adopt the updated plan.

Future plan updates will be overseen by a Steering Committee similar to the one that participated in this plan development process, so keeping an interim steering committee intact will provide a head start on future updates. The Steering Committee's role will be to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

19.2.4 Continuing Public Participation

The public will continue to be apprised of the plan's progress through Metropolitan's website, including providing copies of biennial progress reports on the website. This site will not only house the final plan, but it will also become the one-stop shop for information regarding the plan and plan implementation. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of Metropolitan at the time of the update. At a minimum, this strategy will include the use of a variety of communication tools.

19.2.5 Incorporation into Other Planning Mechanisms

The information on hazard, risk, vulnerability, and mitigation contained in this plan is based on the best science and technology available at the time this plan was prepared. This planning process provided Metropolitan with the opportunity to identify, review and expand on capabilities of Metropolitan that could support or enhance the outcomes of this plan. Opportunities for integration identified by this planning process include:

- Climate Adaptation Master Plan for Water
- Climate Vulnerability and Risk Assessments
- Metropolitan Strategic Plans
- Metropolitan Master Plans
- Metropolitan emergency response plans
- America's Water Infrastructure Act plan
- Capital Investment Plan

Action items can be implemented through specific board approval, plans and programs, 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 via the update process.

REFERENCES

California Department of Finance. 2020. Demographics Research Unit. Accessed at: http://www.dof.ca.gov/forecasting/demographics/

California Department of Water Resources (California DWR). 2020. California's Most Significant Droughts: Comparing Historical and Recent Conditions. January 2020. Accessed at: https://water.ca.gov/-/media/DWR-Website/Web-Pages/What-We-Do/Drought-Mitigation/Files/Publications-And-Reports/a6022_CalSigDroughts19_v9_ay11.pdf

City of Glendale. 2021. "Hazardous Material Business Plan Program." Page on City of Glendale Fire Department website. Accessed at https://www.glendaleca.gov/government/departments/fire-department/fire-prevention/environmental-management-center/hazardous-materials-business-plan

County of Orange and Orange County Fire Authority Local Hazard Mitigation Plan. December 2021. Accessed at: https://www.ocsheriff.gov/sites/ocsd/files/2022-03/2021%20County%20of%20Orange%20and%20Orange%20County%20Fire%20Authority%20Local%20Hazard%20Mitigation%20Plan.pdf

County of Riverside Multi-Jurisdictional Local Hazard Mitigation Plan. July 2018. Accessed at: https://rivcoready.org/sites/g/files/aldnop181/files/About%20EMD/pdf/FINAL%20PUBLIC%20VERSION%20Riv_Co_%202018%20Multi%20Jurisdictional%20Local%20Hazard%20Mitigation%20Plan.pdf

County of Riverside Operational Area Multi-Jurisdictional Local Hazard Mitigation Plan. April 2023 Version 8.7.23. Accessed at: https://rivcoready.org/sites/g/files/aldnop181/files/2023-08/MJLHMP%208.7.23.pdf

County of San Bernardino Multi-Jurisdictional Hazard Mitigation Plan. 2022. Accessed at: https://www.sbcounty.gov/uploads/SBCFire/documents/EmergencyServices/Hazard-Mitigation-Plan-202212.pdf

Federal Emergency Management Agency (FEMA). 2020. Disasters. Accessed at https://www.fema.gov/disasters

Los Angeles Economic Development Corporation., 2025. Impact of 2025 Los Angeles Wildfires and Comparative Study. https://laedc.org/wp-content/uploads/2025/02/LAEDC_2025-LA-Wildfires-Study_090525-UPDATE.pdf

Los Angeles Time. 1993. Bracing for a Reprise of '83, '88 Calamities: Weather: Devastating storms in those years left flooding and destruction in their wakes. This one shouldn't be as bad. January 6, 1993. Accessed at: https://www.latimes.com/archives/la-xpm-1993-01-06-me-950-story.html

National Drought Mitigation Center. 2020. Tustin, CA (1970-2019). Accessed at: https://droughtreporter.unl.edu/advancedsearch/impacts.aspx

National Weather Service (NWS). 1978. report on the Southern California Floods, Flash Floods and Mud Slides of February 8 – 10, 1978. Prepared by Western Regional Headquarters, National Weather Service. Salt Lake City, Utah. December 8, 1978. Accessed at: https://www.weather.gov/media/publications/assessments/Southern%20CA%20Flash%20Floods%20Feb%201978.pdf

National Weather Service (NWS). 2017. A History of Significant Weather Events in Southern California; Organized by Weather Type. May 2017 Accessed at: https://www.weather.gov/media/sgx/documents/weatherhistory.pdf

National Weather Service (NWS). 2020. Understand Tornado Alerts. Accessed at: https://www.weather.gov/safety/tornado-ww

National Oceanic and Atmospheric Administration (NOAA). 2021. NOAA Storm Events Database. https://www.ncdc.noaa.gov/stormevents/

National Oceanic and Atmospheric Administration (NOAA). 2020a. Climate Change: Global Sea Level. August 14, 2020. Accessed at: https://www.climate.gov/news-features/understanding-climate/climate-change-global-sea-level

National Oceanic and Atmospheric Administration (NOAA). 2020b. Global and Regional Sea Level Rise Scenarios for the United States. January 2017. Accessed at: https://tidesandcurrents.noaa.gov/publications/techrpt83_Global_and_Regional_SLR_Scenarios_for_the_U.S._final.pdf

Orange County. 1986. Orange County Hydrology Manual. Accessed at: https://www.ocflood.com/civicax/filebank/blobdload.aspx?BlobID=8336

Orange County. 2015. County of Orange and Orange County Fire Authority Local Hazard Mitigation Plan. November 2015. Accessed at: http://cams.ocgov.com/Web_Publisher/Agenda07_12_2016_files/images/O00216-000668A.PDF

Orange County Fire Authority. 2020. “Vegetation Management.” Accessed at: https://www.ocfa.org/RSG/VegetationManagement

Orange County Public Works. 2020. “Flood Protection.” Orange County Infrastructure Programs. Accessed at: https://www.ocflood.com/civicax/filebank/blobdload.aspx?blobid=114998

Orange County Public Works. 2020a. “Local Flood Hazard.” Orange County Infrastructure Programs. Accessed at: https://www.ocflood.com/safety/protection/hazard

Orange County Register. 2010. O.C. storm damage tops $33 million. December 31, 2020. Accessed at: https://www.ocregister.com/2010/12/31/oc-storm-damage-tops-33-million-2/

San Diego County Multi-Jurisdictional Hazard Mitigation Plan. 2017. Accessed at: https://www.sandiegocounty.gov/content/dam/sdc/oes/emergency_management/HazMit/2017/County-HazMit-Plan-2017-Sections-1-7-with-Appendixes-BOS-Approved.pdf

Santiago Fire. 2020. Accessed at: https://en.wikipedia.org/wiki/Santiago_Fire

Taylor and Francis Online. 2020. The Unusual Storms of February 1992 in Southern California. May 15, 2013. Accessed at: https://www.tandfonline.com/doi/abs/10.1080/02723646.1994.10642528

U.S. Census. 2020. QuickFacts. North Tustin, CA. Accessed at: https://www.census.gov/quickfacts/fact/table/northtustincdpcalifornia,tustincitycalifornia/PST045219

U.S. Census. 2020. QuickFacts. Tustin, CA. Accessed at: https://www.census.gov/quickfacts/tustincitycalifornia

U.S. Department of Health and Human Services, Office of Minority Health. February 2008. "Cultural Competency in Disaster Response: A Review of Current Concepts, Policies, and Practices."

U.S. Geological Survey (USGS). 1975. Summary of Floods in the United States During 1969. Accessed at: https://pubs.usgs.gov/wsp/2030/report.pdf

U.S. Geological Survey (USGS). 1991. Floods of February 1980 in Southern California and Central Arizona. Accessed at: https://pubs.usgs.gov/pp/1494/report.pdf

U.S. Geological Survey (USGS). 1993. Southern California Storms and Floods of January-February 1993. Accessed at: https://pubs.usgs.gov/of/1993/0411/report.pdf

U.S. Geological Survey (USGS). 2020. Earthquake Hazards Program Unified Hazard Tool; Earthquake Hazard and Probability Maps. Accessed at: https://earthquake.usgs.gov/hazards/interactive/

Upper Los Angeles River Area (ULARA) Watermaster. 2021. "Watermaster Service in the Upper Los Angeles River Area." Page of the ULARA Watermaster web site. Accessed at http://ularawatermaster.com/index.html?page_id=589

Ventura County Multi-Hazard Mitigation Plan. 2015. Accessed at: https://www.readyventuracounty.org/wp-content/uploads/2018/05/ventura-hmp_main-body_september-2015.pdf

Western Regional Climate Center. 2020. "Santa Ana Fire Station" https://wrcc.dri.edu/summary/Climsmsca.html.

Western Regional Climate Center. 2020a. "Tustin Irvine Ranch." https://wrcc.dri.edu/summary/Climsmsca.html

Wikipedia. 2020. Severe weather terminology (United States). Accessed at: https://en.wikipedia.org/wiki/Severe_weather_terminology_(United_States)

Appendix A. Planning Process Documentation

PLANNING PROCESS DOCUMENTATION

For planning and public engagement purposes, the "public" for this plan has been defined as Metropolitan member agencies, emergency managers for the six operational areas within Metropolitan's service area, and the general public. Meetings, workshops, presentations and notifications are described below.

Member Agencies

Meeting	Purpose	Participants
June 11, 2021 Member Agency Managers Meeting (online)	Inform member agencies of preparation of Local Hazard Mitigation Plan, FEMA funding opportunity, and components of a Local Hazard Mitigation Plan. Address questions and invite participation.	General Managers and representatives from 26 member agencies, Metropolitan staff
December 3, 2021 Member Agency Managers Meeting (online)	Update member agencies on status of Local Hazard Mitigation Plan; request information on other hazard mitigation planning efforts; inform them of upcoming workshop and invite participation	General Managers and representatives from 26 member agencies, Metropolitan staff
April 27, 2022 Workshop (online)	Provide background information on Local Hazard Mitigation Plan and planning process; provide overview of hazard mitigation and FEMA and CAL OES requirements; provide opportunity to share hazard mitigation planning efforts and priorities in their service areas and participate in an initial discussion of risks and mitigation strategies, goals and objectives.	48 attendees, including representatives from 20 member agencies, Metropolitan and consulting firms Tetra Tech, Inc. and Circlepoint
2022-2025 Member Agency Meetings (hybrid)	Metropolitan meets monthly with member agency managers and staff, periodically with member agency engineering managers, and in workshops with member agency managers and planning staff. While not focused on the Local Hazard Mitigation Plan, these meetings and workshops address risks to water infrastructure and water supply reliability associated with dam	Varies; all 26 member agencies invited to participate

	failure, drought, earthquake, flood and wildfire. Mitigation and grant funding opportunities are discussed. The outcome of these meetings informed the development of the Local Hazard Mitigation Plan.	
December 12, 2025 Member Agency Managers Meeting (hybrid)	Provide overview of the Draft Local Hazard Mitigation Plan, including planning process, planning area, approach and schedule; goals and objectives; risks assessed, mitigation and prioritization. Address questions and comments. Inform member agencies of pending release of Public Review Draft, invite review and comments.	51 attendees, including representatives from 17 member agencies, Metropolitan staff
January 6, 2026 Email Notice	Announce release of Public Review Draft, comment period, and process to submit comments.	Notice to all 26 member agencies

County Emergency Managers

Meeting	Purpose	Participants
June 2, 2022 Meeting (online)	Provide overview of Metropolitan and introduction to Hazard Mitigation Planning. Inform emergency managers of preparation of Local Hazard Mitigation Plan. Seek information on County Operational Areas, hazards of concern, and mitigation planning within operational areas. Seek input on priorities for Metropolitan's mitigation actions. Address questions and comments. Invite additional input through follow up survey on operational areas and concerns Metropolitan should consider in its plan.	Representatives from 6 County Operational Areas, Metropolitan, and consulting firms Tetra Tech, Inc. and Circlepoint. Received 5 responses to survey.
December 15, 2025 Meeting (online)	Provide overview of Metropolitan and the Draft Local Hazard Mitigation Plan, including planning process, planning area, approach and schedule; goals and objectives; risks assessed, mitigation and prioritization. Address questions and comments. Inform County Emergency Managers of pending release of Public Review Draft, invite review and comments.	15 attendees, including representatives from 4 County Operational Areas, Metropolitan staff; presentation shared with all 6 County Operational Areas

January 6, 2026 Email Notice	Announce release of Public Review Draft, comment period, and process to submit comments.	Notice to all 6 County Operational Areas

General Public

Meeting	Purpose	Participants
January 6, 2026 Webinar	Provide overview of Metropolitan and the Draft Local Hazard Mitigation Plan, including planning process, planning area, approach and schedule; goals and objectives; risks assessed, mitigation and prioritization. Address questions and comments. Inform general public of opportunity and process to review and comment on Public Review Draft.	TBD; over 800 invitations sent via email and US Mail to county and city zoning, planning community and economic development departments; building officials, planning commissions; other elected officials; special districts and local governments adjacent to Metropolitan's service area that provide water service; business organizations, sustainability institutes at universities, Southern California Edison, SoCal Gas, San Diego Gas & Electric; organizations that support underserved communities and socially vulnerable populations

Summary of Comments on Public Review Draft

To be provided.

