The Metropolitan Water District of Southern California

Agenda

The mission of the Metropolitan Water District of Southern California 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.

EOT Committee
D. Erdman, Chair
S. Faessel, Vice Chair
D. Alvarez
G. Bryant
J. Crawford
B. Dennstedt
L. Fong-Sakai
R. Jay
J. Lewitt
J. McMillan
C. Miller
M. Petersen
K. Seckel

Engineering, Operations, and Technology Committee

Meeting with Board of Directors *

April 13, 2026

9:00 a.m.

Monday, April 13, 2026 Meeting Schedule
09:00 a.m. EOT
11:00 a.m. LEG
12:30 p.m. BREAK
01:00 p.m. OPE
02:00 p.m. OWA

Written public comments received by 3:00 p.m. the business day before the meeting is scheduled will be posted under the Submitted Items and Responses tab available here: https://mwdh2o.legistar.com/Legislation.aspx.

The listen-only phone line is available at 1-877-853-5257; enter meeting ID: 862 4397 5848.

Members of the public may present their comments to the Board on matters within their jurisdiction as listed on the agenda via teleconference and in-person. To provide public comment by teleconference dial 1-833-548-0276 and enter meeting ID: 815 2066 4276 or to join by computer click here.

Disclaimer: Written and oral public comments are received in compliance with the Ralph M. Brown Act. Please note that Metropolitan does not endorse or ensure the accuracy or reliability of the information provided as public comment or by third parties.

MWD Headquarters Building • 700 N. Alameda Street • Los Angeles, CA 90012
Teleconference Locations:
3008 W. 82nd Place • Inglewood, CA 90305

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* The Metropolitan Water District's meeting of this Committee is noticed as a joint committee meeting with the Board of Directors for the purpose of compliance with the Brown Act. Members of the Board who are not assigned to this Committee may participate as members of the Board, whether or not a quorum of the Board is present. In order to preserve the function of the committee as advisory to the Board, members of the Board who are not assigned to this Committee will not vote on matters before this Committee.

US 2-456

1. Opportunity for members of the public to address the committee on matters within the committee's jurisdiction (As required by Gov. Code Section 54954.3(a))

**** CONSENT CALENDAR ****

2. COMMITTEE ACTION (ONLY)

A. Approval of the Minutes of the Engineering, Operations, and Technology Committee of March 9, 2026 **21-5550**

Attachments: 04132026 EOT 2A (03092026) Minutes

3. COMMITTEE ITEMS (FOR BOARD CONSIDERATION)

7-1 Authorize an agreement with Computer Aid, Inc. in an amount not to exceed $397,628 for the Enterprise Information Technology Software Asset Management module implementation services; the General Manager has determined that the proposed action is exempt or otherwise not subject to CEQA **21-5651**

**** END OF CONSENT CALENDAR ****

4. COMMITTEE ITEMS (ACTION FOR BOARD CONSIDERATION)

8-2 Appropriate $1.1 billion for projects identified in the Capital Investment Plan for fiscal years 2026/27 and 2027/28 and authorize the General Manager to initiate or proceed with work on capital projects identified in the Capital Investment Plan for fiscal years 2026/27 and 2027/28; the General Manager has determined that the proposed action is exempt or otherwise not subject to CEQA **21-5656**

5. COMMITTEE ITEMS (INFORMATIONAL FOR BOARD CONSIDERATION)

NONE

6. COMMITTEE ITEMS (INFORMATIONAL)

a. Overview of Construction Management at Metropolitan **21-5669**

Attachments: 04132026 EOT 6a C-L

b. Hazard Mitigation Plan Update **21-5670**

Attachments: 04132026 EOT 6b C-L

c. Pure Water Southern California Quarterly Update **21-5671**

Attachments: 04132026 EOT 6c C-L

7. MANAGEMENT ANNOUNCEMENTS AND HIGHLIGHTS

a. Engineering Services activities **21-5549**
Information Technology activities
Water System Operations activities

Attachments: 04132026 EOT 7a Engineering Services activities

8. FOLLOW-UP ITEMS

NONE

9. FUTURE AGENDA ITEMS

10. ADJOURNMENT

NOTE: This committee reviews items and makes a recommendation for final action to the full Board of Directors. Final action will be taken by the Board of Directors. Committee agendas may be obtained on Metropolitan's Web site https://mwdh2o.legistar.com/Calendar.aspx. This committee will not take any final action that is binding on the Board, even when a quorum of the Board is present.

Writings relating to open session agenda items distributed to Directors less than 72 hours prior to a regular meeting are available for public inspection at Metropolitan's Headquarters Building and on Metropolitan's Web site https://mwdh2o.legistar.com/Calendar.aspx.

Requests for a disability-related modification or accommodation, including auxiliary aids or services, in order to attend or participate in a meeting should be made to the Board Executive Secretary in advance of the meeting to ensure availability of the requested service or accommodation.

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

MINUTES

ENGINEERING, OPERATIONS & TECHNOLOGY COMMITTEE

March 9, 2026

Chair Erdman called the meeting to order at 9:01 a.m.

Members present: Directors Alvarez, Bryant, Dennstedt, Erdman, Faessel, Fong-Sakai (entered after roll call), Jay, Lewitt, McMillan, Miller (entered after roll call), Petersen, and Seckel.

Members absent: Director Crawford

Other board members present: Chair Ortega, Directors Ackerman, Camacho, Crane, Denham (teleconference posted location), Fellow, Gray (teleconference posted location), Katz, Kurtz, Paule, and Shepherd Romey.

Committee staff present: Bednarski, Boyd, Chaudhuri, Deshmukh, Eckstrom, Hattar, Hudson, Nobriga, Parsons, Rhoads, Rubin

1. OPPORTUNITY FOR MEMBERS OF THE PUBLIC TO ADDRESS THE COMMITTEE ON MATTERS WITHIN THE COMMITTEE'S JURISDICTION

None

CONSENT CALENDAR ITEMS – ACTION

2. CONSENT CALENDAR OTHER ITEMS – ACTION

Approval of the Minutes of the Engineering, Operations, and Technology Committee for February 9, 2026.

3. CONSENT CALENDAR OTHER ITEMS ACTION

None

Director Seckel made a motion, seconded by Director Bryant, to approve the consent calendar consisting of item 2A.

The vote was:

Ayes:	Directors Alvarez, Bryant, Dennstedt, Erdman, Faessel, Jay, Lewitt, McMillan, Petersen, and Seckel.
Noes:	None
Abstentions:	None
Absent:	Directors Crawford, Fong-Sakai, and Miller

The motion to approve item 2A passed by a vote of 10 ayes, 0 noes, 0 abstention, and 3 absent.

**** END OF CONSENT CALENDAR ITEMS ****

4. OTHER BOARD ITEMS – ACTION

None

Director Fong-Sakai entered the meeting.

5. BOARD INFORMATION ITEMS

9-1 Subject: Capital Investment Plan Quarterly Report for Period Ending December 2025

Presented by: Jeffrey Nikolas, Sr Engineer, Capital Investment Plan Team, Engineering Services Group

Mr. Nikolas reported on the following:

- Informational summary of infrastructure projects, comparison of projected spending and actual spending, and project activities listed in the written report.

The following Director provided comments or asked questions.

1. Bryant

Staff responded to the Directors questions and comments.

Director Miller entered the meeting.

6. COMMITTEE ITEMS (INFORMATIONAL FOR BOARD CONSIDERATION)

a. Subject: State Water Project Invasive Mussels Mitigation and Control Update

Presented by: Ying Wu, Team Manager, Treatment & Water Quality Group
Jinny, Huang-Uy, Engineer, Engineering Services Group/Program Management

Staff gave an update on the SWP Invasive Mussel Mitigation and Control Program.

The following Directors provided comments or asked questions.

1. Seckel
2. Ortega
3. Miller
4. Faessel
5. Denham
6. Erdman

Staff responded to the Directors' questions and comments.

b. Assessment of alternatives to stage the development of the Pure Water Southern California Program.

This item was deferred.

c. Subject: Integrated Strategy for Infrastructure Reliability Progress Update

Presented by: Rosa Lau, Engineer, Engineering Services Group, Engineering Planning Section
Eugenia Lin, Sr. Engineer, Engineering Services Group, Program Management Section

Staff provided an overview of the ISIR process and an update on recent developments of equitable supply reliability projects.

The following Directors provided comments or asked questions.

1. Miller
2. Faessel
3. Seckel
4. Ortega
5. Fong-Sakai

Staff responded to the Directors' questions and comments.

7. MANAGEMENT ANNOUNCEMENTS AND HIGHLIGHTS

a. Subject: Engineering Services, Information Technology, and Water System Operations Activities

Presented by: John Bednarski, Assistant General Manager, Water Resources and Technical Services
JR. Rhoads, Group Manager, Conveyance & Distribution
Charlie Eckstrom, Group Manager, Information Technology

Mr. Bednarski reported on the following:

- Engineering support on CRA Shutdown
- 14th annual Engineering Career Launch Program
- Correction to January 2026 Board action for HDR Engineering Inc. which was a new agreement prequalified under RFQ 1404.

Mr. Rhoads reported on the following:

- Completion of the 2026 Annual Operating Plan, which includes a review of 2025 operations and challenges, and plans for a full range of operating conditions in 2026
- Completion of essential system maintenance during the 2026 CRA Shutdown
- Weymouth receiving silver medal for Best Municipal Water at the Berkeley Springs International Water Tasting competition

Mr. Eckstrom reported on the following:

- The Wi-Fi Upgrade project for the facilities in the Los Angeles is nearing completion.
- Replaced legacy wi-fi access points with modern, high-capacity units Reduced dead zones by expanding coverage and implemented improved roaming to ensure uninterrupted connectivity across all areas
- Improved security posture through updated encryption and centralized management controls.

Chair Ortega requested that staff consider putting up a banner in the boardroom to mark Metropolitan winning the Berkeley Springs Silver Medal award for best tasting water.

8. FOLLOW-UP ITEMS

Director Erdman requested a full presentation on the Colorado River Aqueduct shutdown, including details on accommodations for shutdown staff.

Director Faessel suggested a follow-up on Director Bryant's request for a list of outstanding small cap projects from biennium 2020/21-2021/22.

Director Faessel suggested a follow-up on Chair Ortega, Directors Fong-Sakai and Seckel's request for additional information on CAMP4W portfolios, preferably prior to the vote for budget approval.

9. FUTURE AGENDA ITEMS

None

10. ADJOURNMENT

The next meeting will be on April 13, 2026.

Meeting adjourned at 10:42 a.m.

Dennis Erdman
Chair

Engineering, Operations, and Technology Committee

4/13/2026 Committee Meeting

6a

Subject

Overview of Construction Management at Metropolitan

Executive Summary

Metropolitan's Construction Management Unit (CMU) oversees the construction phase of capital projects to ensure safety, quality, cost control, and timely delivery. Staff conducts continuous and hold-point inspections, manages contracts and budgets, leverages technology for efficiency, and coordinates with Metropolitan's operating groups. CMU consistently meets performance targets for cost-effectiveness and safeguards Metropolitan's financial interests. Using a collaborative partnering approach, CMU fosters trust and proactive issue resolution with contractors. Through effective construction management, CMU reduces risks, improves quality, and ensures projects are completed on time and within budget.

Fiscal Impact

None

Applicable Policy

Not applicable

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

Not applicable

Details and Background

Background

Metropolitan's CMU within the Engineering Services Group works to ensure that Metropolitan's construction projects are successfully completed. CMU's managers, engineers, and inspectors are involved in all phases of Metropolitan's capital projects, including planning and design, advertisement and contract award, construction, and warranty and legal support. The CMU ensures that construction projects meet established goals for safety, quality, functionality, cost, and schedule.

Construction projects are complex endeavors that require cooperation between Metropolitan and its contractors. The CMU employs a collaborative partnering approach with contractors to establish a unified project team that aligns on common goals, builds trust, and proactively resolves issues. This approach shifts away from the historical adversarial owner/contractor relationships to ensure successful project delivery (i.e., on time, within budget, and high quality) through shared commitment and open communication, often utilizing workshops to address project risks.

CMU construction project staff includes Residents in charge of construction, who have primary responsibility for overseeing construction; Assistant Residents for larger projects; field office engineers; construction inspectors; and materials testing technicians. They conduct continuous inspections to assess key aspects of construction work, including compliance with health and safety regulations, quality of workmanship, and conformance with project

specifications. The CMU project team coordinates with operating staff to schedule equipment outages and minimize impact to operating facilities. Metropolitan also performs hold-point inspections, which establish checkpoints in the construction process where work must pause for verification and approval. These inspections are essential for ensuring quality and for preventing deficiencies from being concealed, such as verifying reinforcing steel (rebar) installation and embedded features before concrete is placed. CMU management continually reviews project needs and adjusts in-house staff assignments, as appropriate, and supplements them with on-call inspection services staff when needed. Management also aims to assign staff to a variety of project types and roles to support staff career development.

In addition to field oversight, the CMU is responsible for contract administration and budget control functions that are critical to the financial and contractual management of Metropolitan's construction projects. This includes documenting construction issues, tracking extra and disputed work, managing project costs and schedule, verifying construction progress payments, and ensuring contractor compliance with all contractual obligations. CMU regularly negotiates adjustments to contract amounts and durations with contractors to address inevitable changes, using real-time cost and performance data to protect Metropolitan's financial interests.

CMU leverages technology to boost collaboration, increase safety and efficiency, reduce costs, optimize resources, and minimize waste. Key technology implementations include mobile devices (tablets) and connected communication platforms (e.g., Bluebeam, SharePoint) for real-time access and streamlined workflows. CMU also works closely with Metropolitan's External Affairs regarding public outreach to mitigate the impacts of Metropolitan's construction contracts on local communities.

To measure project performance efficiency and identify areas for continuous improvement, Metropolitan has established performance metrics for construction management activities. The metric compares the cost of construction management and inspection versus the total construction cost. For projects with construction contracts of $3 million or less, the target is 9 to 15 percent, and for projects greater than $3 million, the target is 9 to 12 percent. CMU typically meets these targets and carefully documents the reasons and causes when the target values are exceeded and evaluates potential changes to improve its processes.

In summary, the ability of Metropolitan to maintain a formally established in-house construction management function directly benefits projects by saving time and money, improving quality, and reducing risks through better planning and communication, thereby ensuring projects are completed on schedule, within budget, and with high quality. Engineering Services' CMU is committed to supporting Metropolitan's mission through effective construction management.

3/24/2026

Mai M. Hattar *Date*
Chief Engineer
Engineering Services

3/24/2026

Shivaji Deshmukh *Date*
General Manager

Ref# es12708916

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.

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

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

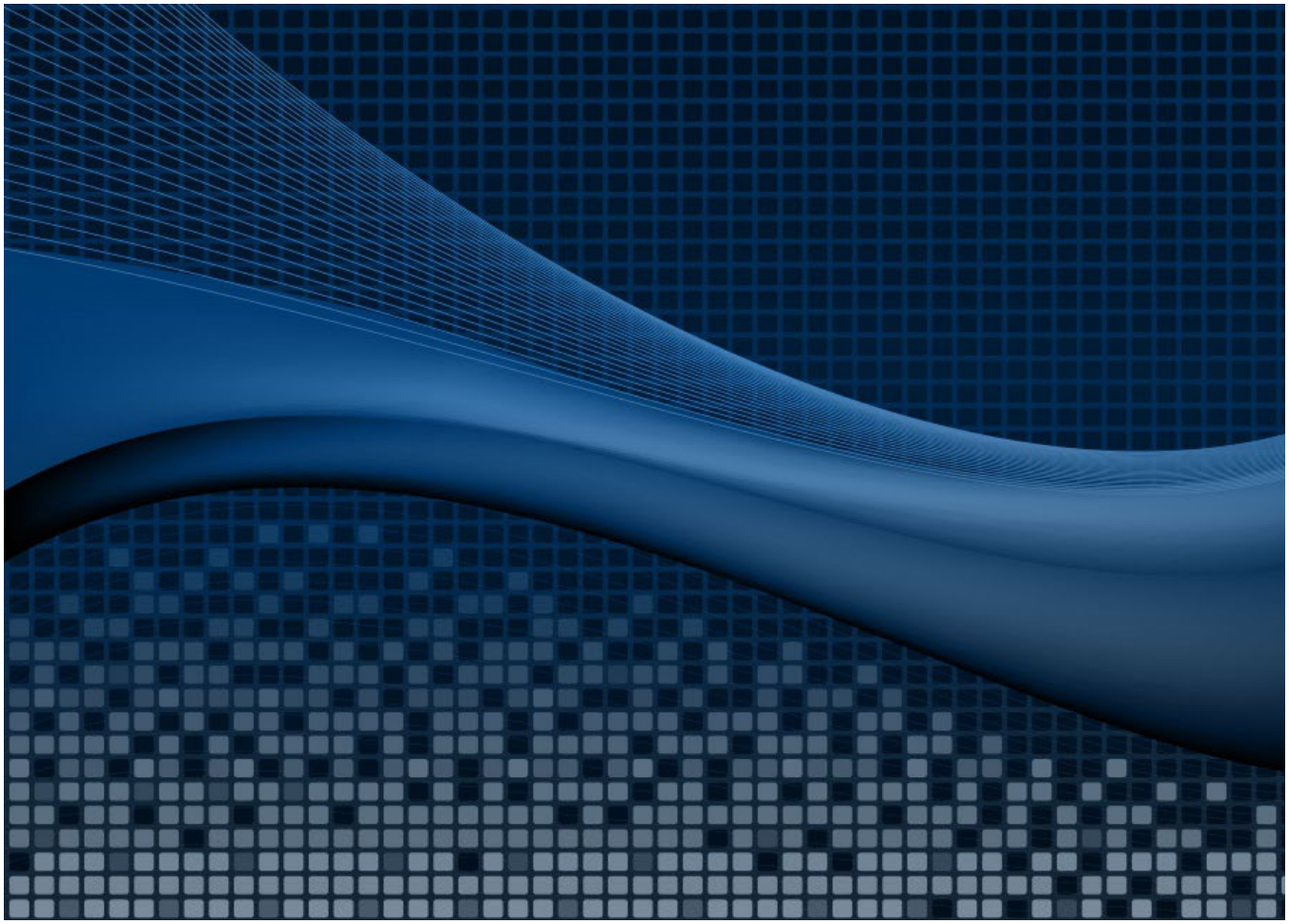
Attachment 1 – Local Hazard Mitigation Plan – Public Review Draft