Appendix B. Federal and State Agencies, Programs and Regulations

FEDERAL AND STATE AGENCIES, PROGRAMS AND REGULATIONS

Existing laws, ordinances, plans and programs at the federal and state level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used to review local capabilities to implement mitigation actions. A review of local plans, studies, reports, and technical information is provided in Chapter 4 of this hazard mitigation plan.

FEDERAL

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) seeks to prevent discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Act in emergency management and disaster-related programs, services, and activities. It applies to state and local governments as well as third parties, including religious entities and private nonprofit organizations.

The ADA has implications for sheltering requirements and public notifications. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have all necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or other visual alerts. Two technical documents for shelter operators address physical accessibility needs of people with disabilities, as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regard to transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

America's Water Infrastructure Act

America's Water Infrastructure Act of 2018 (AWIA) improves drinking water and water quality, deepens infrastructure investments, and enhances public health and quality of life. AWIA requires water systems serving more than 3,300 people to develop or update risk assessments and emergency response plans. The U.S. Environmental Protection Agency is tsked with orchestrating AWIA.

AWIA requires community water systems serving more than 3,300 people to develop or update risk assessments and emergency response plans (ERPs). The law specifies the components that the risk assessments and ERPs must address and establishes deadlines by which water systems must certify to EPA completion of the risk assessment and ERP.

AWIA requires that EPA issue a regulation which authorizes primacy agencies to mandate restructuring assessments for public water systems which frequently violate health-based standards, and which have unsuccessfully attempted, or which are unable to attempt, feasible and affordable actions to comply and must describe liability protection for a compliant public water system which is consolidating with an assessed public water system.

States must amend their state capacity development strategies to include a description of how the state will encourage the development of asset management plans that include best practices, training, technical assistance and other activities to help with implementation of those plans. States also must include an update of these activities to encourage asset management practices in the Governor's report. EPA must review and update, if appropriate, asset management documents and trainings every five years.

AWIA provides funding to assist public water systems in small and disadvantaged communities with reducing lead in drinking water systems, provides financial assistance to homeowners for lead line replacement and testing drinking water in schools and childcare facilities for lead.

AWIA requires state and tribal emergency response commissions to notify the applicable State agency (i.e., the drinking water primacy agency) of any reportable releases and provide community water systems with hazardous chemical inventory data. This guide provides information for community water systems and state drinking water primacy agencies.

Bureau of Land Management

The U.S. Bureau of Land Management (BLM) funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands. BLM works closely with the Forest Service and state and local governments to coordinate fire safety activities. The Interagency Fire Coordination Center in Boise, Idaho serves as the center for this effort.

Civil Rights Act

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex, or nation origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with

applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's surface waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water."

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. Numerous issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

The CWA is important to hazard mitigation in several ways. There are often permitting requirements for any construction within 200 feet of water of the United States, which may have implications for mitigation projects identified by a local jurisdiction. Additionally, CWA requirements apply to wetlands, which serve important functions related to preserving and protecting the natural and beneficial functions of floodplains and are linked with a community's floodplain management program. Finally, the National Pollutant Discharge Elimination System is part of the CWA and addresses local stormwater management programs. Stormwater management plays a critical role in hazard mitigation by addressing urban drainage or localized flooding issues within jurisdictions.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster
- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. CDBG-DR funding is a potential alternative source of funding for actions identified in this plan.

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs (Office of Federal Lands Highway, 2016). Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

Emergency Watershed Program

The USDA Natural Resources Conservation Service (NRCS) administers the Emergency Watershed Protection (EWP) Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. EWP is an emergency recovery program. Financial and technical assistance are available for the following activities (Natural Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The

ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- Endangered means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- Threatened means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- Critical habitat means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- Section 4: Listing of a Species—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- Section 7: Consultation—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- Section 9: Prohibition of Take—It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding, or sheltering.
- Section 10: Permitted Take—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- Section 11: Citizen Lawsuits—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

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

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

FERC monitors seismic research and applies it in performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication Engineering Guidelines for the Evaluation of Hydropower Projects guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing 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 everyone knows what to do in emergency situations.

Federal Wildfire Management Policy and Healthy Forests Restoration Act

Federal Wildfire Management Policy and Healthy Forests Restoration Act (2003). These documents call for a single comprehensive federal fire policy for the Interior and Agriculture Departments (the agencies using federal fire management resources). They mandate community-based collaboration to reduce risks from wildfire.

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Inspection Act in 1972, creation of the National Dam Safety Program in 1996, and reauthorization of the program through the Dam Safety Act in 2006. National Dam Safety Program, administered by FEMA requires a periodic engineering analysis of the majority of dams in the country; exceptions include the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission
- Dams constructed pursuant to licenses issued under the Federal Power Act

- Dams that the Secretary of the Army determines do not pose any threat to human life or property.

The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's 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 of the dams in the United States.

National Environmental Policy Act

The National Environmental Policy Act requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. The National Environmental Policy Act established the Council on Environmental Quality, whose regulations (40 CFR Parts 1500-1508) set standards for compliance. Consideration and decision-making regarding environmental impacts must be documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

National Fire Plan

The 2001 National Fire Plan was developed based on the National Fire Policy. A major aspect of the National Fire Plan is joint risk reduction planning and implementation carried out by federal, state, and local agencies and communities. The National Fire Plan presented a comprehensive strategy in five key initiatives:

- Firefighting—Be adequately prepared to fight fires each fire season.
- Rehabilitation and Restoration—Restore landscapes and rebuild communities damaged by wildfires.
- Hazardous Fuel Reduction—Invest in projects to reduce fire risk.
- Community Assistance—Work directly with communities to ensure adequate protection.
- Accountability—Be accountable and establish adequate oversight, coordination, program development, and monitoring for performance.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In some cases, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency responder disciplines. These cases necessitate coordination across a spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of

emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, technological hazards, and human-caused hazards) regardless of size or complexity.

Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards. The content of this plan is considered to be a viable support tool for any phase of emergency management. The NIMS program is considered as a response function, and information in this hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the planning area.

National Landslide Preparedness Act

The 2021 National Landslide Preparedness Act authorized a national landslide hazards reduction program and a 3D elevation program within the USGS. This broadened the existing Landslide Hazards Program (under the Natural Hazards Mission Area) and the 3D Elevation Program (under the National Geospatial Program). The act required coordination among federal agencies through an Interagency Coordinating Committee on Landslide Hazards representing USGS and other agencies. The act calls for development of a national strategy for landslide loss reduction and a publicly accessible national landslide database of landslide hazard and risk.

Presidential Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 2015a):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Presidential Executive Order 11990, Protection of Wetlands

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities (National Archives, 2016):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.
- All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers operates and maintains approximately 700 dams nationwide. It is also 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. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation, and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety. The Corps maintains the National Inventory of Dams, which contains information about a dam's location, size, purpose, type, last inspection, and regulatory status (U.S. Army Corps of Engineers, 2017).

U.S. Army Corps of Engineers Flood Hazard Management

The following U.S. Army Corps of Engineers authorities and programs related to flood hazard management:

- The Floodplain Management Services program offers 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration, and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.
- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000 with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating, and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
  - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
  - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
  - Watershed management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance is provided in the flowing categories:
  - Preparedness—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state, and federal agencies.
  - Response Activities—Public Law 84-99 allows the Corps of Engineers to supplement state and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a project cooperation agreement signed by the public sponsor and the sponsor must remove all flood fight material after the flood has receded. Public Law 84-99 also authorizes emergency water support and drought assistance

in certain situations and allows for "advance measures" assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.

- Rehabilitation—Under Public Law 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems considered eligible for Public Law 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

These authorities and programs are all available to support any related hazard mitigation actions.

U.S. Fire Administration

There are federal agencies that provide technical support to fire agencies/organizations. For example, the U.S. Fire Administration, which is a part of FEMA, provides leadership, advocacy, coordination, and support for fire agencies and organizations.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service fire management strategy uses prescribed fire to maintain early successional fire-adapted grasslands and other ecological communities throughout the National Wildlife Refuge system.

STATE

AB 32: The California Global Warming Solutions Act

This bill identifies the following potential adverse impacts of global warming:

> "… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."

AB 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels), with further reductions to follow. The law requires the state Air Resources Board to do the following:

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board has adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

Assembly Bill 756: Public Water System PFAs

Existing law, the California Safe Drinking Water Act, requires the State Water Resources Control Board to administer provisions relating to the regulation of drinking water to protect public health, including, but not limited to, conducting research, studies, and demonstration programs relating to the provision of a dependable, safe supply of drinking water, enforcing the federal Safe Drinking Water Act, adopting implementing regulations, and conducting studies and investigations to assess the quality of water in private domestic water supplies. Under the California Safe Drinking Water Act, the implementing regulations are required to include, but are not limited to, monitoring of contaminants and requirements for notifying the public of the quality of the water delivered to customers.

This bill authorizes the state Water Resources Control Board to order a public water system to monitor for perfluoroalkyl substances and polyfluoroalkyl substances (PFAs). It requires a community water system or a non-transient noncommunity water system, upon a detection of these substances, to report that detection, as specified. The bill requires a community water system or a non-transient noncommunity water system where a detected level of these substances exceeds the response level to take a water source where the detected levels exceed the response level out of use or provide a prescribed public notification.

AB 2800: Climate Change—Infrastructure Planning

This California State Assembly bill passed in 2016 and until July 1, 2020, requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill, by July 1, 2017, and until July 1, 2020, requires an agency to establish a Climate-Safe Infrastructure Working Group to examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act's main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires the State of California Geologist to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

California Department of Forestry and Fire Protection

CAL FIRE has responsibility for wildfires in areas that are not under the jurisdiction of the Forest Service or a local fire organization, including lands designated as State Responsibility Areas. CAL FIRE also has fire protection responsibilities by contract and mutual aid agreements. For example, CAL FIRE provides year-round fire protection under Amador Plan agreements with certain local government agencies (Public Resources Code §4144). Through these agreements, CAL FIRE provides local structural and wildfire protection or dispatch services to a community and maintains a staffing level that otherwise would be available only during the fire season. The local entity pays the additional cost of the service.

California Department Water Resources

In California, the DWR is the coordinating agency for floodplain management. The DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by the DWR.

California Division of Safety of Dams

California's Division of Safety of Dams (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 (California Division of Safety of Dams, 2017).

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government enacted the National Environmental Policy Act, to institute a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision-making process.