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).

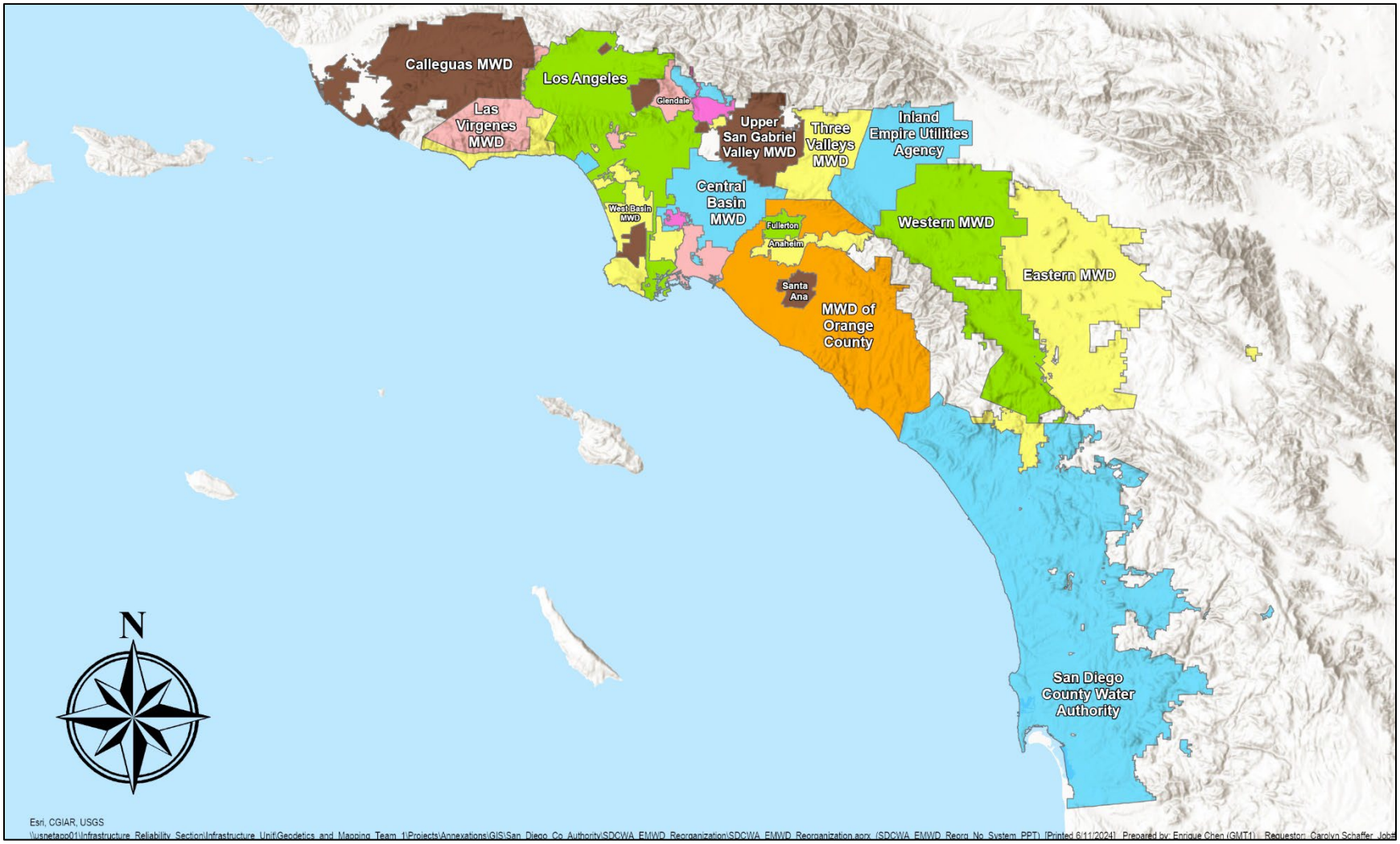


Figure 2-1. Metropolitan Water District Member Agencies and Service Area

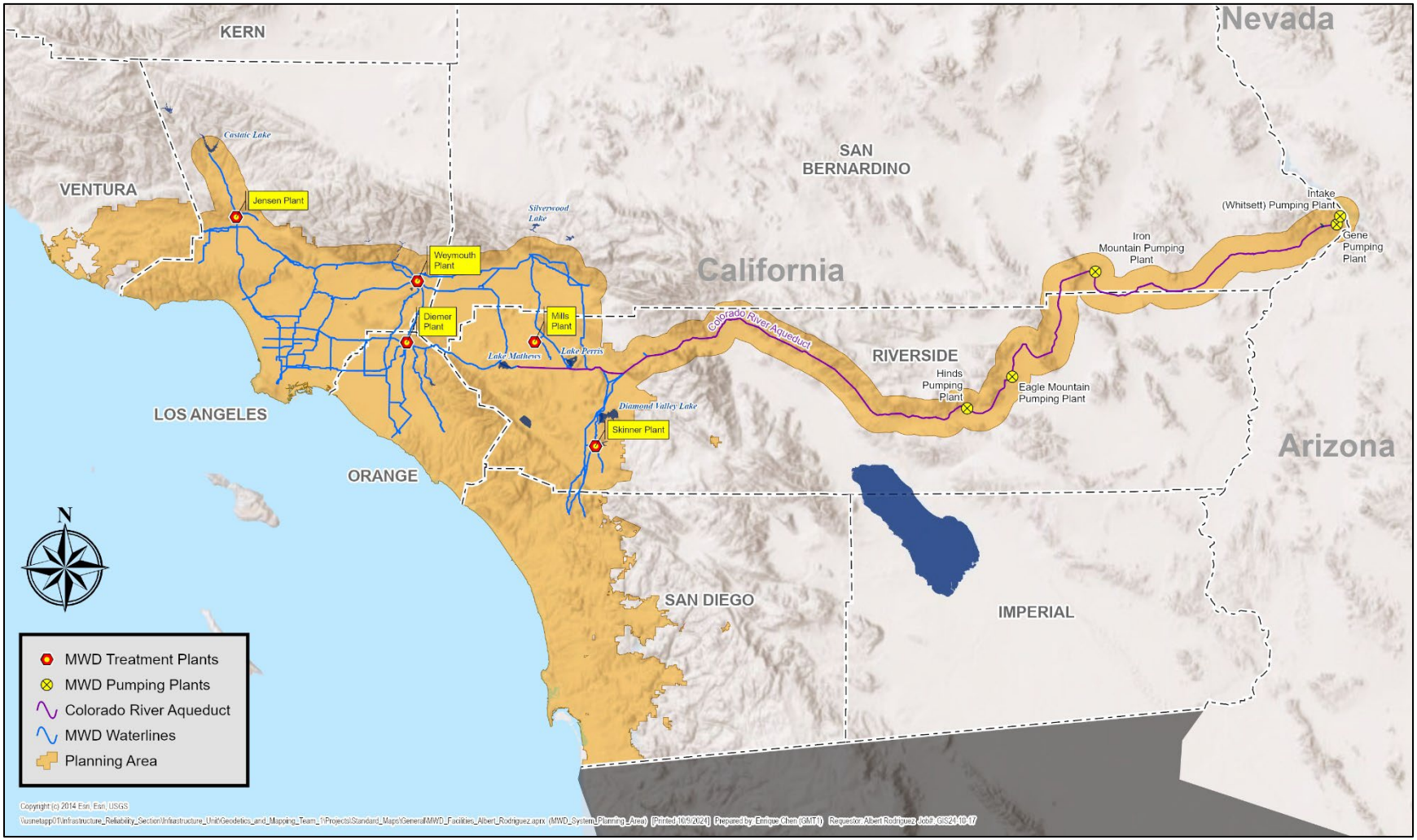


Figure 2-2. Metropolitan Water District Hazard Mitigation Planning Area

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).

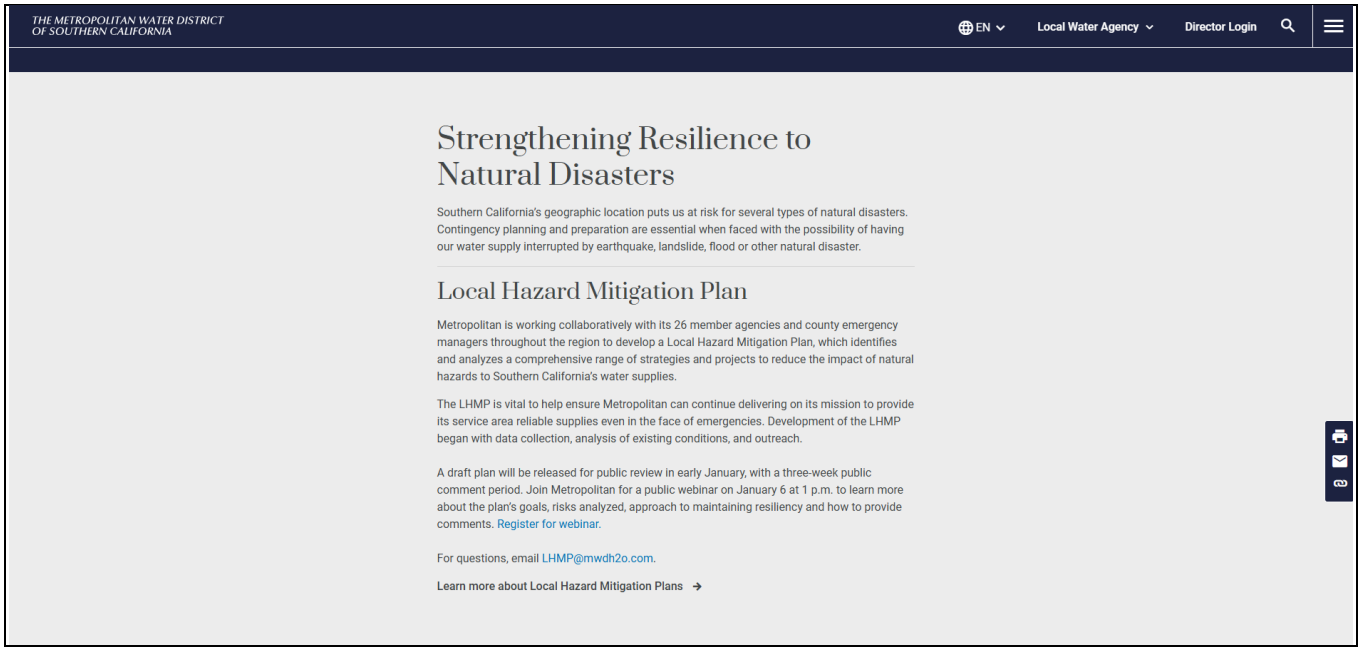


Figure 2-3. Metropolitan's Hazard Mitigation Plan Web Page

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.

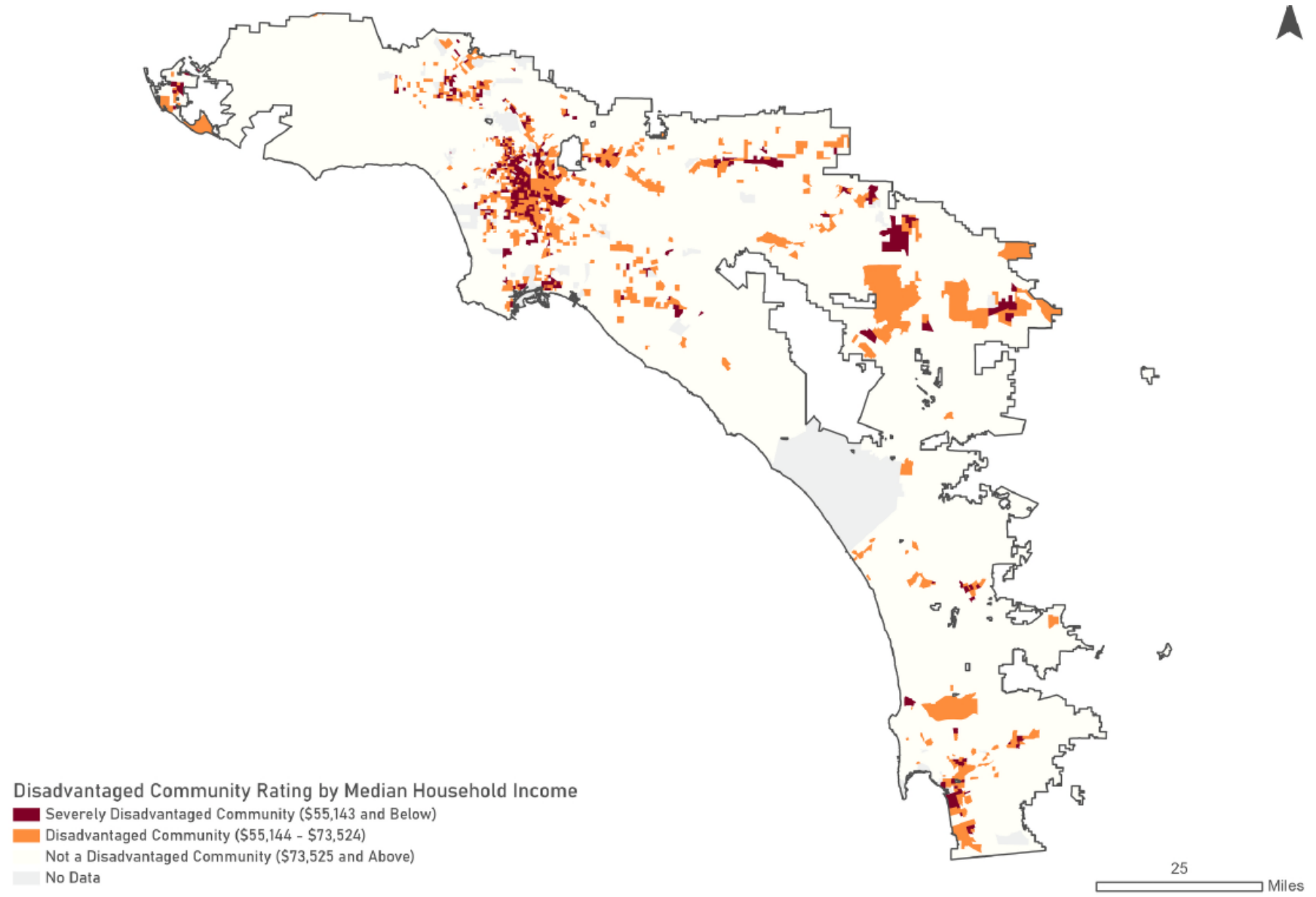


Figure 3-1. Socially Vulnerable Communities Within Metropolitan's Service Area

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.