CEQA establishes a statewide environmental policy, and mandates actions all state and local agencies must take to advance the policy. Jurisdictions conduct analysis of the project to determine if there are potentially significant environmental impacts, identify mitigation measures, and possible project alternatives by preparing environmental reports for projects that requires CEQA review. This environmental review is required before an agency takes action on any policy, program, or project. Any project action identified in this plan will seek full CEQA compliance upon implementation.

California Fire Alliance

The California Fire Alliance (CFA) was established in response to directives from the 2001 National Fire Plan. The CFA pursues four strategies to deal with the National Fire Plan's community assistance initiative:

- Work with communities at risk from wildfires to develop community-based planning leadership and facilitate the development of community fire loss mitigation plans, which transcend jurisdiction and ownership boundaries.
- Assist communities in development of fire loss mitigation planning, education, and projects to reduce the threat of wildfire losses on public and private lands.
- Develop an information and education outreach plan to increase awareness of wildfire protection program opportunities available to communities at risk.
- Work collaboratively to develop, modify, and maintain a comprehensive list of communities at risk.

California Fire Plan

The State Board of Forestry and CAL FIRE have prepared a comprehensive update of the California Fire Plan for wildfire protection. The planning process included defining a level of service measurement; considering assets at risk; incorporating the cooperative interdependent relationships of wildfire protection providers; providing for public stakeholder involvement; and creating a fiscal framework for policy analysis. The California Fire Plan's overall goal is to reduce costs and losses from wildfire in the state by protecting assets at risk through pre-fire management and by reducing the spread of fire through more successful initial response.

California Fire Safe Council

In 1993, the statewide Fire Safe Council, consisting of private and public membership, was formed to educate and encourage Californians to plan and prepare for wildfires by reducing the risk of fire to property, communities, and natural/structural resources. In 2002, this group created a nonprofit organization and board of directors, called the California Fire Safe Council. The Council works with the California Fire Alliance to facilitate the distribution of National Fire Plan grants for wildfire risk reduction and education (www.grants.firesafecouncil.org). The Council also provides assistance to local Fire Safe Councils through its website (www.firesafecouncil.org), the distribution of educational materials, and technical assistance, primarily through regional representatives. More than 130 local Fire Safe Councils have formed in California to plan, coordinate, and implement fire prevention activities.

California Fire Service and Rescue Emergency Mutual Aid Plan

The Governor's Office of Emergency Services Fire and Rescue Branch administers the California Fire Service and Rescue Emergency Mutual Aid Plan. The agency provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support, primarily to overall emergency service organizations and urban search and rescue Committees.

California Multi-Hazard Mitigation Plan

Under the 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 through the following:

- Documenting statewide hazard mitigation planning in California
- Describing strategies and priorities for future mitigation activities
- Facilitating the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meeting state and federal statutory and regulatory requirements.

The plan is an annex to the State Emergency Plan, and it identifies past and present mitigation activities, current policies and programs, and mitigation strategies for the future. It also establishes hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities.

Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state's hazard mitigation plan. In updating this plan, the Planning Committee reviewed the California State Hazard Mitigation Plan to identify key relevant state plan elements.

California Residential Mitigation Program

The California Residential Mitigation Program was established in 2011 to help Californians strengthen their homes against damage from earthquakes. The program is a joint powers authority created by Cal OES and the California Earthquake Authority, which is a not-for-profit, publicly managed, privately funded provider of home earthquake insurance to California homeowners and renters.

Earthquake Brace + Bolt was developed to help homeowners lessen the potential for damage to their houses during an earthquake. A residential seismic retrofit strengthens an existing older house, making it more resistant to earthquake activity such as ground shaking and soil failure. The seismic retrofitting involves bolting the house to its foundation and adding bracing around the perimeter of the crawl space. Most homeowners hire a contractor to do the retrofit work, and owners of houses in ZIP Codes with house characteristics suitable for this type of retrofit are eligible for up to $3,000 toward the cost. A typical retrofit by a contractor may cost between $3,000 and $7,000, depending on the location and size of the house, contractor fees, and the amount of materials and work involved. If the homeowner is an experienced do-it-yourselfer, a retrofit can cost less than $3,000.

California Water Use Efficiency Legislation

Two long-term water-use efficiency/conservation bills signed into law in 2018 (SB 606 and AB 1668) are intended to help the state better prepare for droughts and climate change. One of the biggest components of the bills is the creation of water-use objectives for water agencies (not individual households or businesses). Local water agencies are responsible for calculating their water-use objective and determining whether their systemwide, aggregate water use meets that objective. If necessary, they will also have flexibility in how best to help customers use water more efficiently, such as conservation rebates and educational programs.

Starting in 2027, the State Water Board could issue fines to local water agencies that have not met their water-use objectives. These fines would be levied on agencies, not individuals. The bills also establish new planning and submittal requirements for Agricultural Water Management and Urban Water Management plans. Water agencies must calculate their system-wide, water-use objectives by November 2023 based on the following components:

- Water efficiency standards for indoor water use—This will be based on a provisional standard of 55 gallons of water a day per person served by the water agency.

- Outdoor water use—This standard is still being determined but will account for local climate and irrigable acres.
- Commercial, industrial, and institutional landscape irrigation
- Water loss (system leaks)
- Unique local circumstances (e.g., livestock water use)
- Credit for recycled water use

Disadvantaged and Low-Income Communities Investments

Senate Bill (SB) 535 directs state and local agencies to make investments that benefit California's disadvantaged communities. It also directs the California Environmental Protection Agency to identify disadvantaged communities for the purposes of these investments based on geographic, socio-economic, public health, and environmental hazard criteria. Assembly Bill (AB) 1550 increased the percent of funds for projects located in disadvantaged communities from 10 to 25 percent and added a focus on investments in low-income communities and households. This program is a potential alternative source of funding for actions identified in this 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.

Office of the State Fire Marshal

The Office of the State Fire Marshal is a division of CAL FIRE that has a wide variety of fire safety and training responsibilities and provides technical support to fire agencies/organizations.

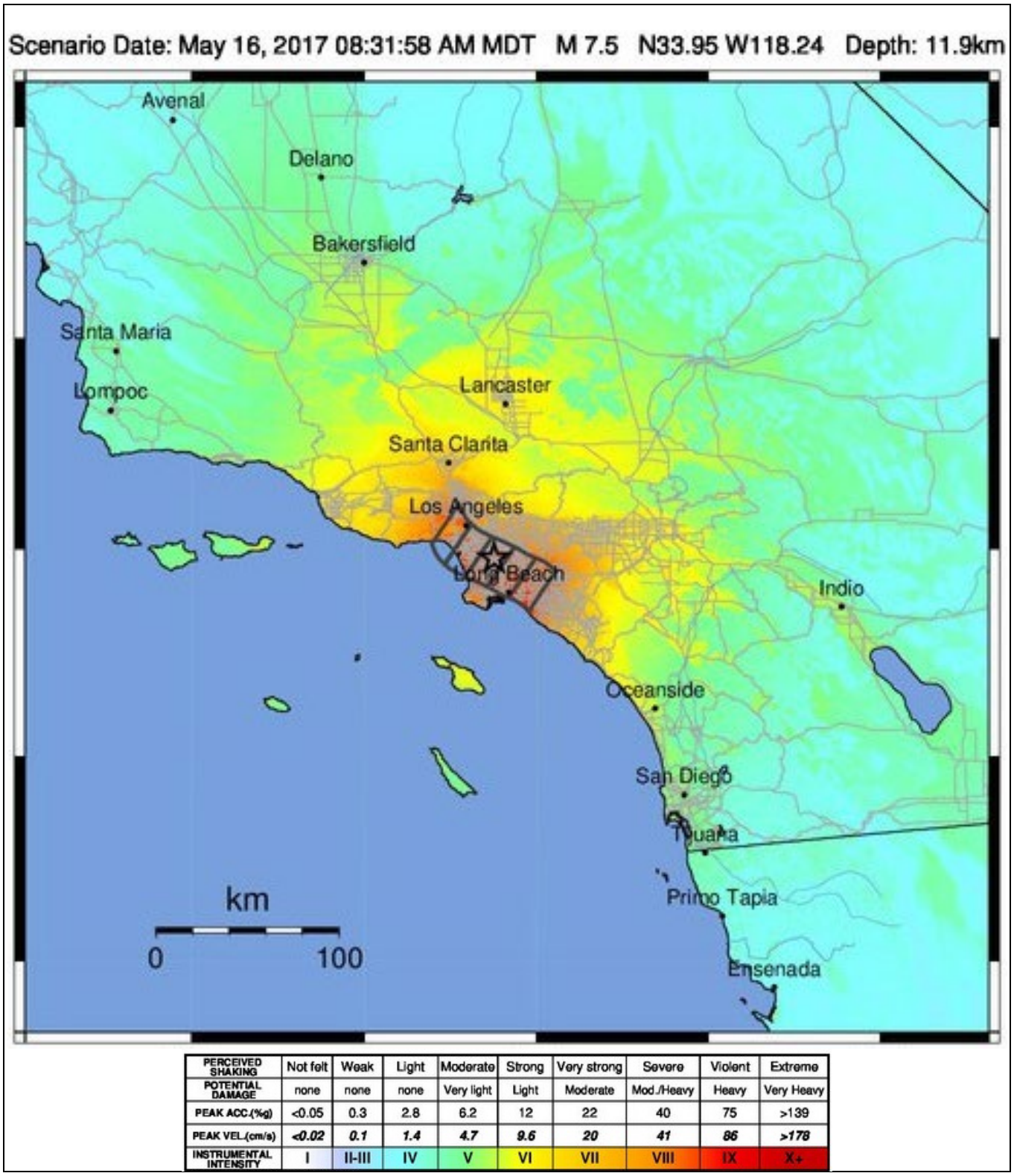
Senate Bill 97: Guidelines for Greenhouse Gas Emissions

Senate Bill 97, enacted in 2007, amends CEQA to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for CEQA analysis. It directs the Governor's Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects by July 1, 2009, and directs the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

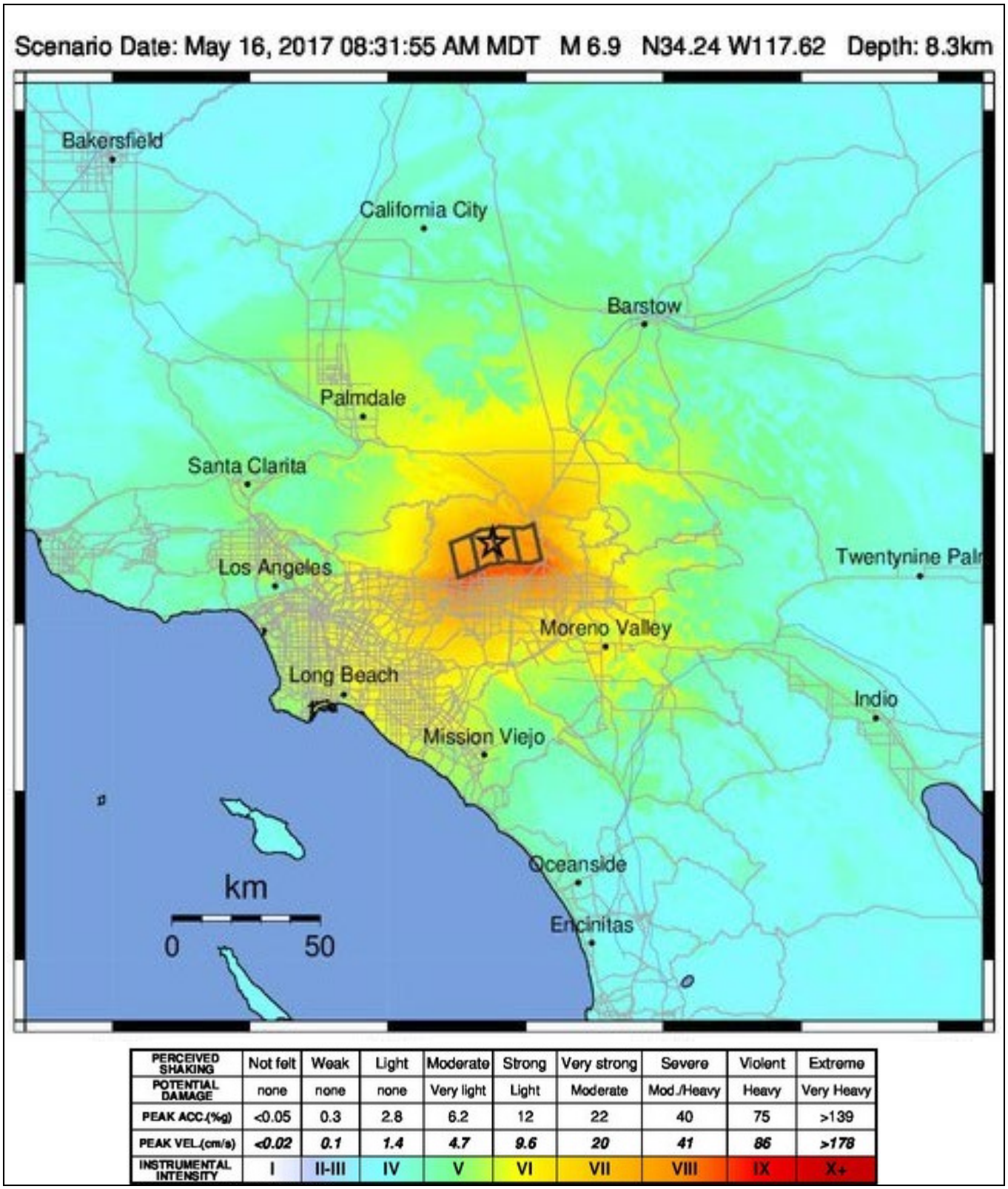
Standardized Emergency Management System

California Code Title 19 establishes the Standardized Emergency Management System to standardize the response to emergencies involving multiple jurisdictions. The system is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use the system by December 1, 1996, to be eligible for state funding of response-related personnel costs under California Code Title 19 (Sections 2920, 2925 and 2930). The roles and responsibilities of individual agencies contained in existing laws or the state emergency plan are not superseded by these regulations. The hazard mitigation plan is considered to be a support document for all phases of emergency management, including those associated with the system.

Appendix C. USGS Intensity Maps for Earthquake Scenarios Used in Hazus

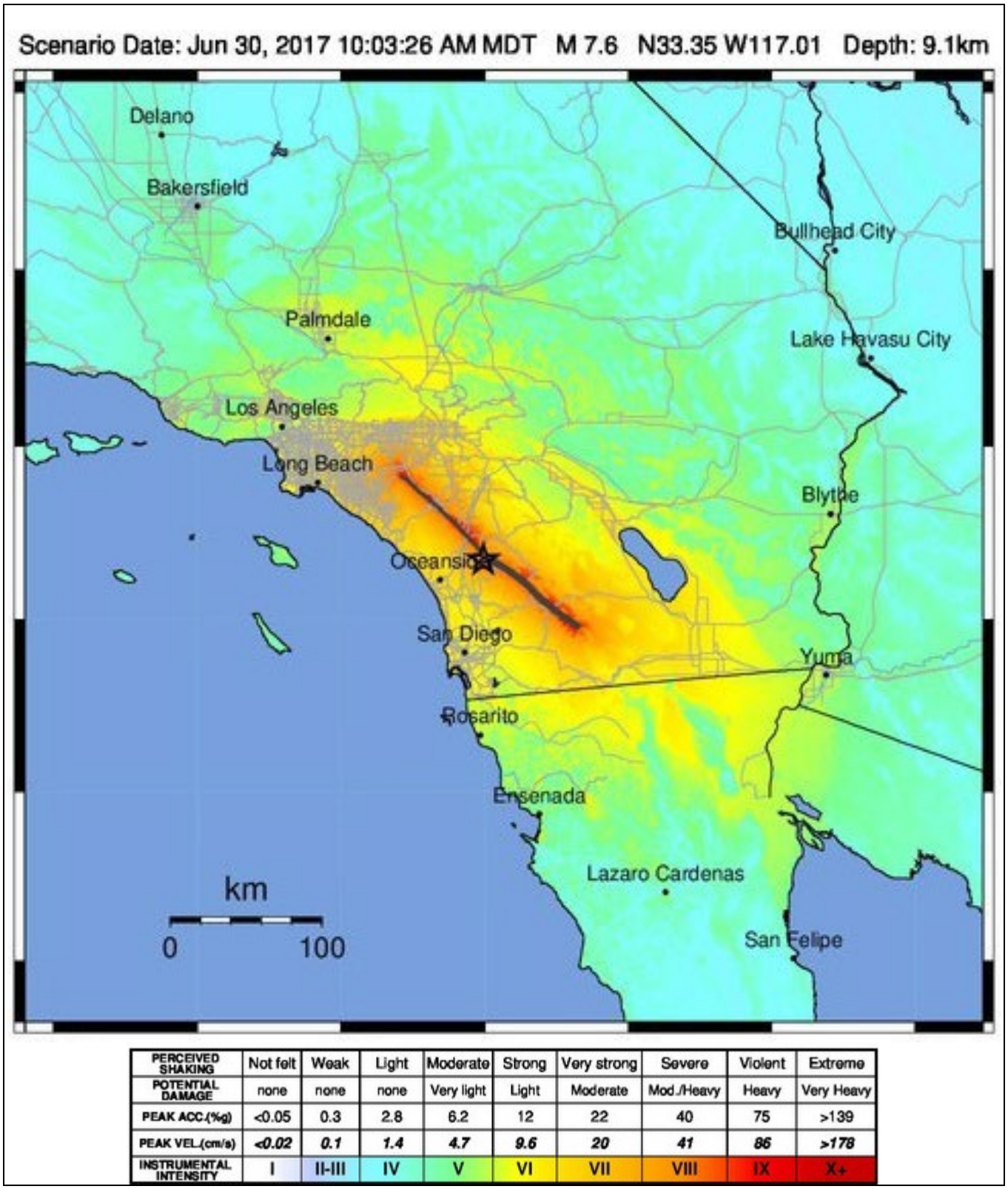


USGS Intensity Mapping for the M7.5 Compton Earthquake Scenario



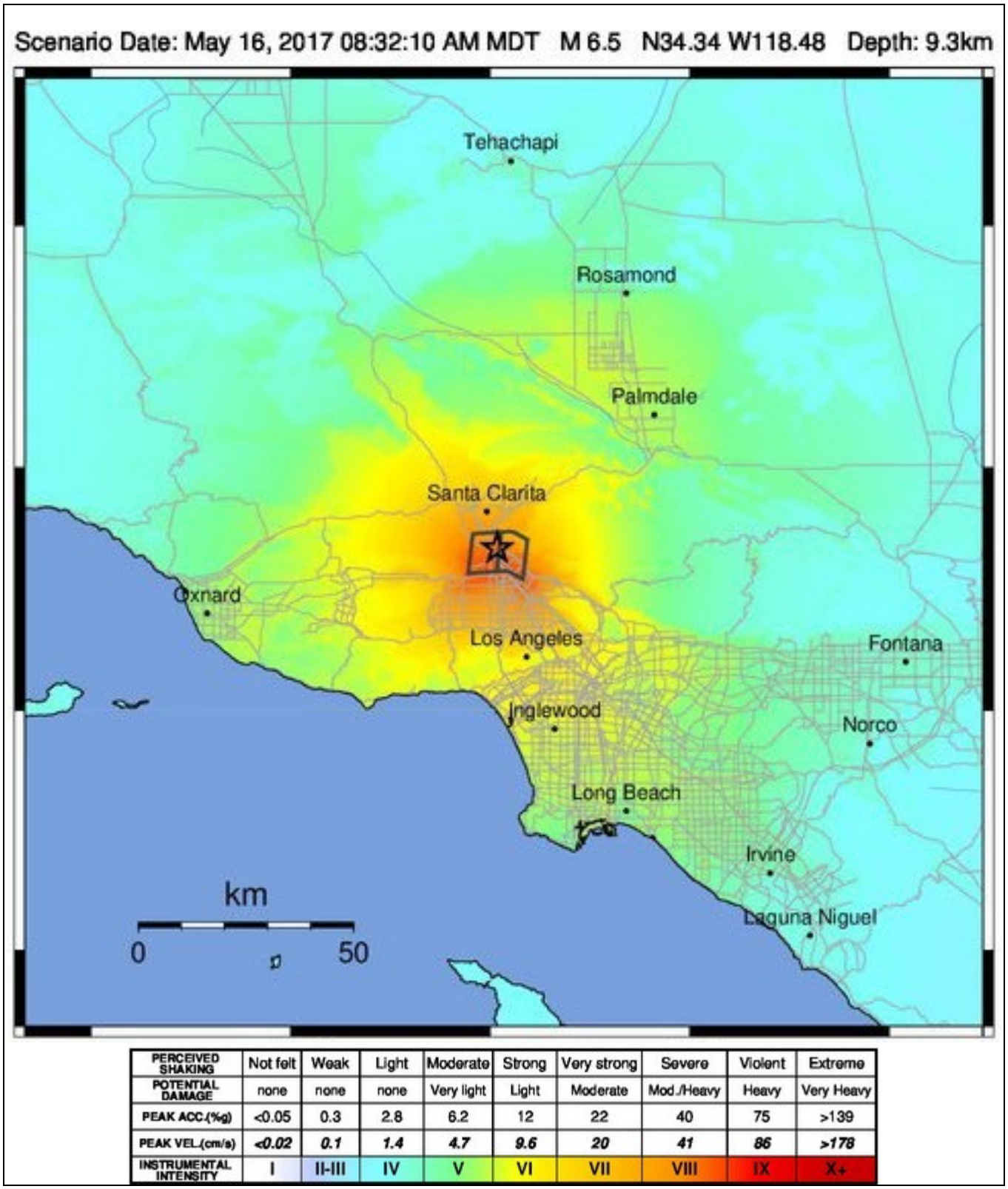
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.9 Cucamonga Earthquake Scenario



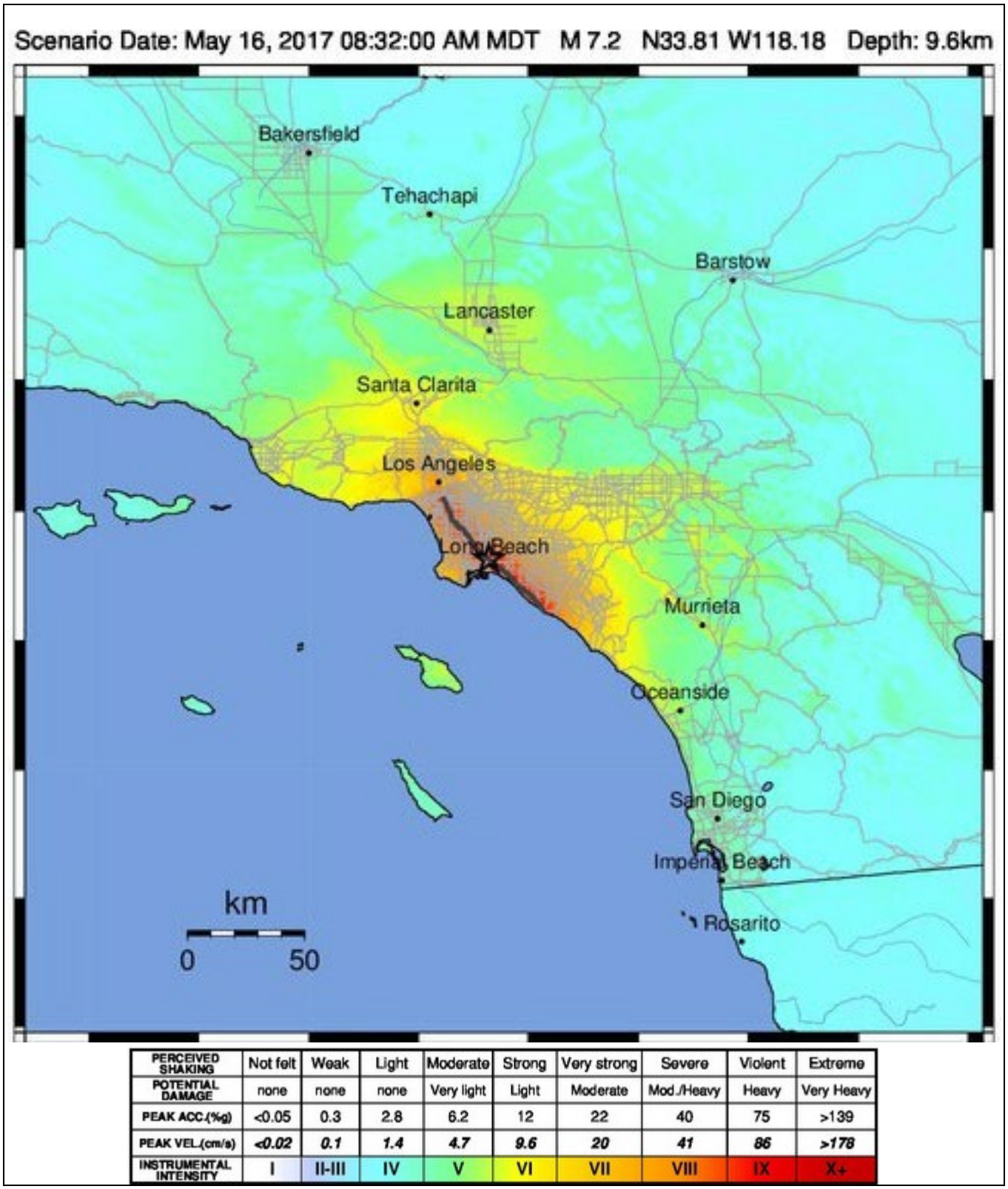
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.6 Elsinore Earthquake Scenario