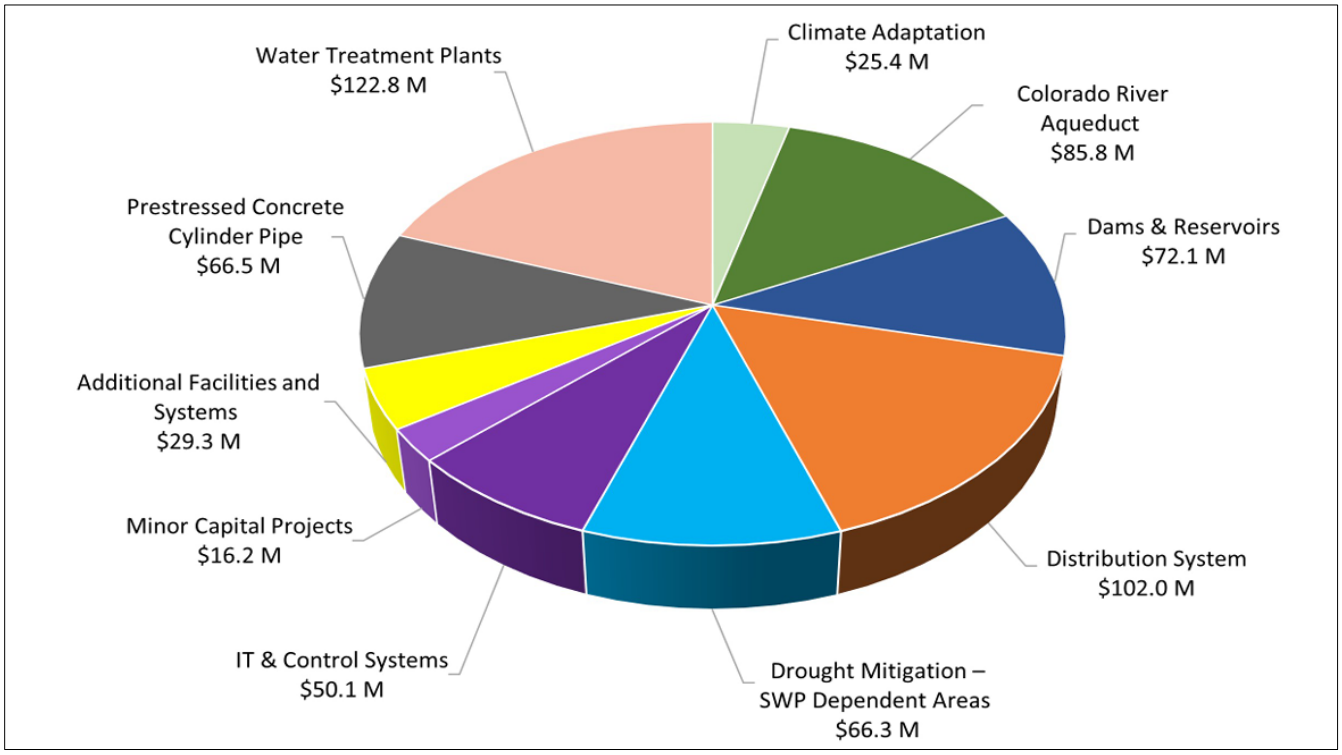


Figure 3-2. Metropolitan Capital Investment Plan Breakdown for FY 2024/25 and FY 2025/26

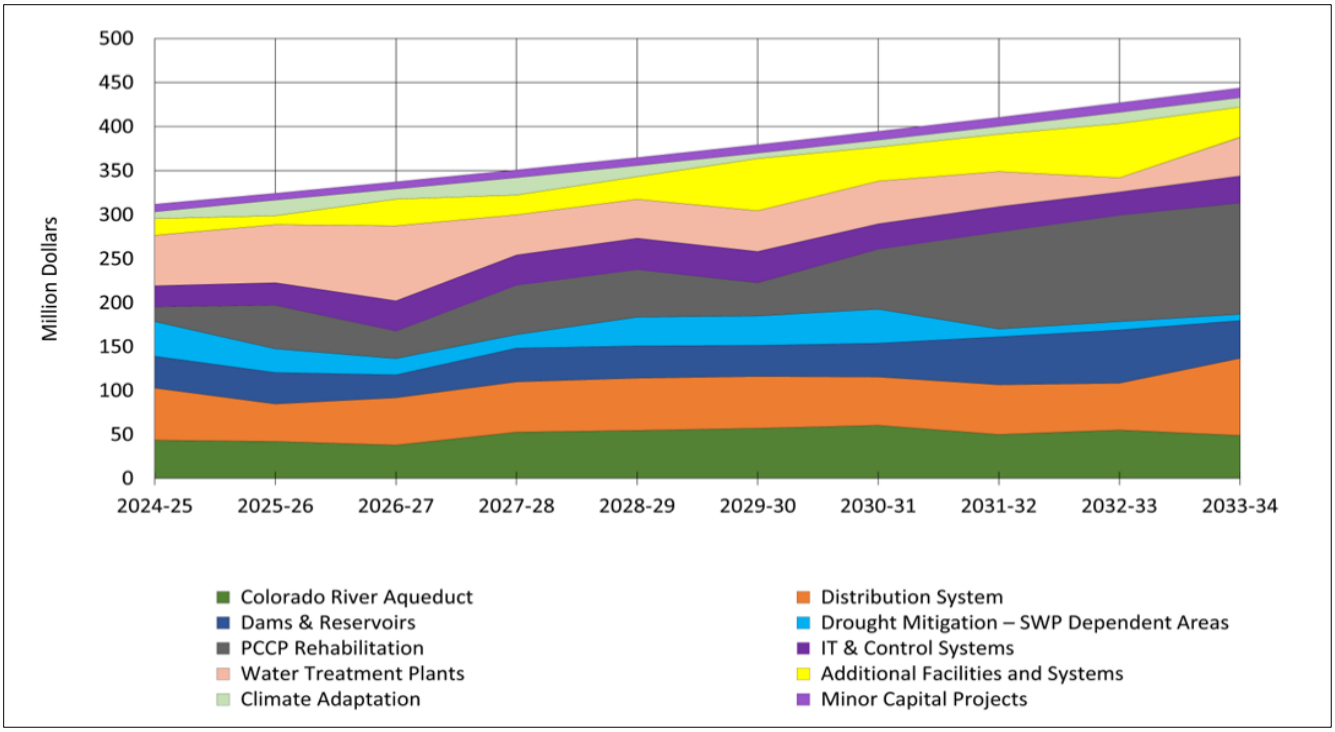


Figure 3-3. CIP 10-Year Window by Program, FY 2024/25 through FY 2033/34

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.

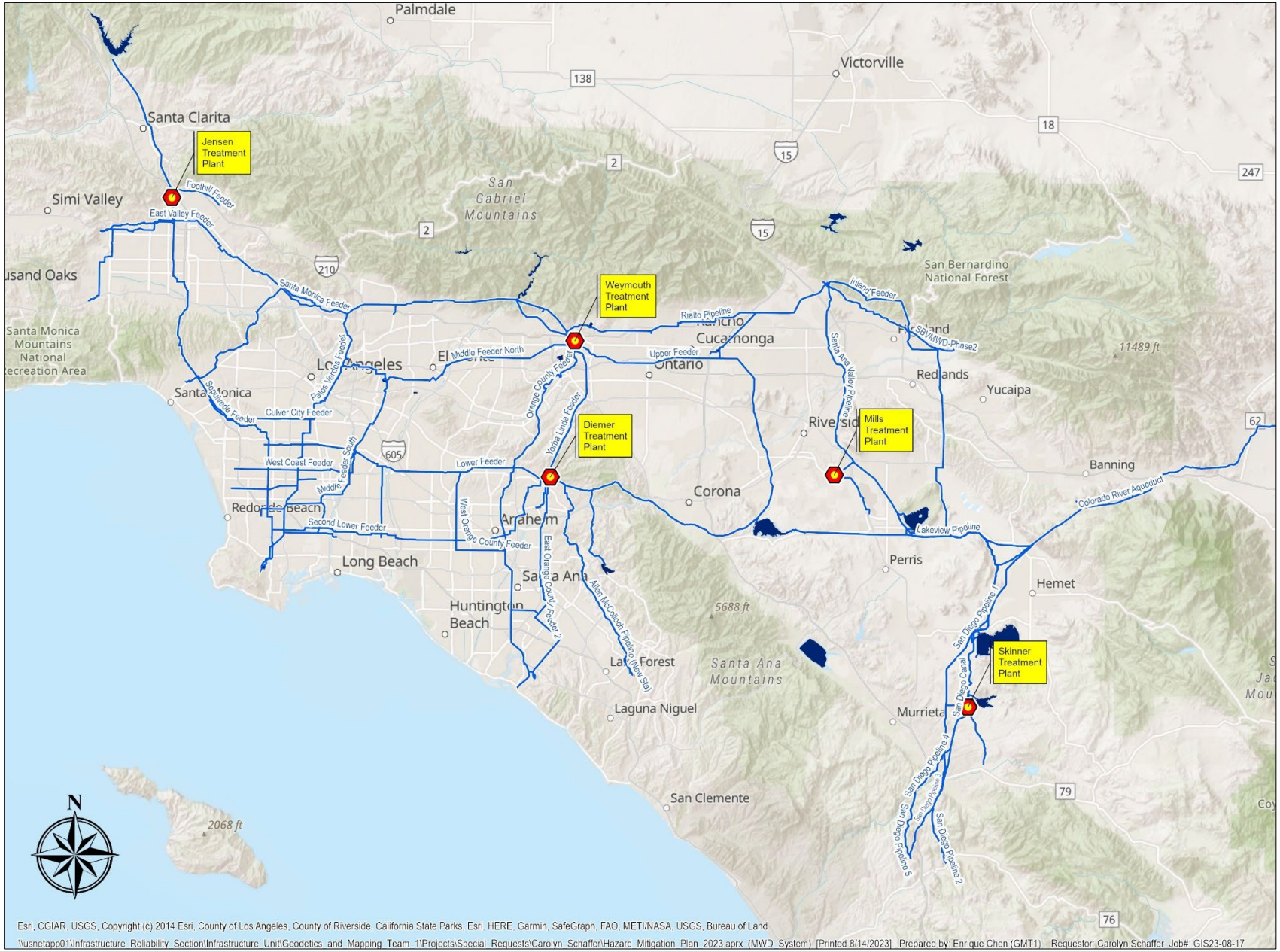


Figure 3-4. Major Geographic Features and Regional Water Infrastructure in Western Portion of Metropolitan Planning Area