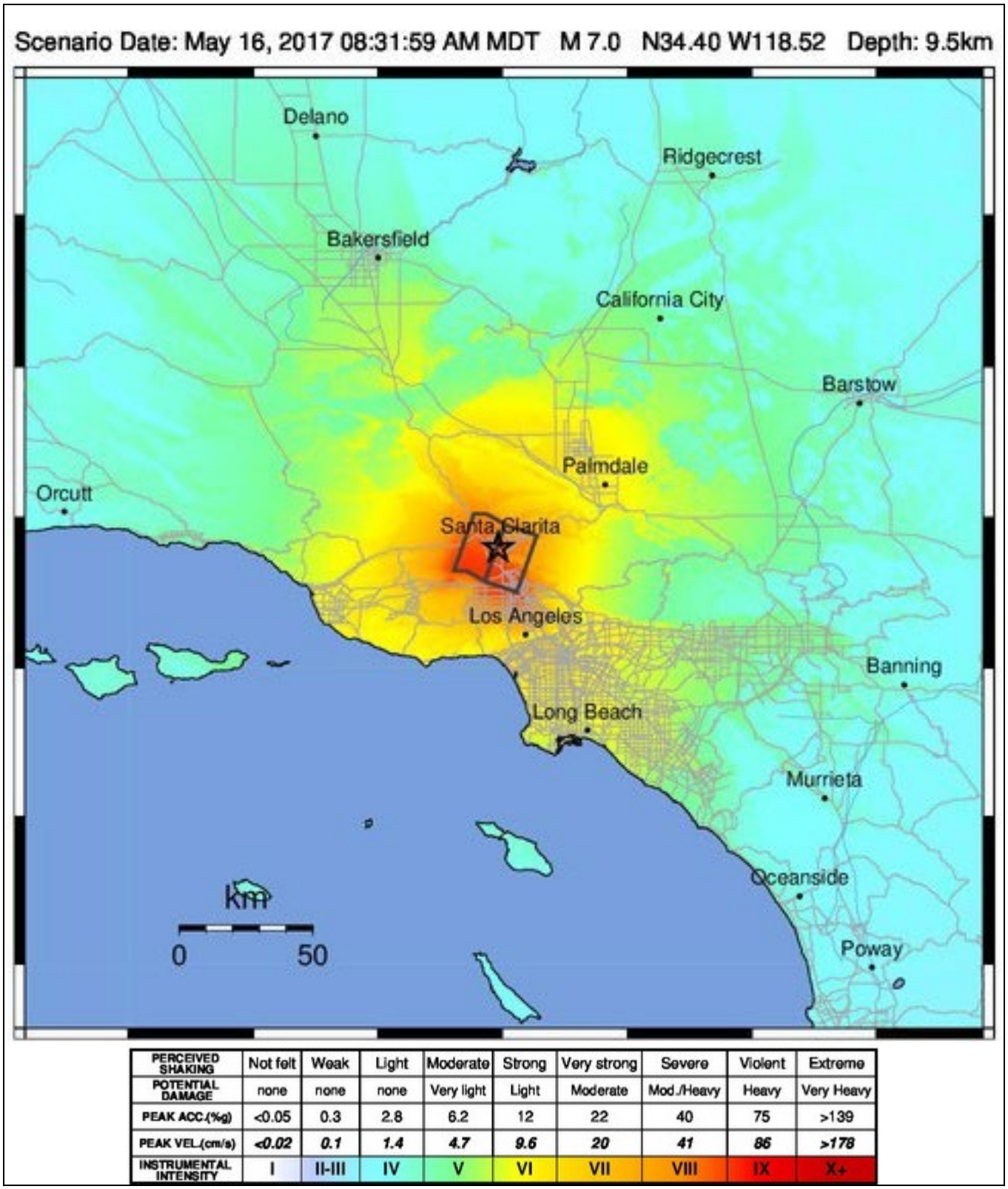
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.5 Mission Hills Earthquake Scenario



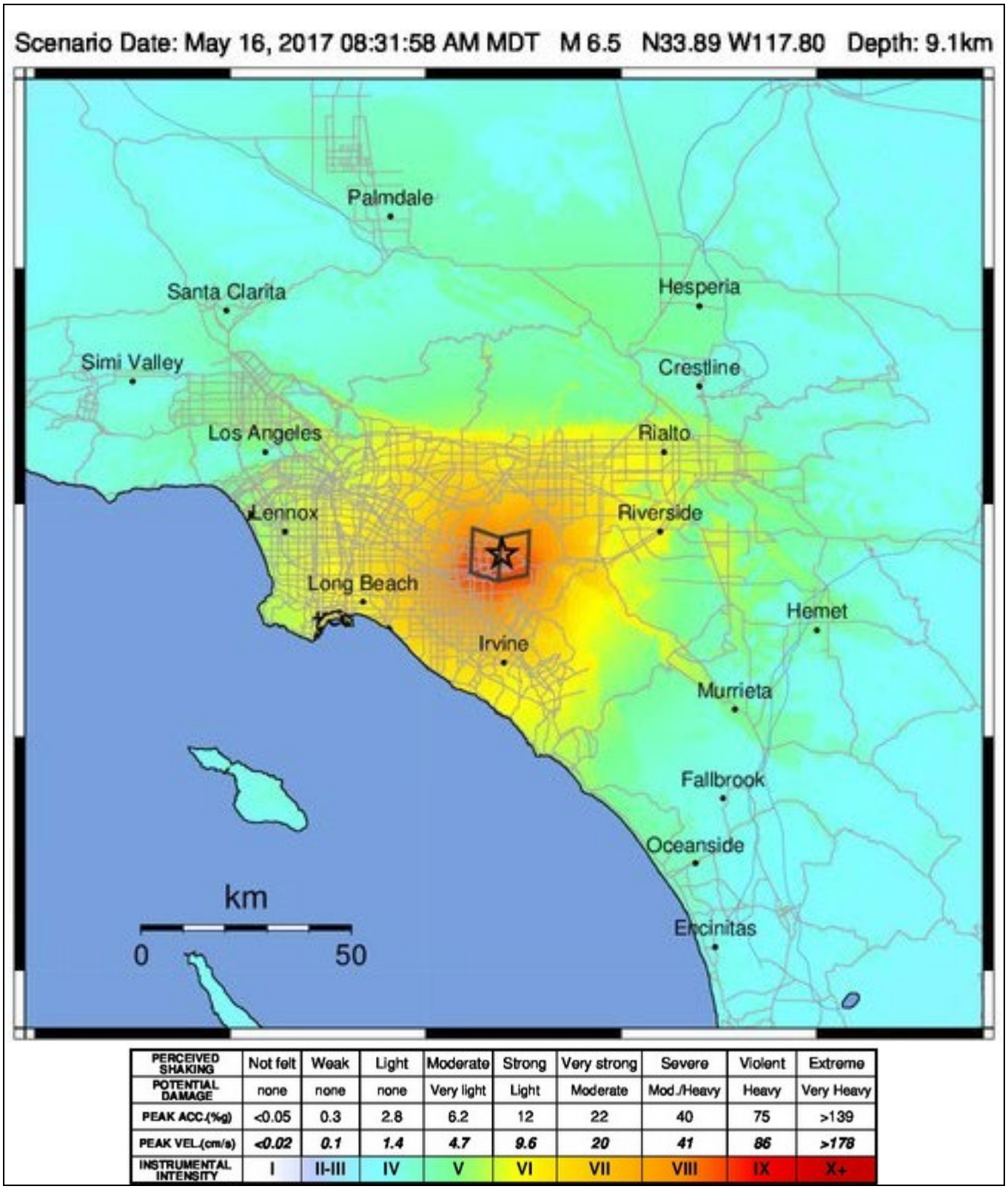
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.2 Newport-Inglewood Earthquake Scenario



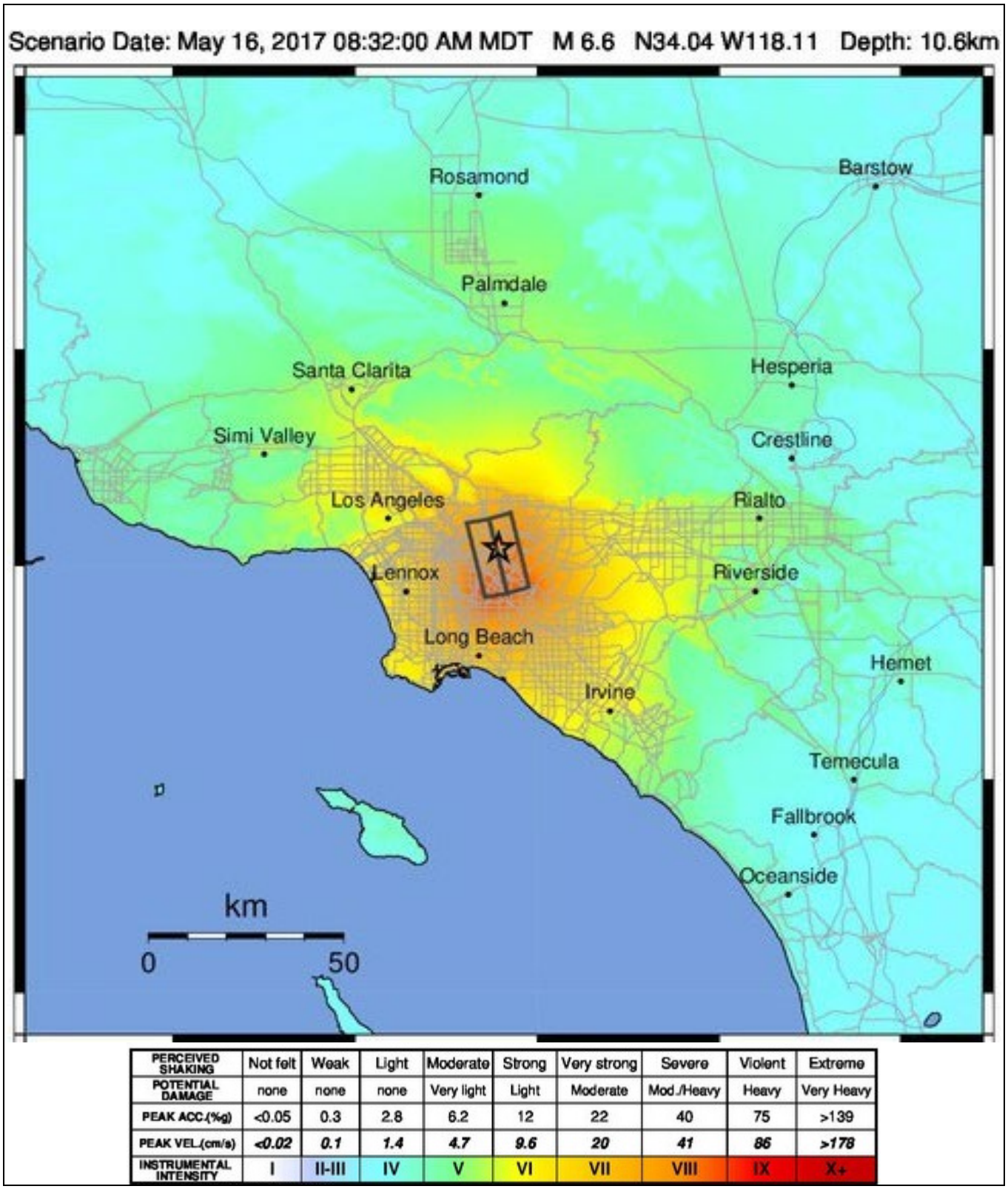
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.0 Northridge Hills Earthquake Scenario