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

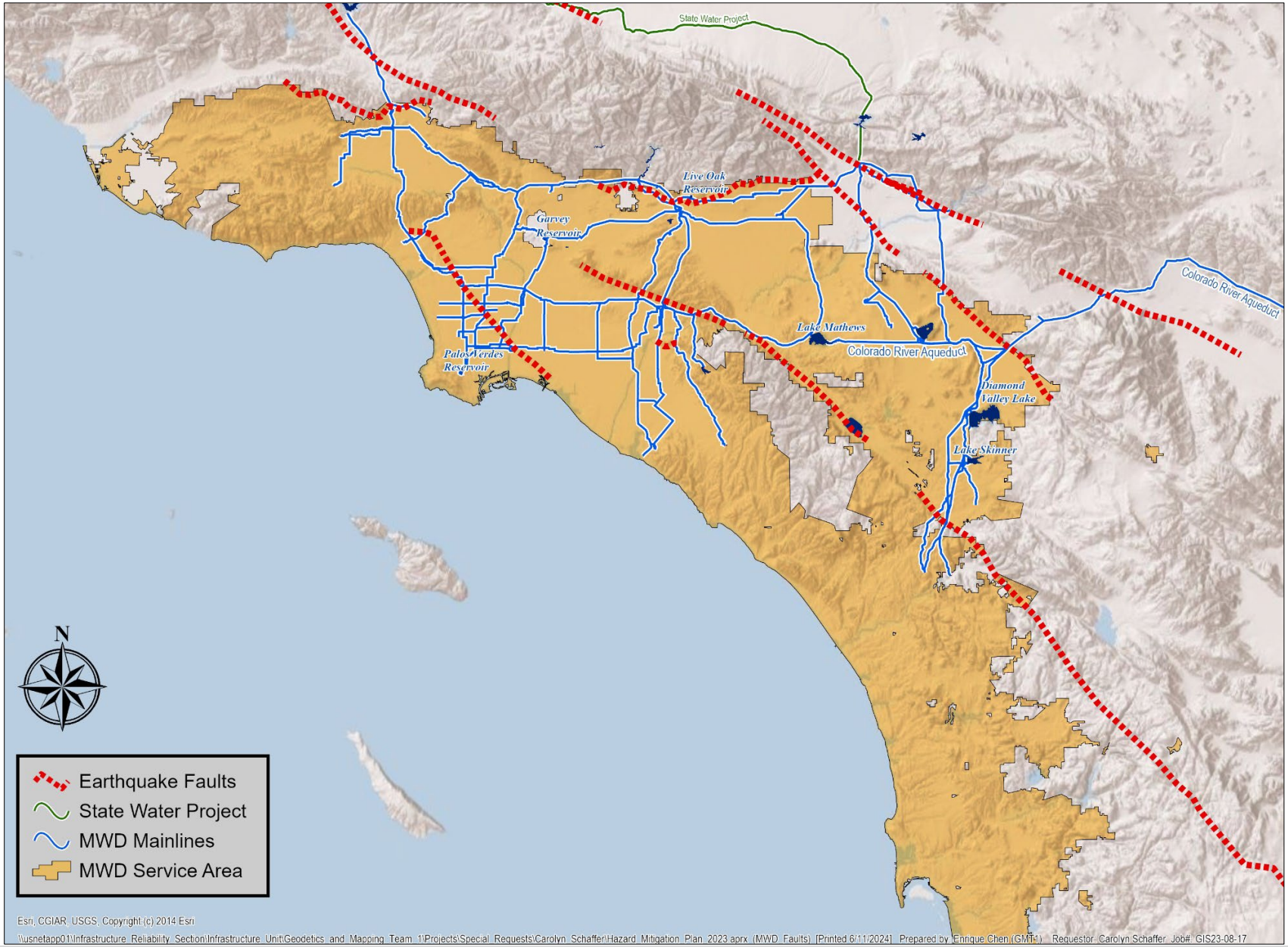


Figure 3-6. Major Earthquake Faults in Metropolitan Service Area

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)

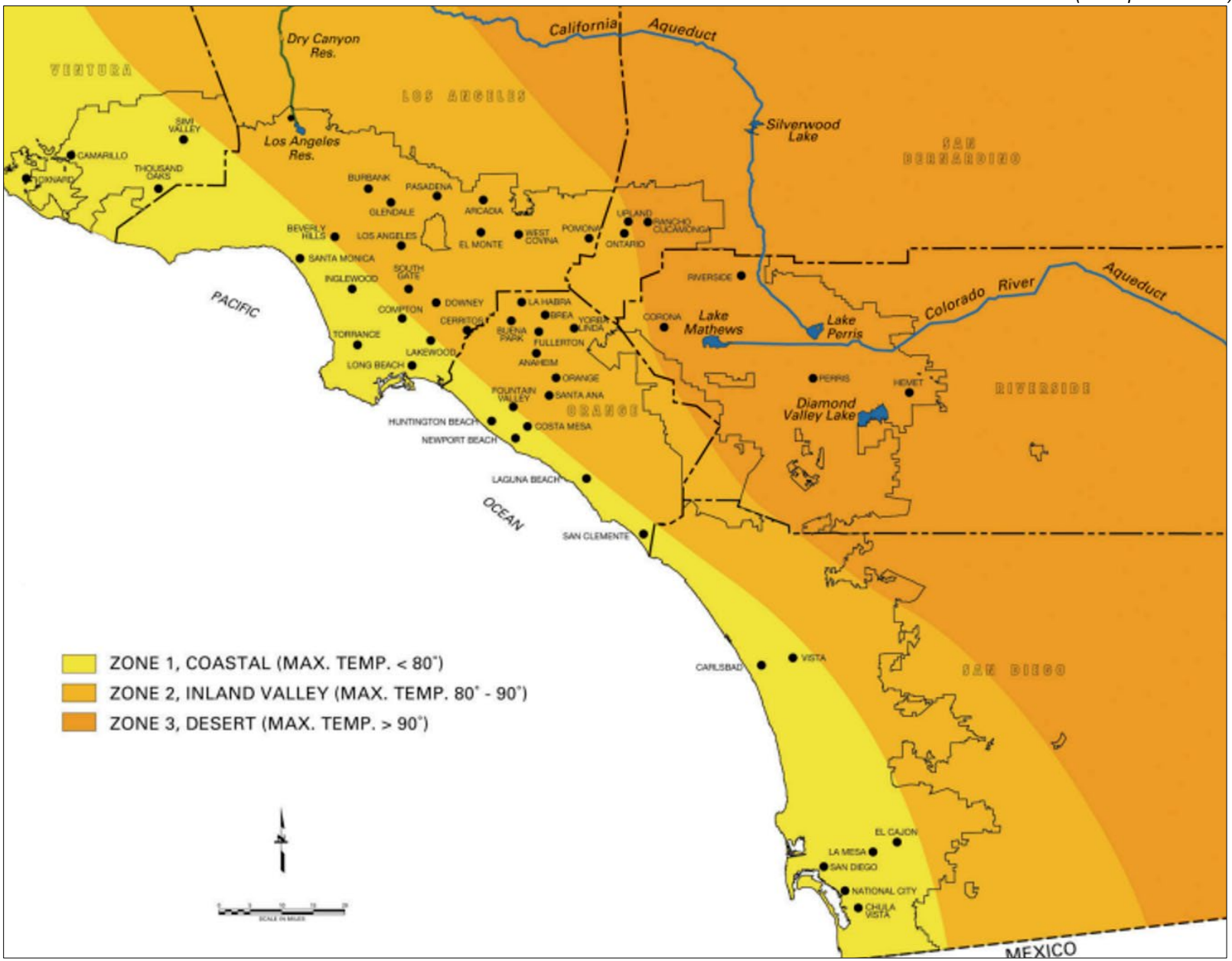


Figure 3-7. Climate Zones in Southern California

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)

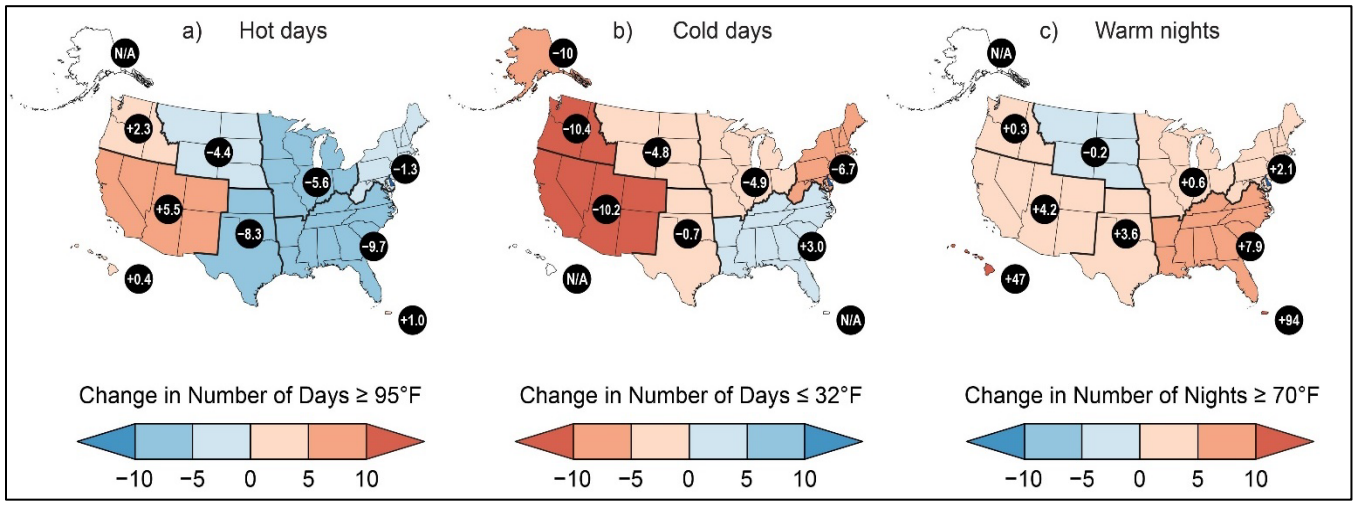


Figure 3-8. Observed Changes in Hot and Cold Extremes

Source: (USGCRP 2023)

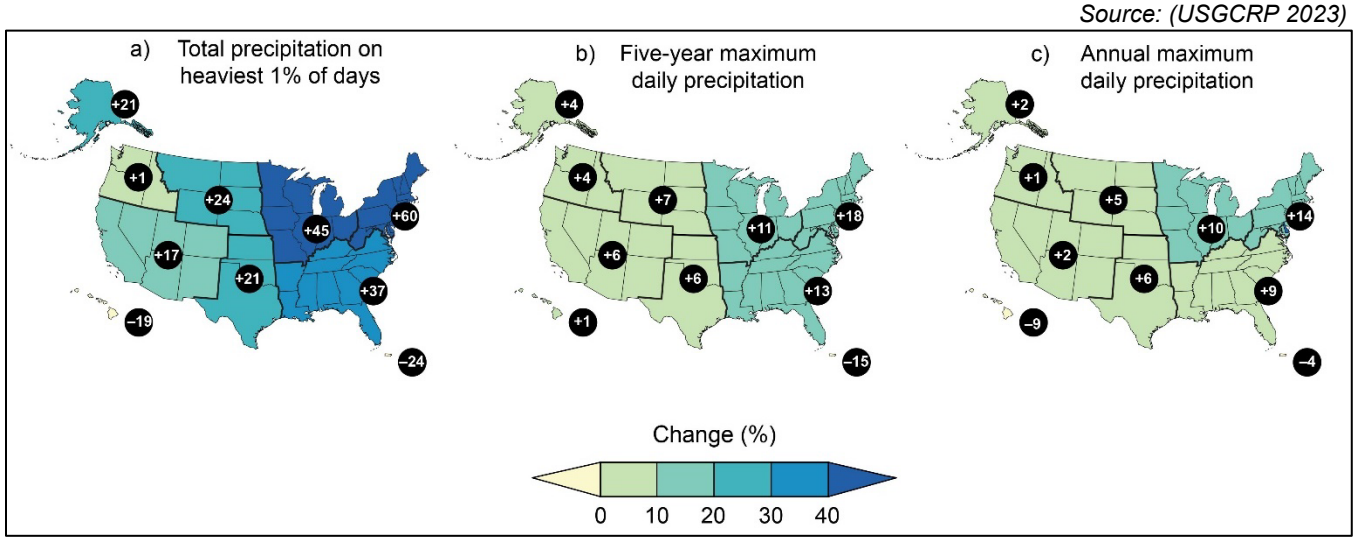


Figure 3-9. Observed Changes in the Frequency and Severity of Heavy Precipitation Events

Source: (USGCRP 2023)

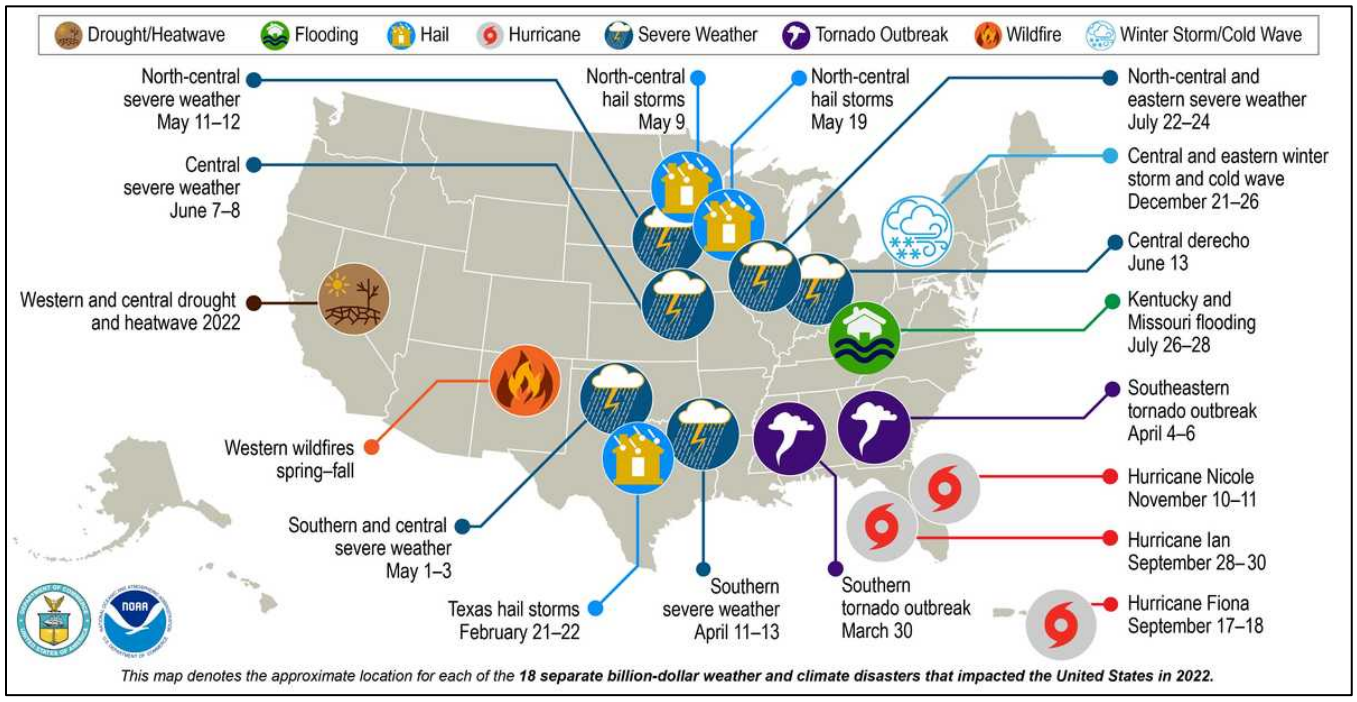


Figure 3-10. Billion-Dollar Weather and Climate Disasters in 2022

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)