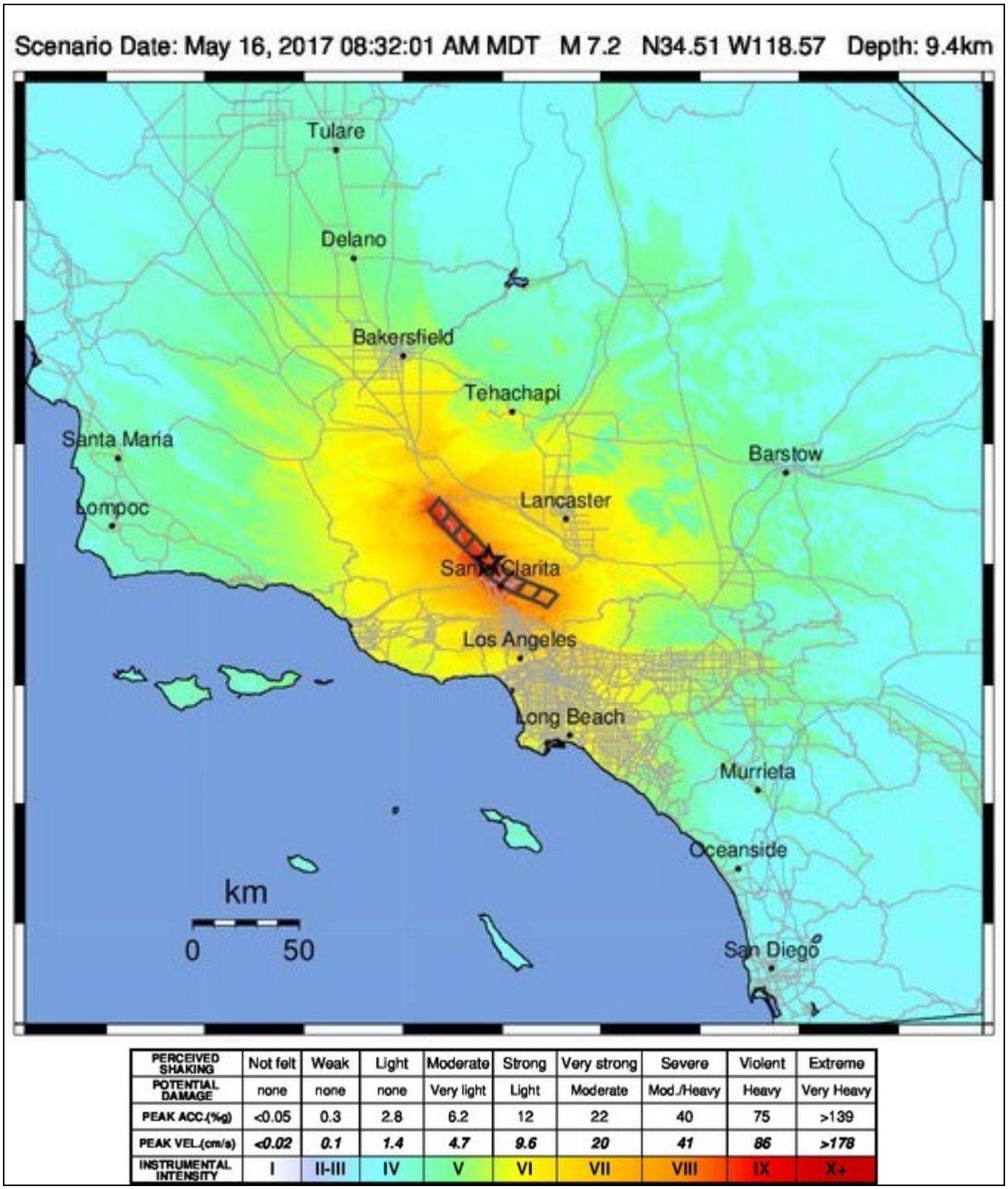
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.5 Peralta Hills Earthquake Scenario



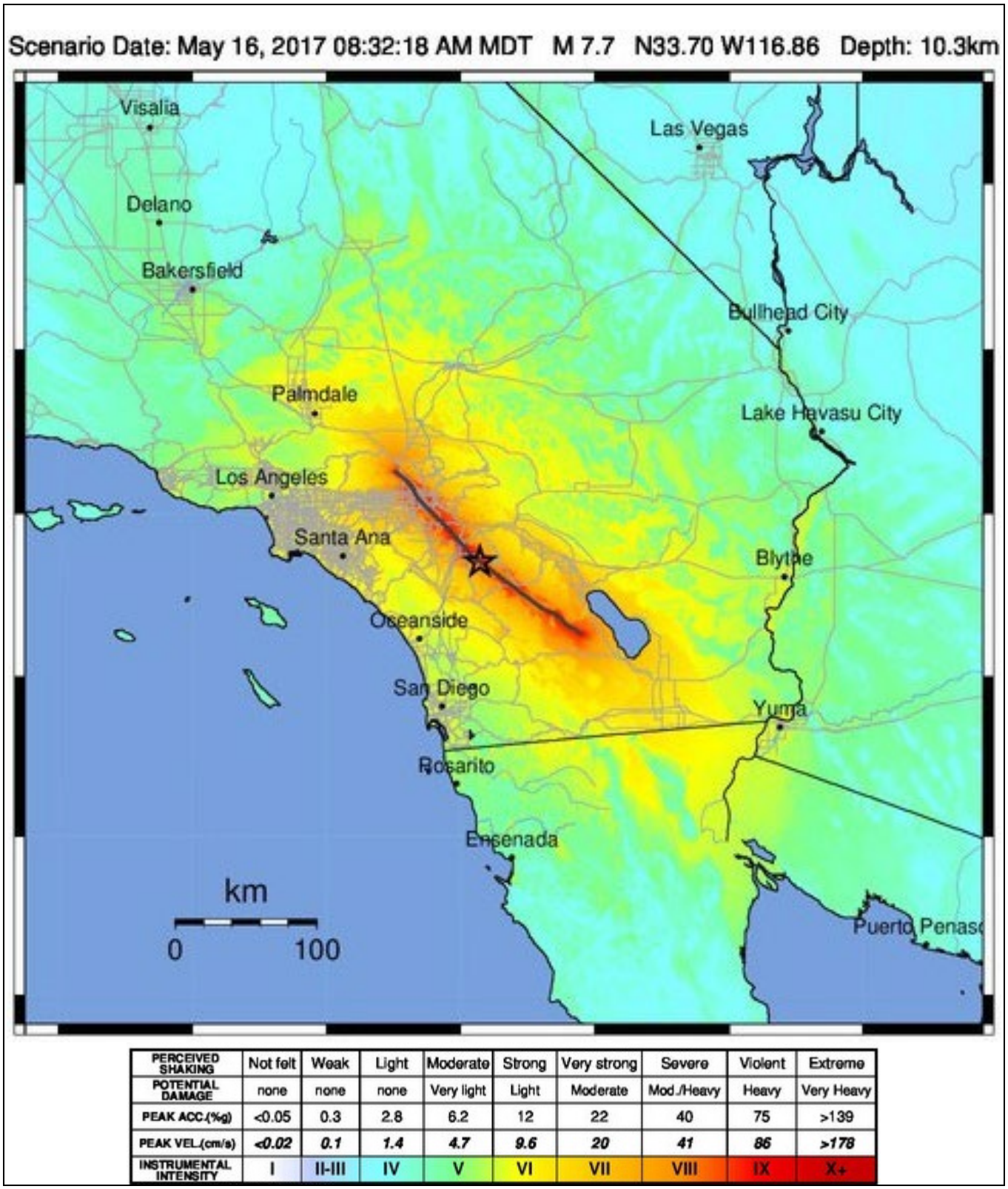
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.6 Puente Hills Earthquake Scenario



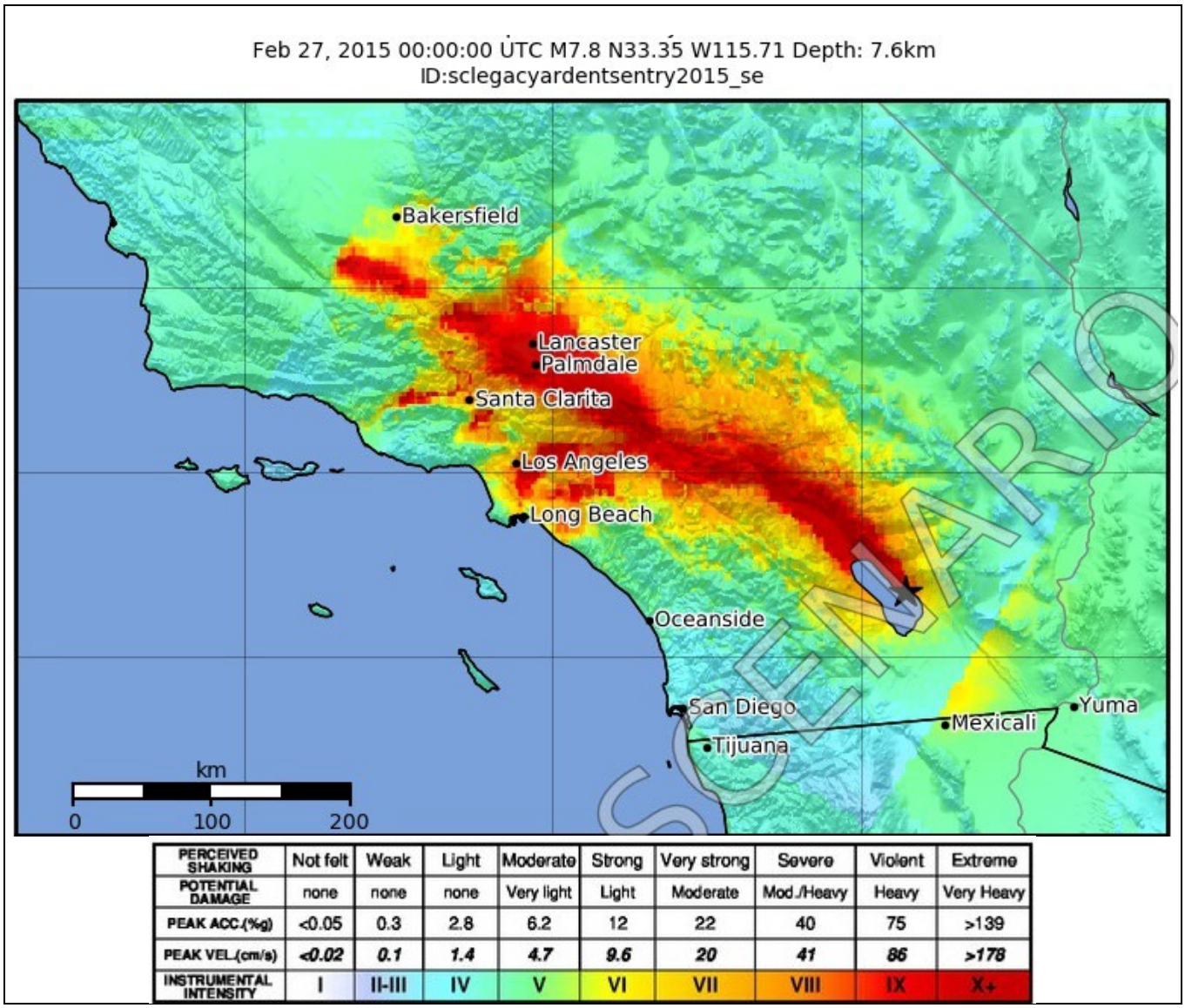
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.2 San Gabriel Earthquake Scenario



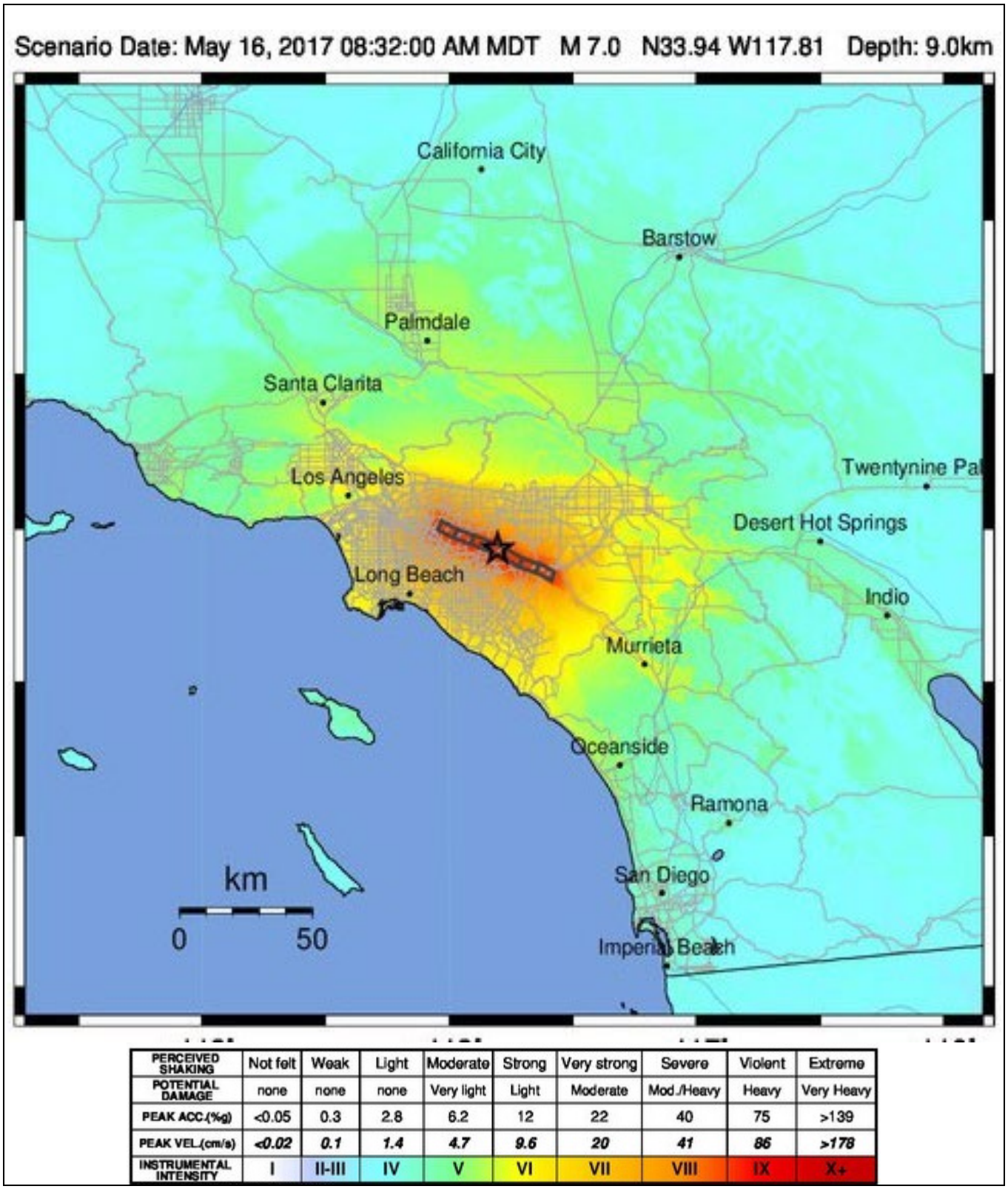
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.7 San Jacinto Earthquake Scenario



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

USGS Intensity Mapping for the M7.8 Southern San Andreas Earthquake Scenario



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

USGS Intensity Mapping for the M7.0 Whittier Earthquake Scenario

Appendix D. Detailed Risk Assessment Results

Dam Failure - Combined Dams Inundation Areas (extremely high and high hazard dams only)

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	4	80.0%	$4,328,980,923	81.9%
Hydroelectric Power Plant	15	$328,416,196	2	13.3%	$55,417,999	16.9%
Pumping Plant	4	$0	0	0.0%	$0	0.0%
Meter Structure	479	$0	91	19.0%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	10	17.2%	$53,214,931	17.2%
Service Connection	543	$221,112,315	91	16.8%	$37,055,655	16.8%
Total	**1,104**	**$6,146,051,006**	**198**	17.9%	**$4,474,669,508**	72.8%

Colorado River Aqueduct (Non-linear Assets)

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	0	0.0%	$0	0.0%
Pumping Plant Support Buildings	5	$59,478,171	0	0.0%	$0	0.0%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**0**	0.0%	**$0**	0.0%

Building Facilties

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
La Verne Offices	1	$201,747,367	1	100.0%	$201,747,367	100.0%
Headquarters	1	$230,337,633	0	0.0%	$0	0.0%
Total	**4**	**$453,654,137**	**1**	25.0%	**$201,747,367**	44.5%

Dam Failure - Combined Dams Inundation Areas (extremely high and high hazard dams only)

Other

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	0	0.0%	$0	0.0%

Reservoirs

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	0	0.0%	$0	0.0%
Total	**9**	**$3,942,604,796**	**0**	0.0%	**$0**	0.0%

CRA (Linear Assets)

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of Length in Hazard Area
Aqueduct	242	$5,317,333,152	0	0.0%	$0	0.0%

Conveyance and Distribution (Linear Assets)

Type	MWD		Dam Failure - Combined Dams Inundation Areas			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of Length in Hazard Area
Mainlines	830	$9,122,286,538	9.25	1.1%	$101,664,037	1.1%

Earthquake - Significant Shaking Potential

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Significant Shaking Potential			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	1	20.0%	$958,894,972	18.1%
Hydroelectric Power Plant	15	$328,416,196	3	20.0%	$88,719,186	27.0%
Pumping Plant	4	$0	3	75.0%	$0	0.0%
Meter Structure	479	$0	98	20.5%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	14	24.1%	$74,500,903	24.1%
Service Connection	543	$221,112,315	139	25.6%	$56,601,495	25.6%
Total	**1,104**	**6,146,051,006**	**258**	23.4%	**$1,178,716,556**	19.2%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		Significant Shaking Potential			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	0	0.0%	$0	0.0%
Pumping Plant Support Buildings	5	$59,478,171	0	0.0%	$0	0.0%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**0**	0.0%	**$0**	0.0%

Building Facilities

Type	MWD		Significant Shaking Potential			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Soto Street	1	$5,835,176	1	100.0%	$5,835,176	100.0%
Headquarters	2	$230,337,633	1	50.0%	$230,337,632	100.0%
La Verne	1	$201,747,367	0	0.0%	$0	0.0%
Total	**1**	**$15,733,961**	**0**	0.0%	**$0**	0.0%

Earthquake - Significant Shaking Potential

Other

Type	MWD		Significant Shaking Potential			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	1	5.0%	$0	0.0%

Reservoirs

Type	MWD		Significant Shaking Potential			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	1	16.7%	$3,050,701,926	82.1%
Total	**9**	**$3,942,604,796**	**1**	11.1%	**$3,050,701,926**	77.4%

Earthquake - NEHRP D & E Soils

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		NEHRP D & E Soils			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Hydroelectric Power Plant	15	$328,416,196	4	26.7%	$107,190,636	32.6%
Water Treatment Plant	5	$5,287,875,895	2	40.0%	$1,998,665,135	37.8%
Pumping Plant	4	$0	4	100.0%	$0	0.0%
Meter Structure	479	$0	231	48.2%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	34	58.6%	$180,930,765	58.6%
Service Connection	543	$221,112,315	267	49.2%	$108,723,735	49.2%
Total	**1,104**	**$6,146,051,006**	**542**	49.1%	**$2,395,510,271**	39.0%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		NEHRP D & E Soils			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	2	50.0%	$372,456	50.0%
Pumping Plant	5	$1,385,939,975	1	20.0%	$313,287,098	22.6%
Pumping Plant Support Buildings	5	$59,478,171	2	40.0%	$25,407,539	42.7%
Residences	5	$50,881,309	2	40.0%	$15,972,633	31.4%
Total	**19**	**$1,497,044,367**	**7**	36.8%	**$355,039,726**	23.7%

Building Facilities

Type	MWD		NEHRP D & E Soils			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	1	100.0%	$230,337,633	100.0%
La Verne Offices	1	$201,747,367	0	0.0%	$0	0.0%
Total	**4**	**$453,654,137**	**1**	25.0%	**$230,337,633**	50.8%

Earthquake - NEHRP D & E Soils

Other

Type	MWD		NEHRP D & E Soils			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	2	10.0%	$0	#DIV/0!

Reservoirs

Type	MWD		NEHRP D & E Soils			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	3	50.0%	$3,611,769,823	97.2%
Total	**9**	**$3,942,604,796**	**3**	33.3%	**$3,611,769,823**	91.6%

Earthquake - High & Very High Liquefaction Susceptibility

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		High & Very High Liquefaction Susceptibility			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	2	40.0%	$1,998,665,135	37.8%
Hydroelectric Power Plant	15	$328,416,196	0	0.0%	$0	0.0%
Pump Plant	4	$0	2	50.0%	$0	0.0%
Meter Structure	479	$0	74	15.4%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	12	20.7%	$63,857,917	20.7%
Service Connection	543	$221,112,315	82	15.1%	$33,390,810	15.1%
Total	**1,104**	**$6,146,051,006**	**172**	15.6%	**$2,095,913,862**	34.1%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		High & Very High Liquefaction Susceptibility			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	0	0.0%	$0	0.0%
Pumping Plant Support Buildings	5	$59,478,171	0	0.0%	$0	0.0%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**0**	0.0%	**$0**	0.0%

Building Facilties

Type	MWD		High & Very High Liquefaction Susceptibility			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	1	100.0%	$230,337,632	100.0%
La Verne	1	$201,747,367	0	0.0%	$0	0.0%
Total	**4**	**453,654,137**	**1**	25.0%	**$230,337,632**	50.8%

Earthquake - High & Very High Liquefaction Susceptibility

Other

Type	MWD		High & Very High Liquefaction Susceptibility			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	0	0.0%	$0	0.0%

Reservoirs

Type	MWD		High & Very High Liquefaction Susceptibility			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	0	0.0%	$0	0.0%
Total	**9**	**$3,942,604,796**	**0**	0.0%	**$0**	0.0%

Flood - 100-year (1% Annual Chance)

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Flood - 100-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	0	0.0%	$0	0.0%
Hydroelectric Power Plant	15	$328,416,196	0	0.0%	$0	0.0%
Pump Plant	4	$0	0	0.0%	$0	0.0%
Meter Structure	479	$0	14	2.9%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	0	0.0%	$0	0.0%
Service Connection	543	$221,112,315	17	3.1%	$6,922,485	3.1%
Total	**1,104**	**6,146,051,006**	**31**	2.8%	**$6,922,485**	0.1%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		Flood - 100-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	1	20.0%	$265,429,246	19.2%
Pumping Plant Support Buildings	5	$59,478,171	0	0.0%	$0	0.0%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**1**	5.3%	**$265,429,246**	17.7%

Building Facilities

Type	MWD		Flood - 100-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	0	0.0%	$0	0.0%
La Verne Offices	1	$201,747,367	0	0.0%	$0	0.0%
Total	**4**	**$453,654,137**	**0**	0.0%	**$0**	0.0%

Flood - 100-year (1% Annual Chance)

Other

Type	MWD		Flood - 100-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	0	0.0%	$0	#DIV/0!
Total	**20**	**$0**	**0**	0.0%	**$0**	#DIV/0!

Reservoirs

Type	MWD		Flood - 100-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	0	0.0%	$0	0.0%
Total	**9**	**$3,942,604,796**	**0**	0.0%	**$0**	0.0%

Colorado River Aqueduct (linear Assets)

Type	MWD		Flood - 100-year			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Aqueduct	242	$5,317,333,152	0	0.0%	$0	0.0%

Conveyance & Distribution (Linear Assets)

Type	MWD		Flood - 100-year			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Mainlines	830	$9,122,286,538	0	0.0%	$0	0.0%

Flood - 500-year (0.2% Annual Chance)

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Flood - 500-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	0	0.0%	$0	0.0%
Hydroelectric Power Plant	15	$328,416,196	0	0.0%	$0	0.0%
Pump Plant	4	$0	0	0.0%	$0	0.0%
Meter Structure	479	$0	52	10.9%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	4	6.9%	$21,285,972	6.9%
Service Connection	543	$221,112,315	64	11.8%	$26,061,120	11.8%
Total	**1,104**	**6,146,051,006**	**120**	10.9%	**$47,347,092**	0.8%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		Flood - 500-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	1	20.0%	$265,429,246	19.2%
Pumping Plant Support Buildings	5	$59,478,171	0	0.0%	$0	0.0%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**1**	5.3%	**$265,429,246**	17.7%

Building Facilities

Type	MWD		Flood - 500-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	0	0.0%	$0	0.0%
La Verne Offices	1	$201,747,367	0	0.0%	$0	0.0%
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Total	**4**	**$453,654,137**	**0**	0.0%	**$0**	0.0%

Flood - 500-year (0.2% Annual Chance)

Other

Type	MWD		Flood - 500-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	0	0.0%	$0	0.0%

Reservoirs

Type	MWD		Flood - 500-year			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	0	0.0%	$0	0.0%
Total	**9**	**$3,942,604,796**	**0**	0.0%	**$0**	0.0%

Colorado River Aqueduct (linear Assets)

Type	MWD		Flood - 500-year			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Aqueduct	242	$5,317,333,152	0	0.0%	$0	0.0%

Conveyance & Distribution (Linear Assets)

Type	MWD		Flood -500-year			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Mainlines	830	$9,122,286,538	0.01	0.00%	$109,907	0.00%

Flood - Awareness Floodplains

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Flood - Awareness Floodplains			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	1	20.0%	$1,039,770,163	19.7%
Hydroelectric Power Plant	15	$328,416,196	0	0.0%	$0	0.0%
Meter Structure	479	$0	18	3.8%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	0	0.0%	$0	0.0%
Service Connection	543	$221,112,315	13	2.4%	$5,293,665	2.4%
Total	**1,080**	**$529,758,915**	**31**	2.9%	**$5,293,665**	1.0%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		Flood - Awareness Floodplains			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	1	25.0%	$186,228	25.0%
Pumping Plant	5	$1,385,939,975	0	0.0%	$0	0.0%
Pumping Plant Support Buildings	5	$59,478,171	1	20.0%	$17,127,915	28.8%
Residences	5	$50,881,309	1	20.0%	$8,584,056	16.9%
Total	**19**	**$1,497,044,367**	**3**	15.8%	**$25,898,199**	1.7%

Building Facilities

Type	MWD		Flood - Awareness Floodplains			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	0	0.0%	$0	0.0%
La Verne Offices	1	$201,747,367	0	0.0%	$0	0.0%
Eagle Rock	1	$15,733,961	0	0.0%	$0	0.0%
Total	**4**	**453,654,137**	**0**	0.0%	**$0**	0.0%

Flood - Awareness Floodplains

Other

Type	MWD		Flood - Awareness Floodplains			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	0	0.0%	$0	0.0%

Reservoirs

Type	MWD		Flood - Awareness Floodplains			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	0	0.0%	$0	0.0%
Total	**9**	**$3,942,604,796**	**0**	0.0%	**$0**	0.0%

CRA (linear Assets)

Type	MWD		Flood - 500-year			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Aqueduct	242	$5,317,333,152	0.27	0.1%	$5,932,562	0.1%

Conveyance and Distribution (Assets)

Type	MWD		Flood -500-year			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Mainlines	830	$9,122,286,538	2.03	0.24%	$22,311,135	0.24%

Landslide Susceptibility - Susceptibility to Deep-Seated Landslides - High & Very High Categories

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	4	80.0%	$4,686,945,492	88.6%
Hydroelectric Power Plant	15	$328,416,196	5	33.3%	$90,743,160	27.6%
Pump Plant	4	$0	1	25.0%	$0	0.0%
Meter Structure	479	$0	77	16.1%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	16	27.6%	$85,143,890	27.6%
Service Connection	543	$221,112,315	94	17.3%	$38,277,270	17.3%
Total	**1,104**	**6,146,051,006**	**197**	17.8%	**$4,901,109,812**	79.7%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	1	20.0%	$313,287,098	22.6%
Pumping Plant Support Buildings	5	$59,478,171	1	20.0%	$8,279,624	13.9%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**2**	10.5%	**$321,566,722**	21.5%

Building Facilties

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	0	0.0%	$0	0.0%
La Verne Offices	1	$201,747,367	0	0.0%	$0	0.0%
Eagle Rock	1	$15,733,961	1	100.0%	$15,733,961	100.0%
Total	**4**	**453,654,137**	**1**	25.0%	**$15,733,961**	3.5%

Landslide Susceptibility - Susceptibility to Deep-Seated Landslides - High & Very High Categories

Other

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	8	40.0%	$0	#DIV/0!
Total	**20**	**$0**	**8**	40.0%	**$0**	#DIV/0!

Reservoirs

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	0	0.0%	$0	0.0%
Raw Water Reservoir	6	$3,715,961,964	0	0.0%	$0	0.0%
Total	**9**	**$3,942,604,796**	**0**	0.0%	**$0**	0.0%

Colorado River Aqueduct (linear Assets)

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Aqueduct	242	$5,317,333,152	99.4	41.1%	$2,184,061,633	41.1%

Conveyance & Distribution (Linear Assets)

Type	MWD		Susceptibility to Deep-Seated Landslides - High & Very High			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Mainlines	830	$9,122,286,538	191.6	23.1%	$2,107,248,190	23.1%

Wildfire - Very High & High Fire Severity Zones

Treatment, Conveyance, and Distribution Facilities (Non-Linear Assets)

Type	MWD		Very High & High Fire Severity Zones			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Water Treatment Plant	5	$5,287,875,895	3	60.0%	$3,265,183,517	61.7%
Hydroelectric Power Plant	15	$328,416,196	9	60.0%	$184,852,179	56.3%
Pump Plant	4	$0	1	25.0%	$0	0.0%
Meter Structure	479	$0	94	19.6%	$0	0.0%
Pressure Reducing Structure	58	$308,646,600	20	34.5%	$106,429,862	34.5%
Service Connection	543	$221,112,315	82	15.1%	$33,390,810	15.1%
Total	**1,104**	**6,146,051,006**	**209**	18.9%	**$3,589,856,368**	58.4%

Colorado River Aqueduct (Non-Linear Assets)

Type	MWD		Very High & High Fire Severity Zones			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Airstrip	4	$744,912	0	0.0%	$0	0.0%
Pumping Plant	5	$1,385,939,975	0	0.0%	$0	0.0%
Pumping Plant Support Buildings	5	$59,478,171	0	0.0%	$0	0.0%
Residences	5	$50,881,309	0	0.0%	$0	0.0%
Total	**19**	**$1,497,044,367**	**0**	0.0%	**$0**	0.0%

Eagle Rock

Type	MWD		Very High & High Fire Severity Zones			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Soto Street	1	$5,835,176	0	0.0%	$0	0.0%
Headquarters	1	$230,337,633	0	0.0%	$0	0.0%
La Verne Offices	1	$201,747,367	0	0.0%	$0	0.0%
Eagle Rock	1	$15,733,961	1	100.0%	$15,733,961	100.0%
Total	**4**	**453,654,137**	**1**	25.0%	**$15,733,961**	3.5%

Wildfire - Very High & High Fire Severity Zones

Other

Type	MWD		Very High & High Fire Severity Zones			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Dam	20	$0	9	45.0%	$0	0.0%

Reservoirs

Type	MWD		Very High & High Fire Severity Zones			
	Total Number of Structures	Total RCV	Number of Structures in Hazard Area	Percent of Total Structures in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Finished Water Reservoir	3	$226,642,832	2	66.7%	$106,694,744	47.1%
Raw Water Reservoir	6	$3,715,961,964	4	66.7%	$3,664,219,843	98.6%
Total	**9**	**$3,942,604,796**	**6**	66.7%	**$3,770,914,587**	95.6%

Colorado River Aqueduct (linear Assets)

Type	MWD		Very High & High Fire Severity Zones			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Aqueduct	242	$5,317,333,152	0	0.0%	$0	0.0%

Conveyance & Distribution (Linear Assets)

Type	MWD		Very High & High Fire Severity Zones			
	Total Length (miles)	Total RCV	Length (miles) in Hazard Area	Percent of Length in Hazard Area	RCV in Hazard Area	Percent of RCV in Hazard Area
Mainlines	830	$9,122,286,538	6.9	0.83%	$75,835,876	0.83%

Appendix E. Hazard Mitigation Plan Adoption Resolution

RESOLUTION NO. ____

RESOLUTION OF THE BOARD OF DIRECTORS OF
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
ADOPTING THE HAZARD MITIGATION PLAN, DATED [DATE]

WHEREAS The Metropolitan Water District of Southern California (Metropolitan) recognizes the threat that natural hazards pose to people and property within Metropolitan; and

WHEREAS Metropolitan has prepared a multi-hazard mitigation plan, hereby known as the Hazard Mitigation Plan, dated [date], in accordance with federal laws, including the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended; the National Flood Insurance Act of 1968, as amended; and the National Dam Safety Program Act, as amended; and

WHEREAS the Hazard Mitigation Plan, dated [date], identifies mitigation goals and actions to reduce or eliminate long-term risk to people and property in Metropolitan from the impacts of future hazards and disasters; and

WHEREAS adoption by the Board of Directors of Metropolitan demonstrates its commitment to hazard mitigation and achieving the goals outlined in the Hazard Mitigation Plan, dated [date].

NOW THEREFORE, BE IT RESOLVED that the Board of Directors of Metropolitan adopts the Hazard Mitigation Plan, dated [date]. While content related to Metropolitan may require revisions to meet the plan approval requirements, changes occurring after adoption will not require Metropolitan to re-adopt any further iterations of the plan. Subsequent substantive plan updates following the approval period for this plan will require separate adoption resolutions.

I HEREBY CERTIFY that the foregoing is a full, true and correct copy of a resolution adopted by the Board of Directors of The Metropolitan Water District of Southern California, at its meeting held on [DATE], 2026.

_____
Board Executive Secretary
The Metropolitan Water District
of Southern California