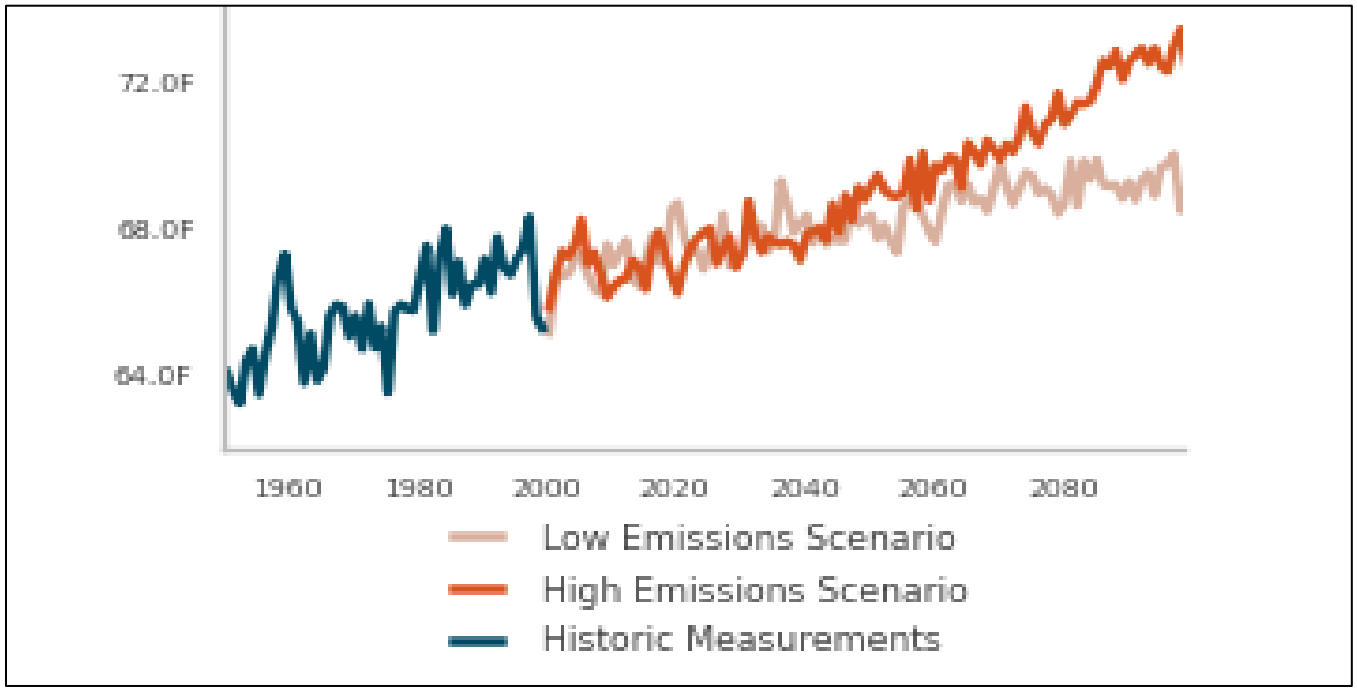


Figure 3-11. Observed and Projected Average Temperatures for the Los Angeles Region

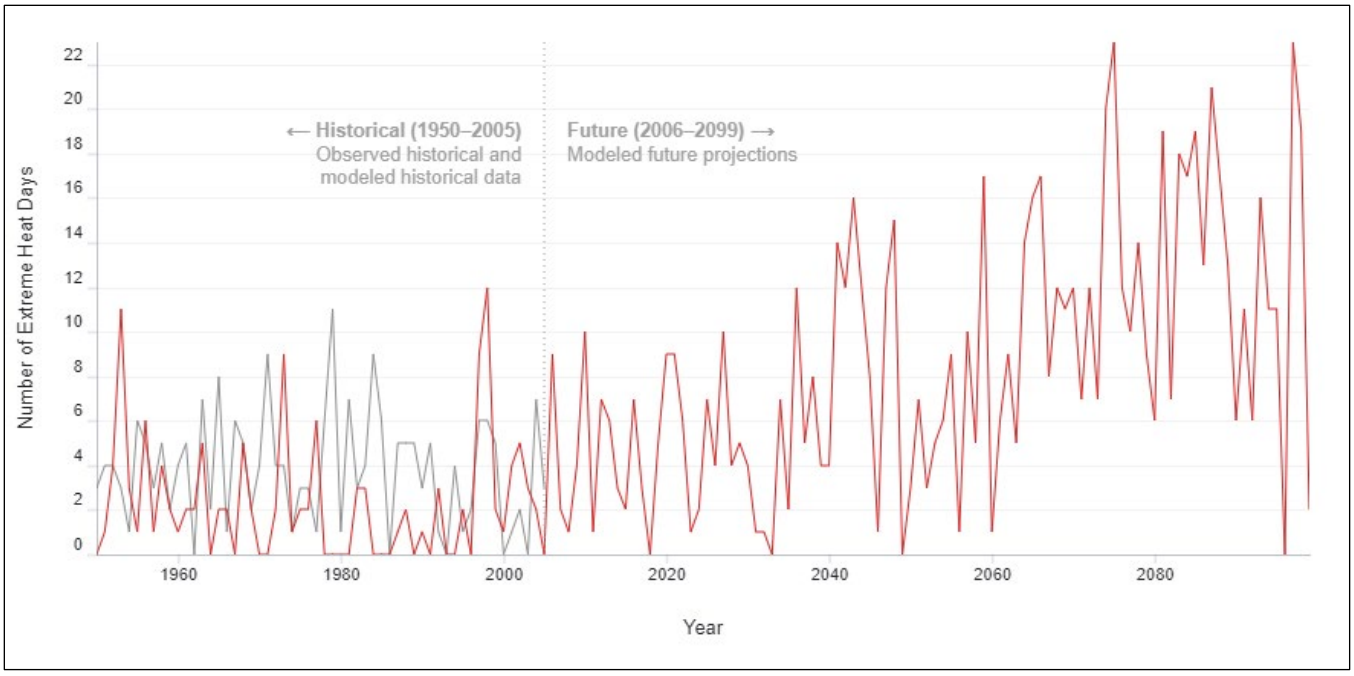


Figure 3-12. Projected Number of Extreme Heat Days by Year for the Los Angeles Region

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.

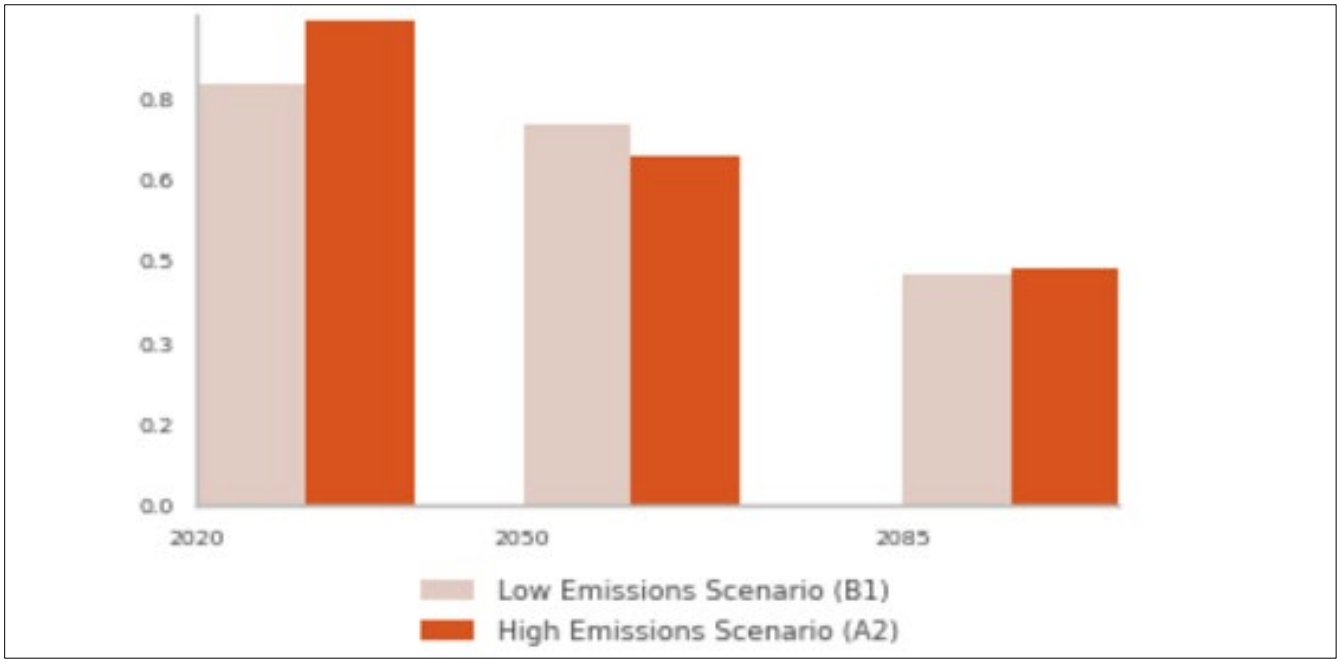


Figure 3-13. Projected Changes in Fire Risk for Los Angeles Region, Relative to 2010 Levels

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

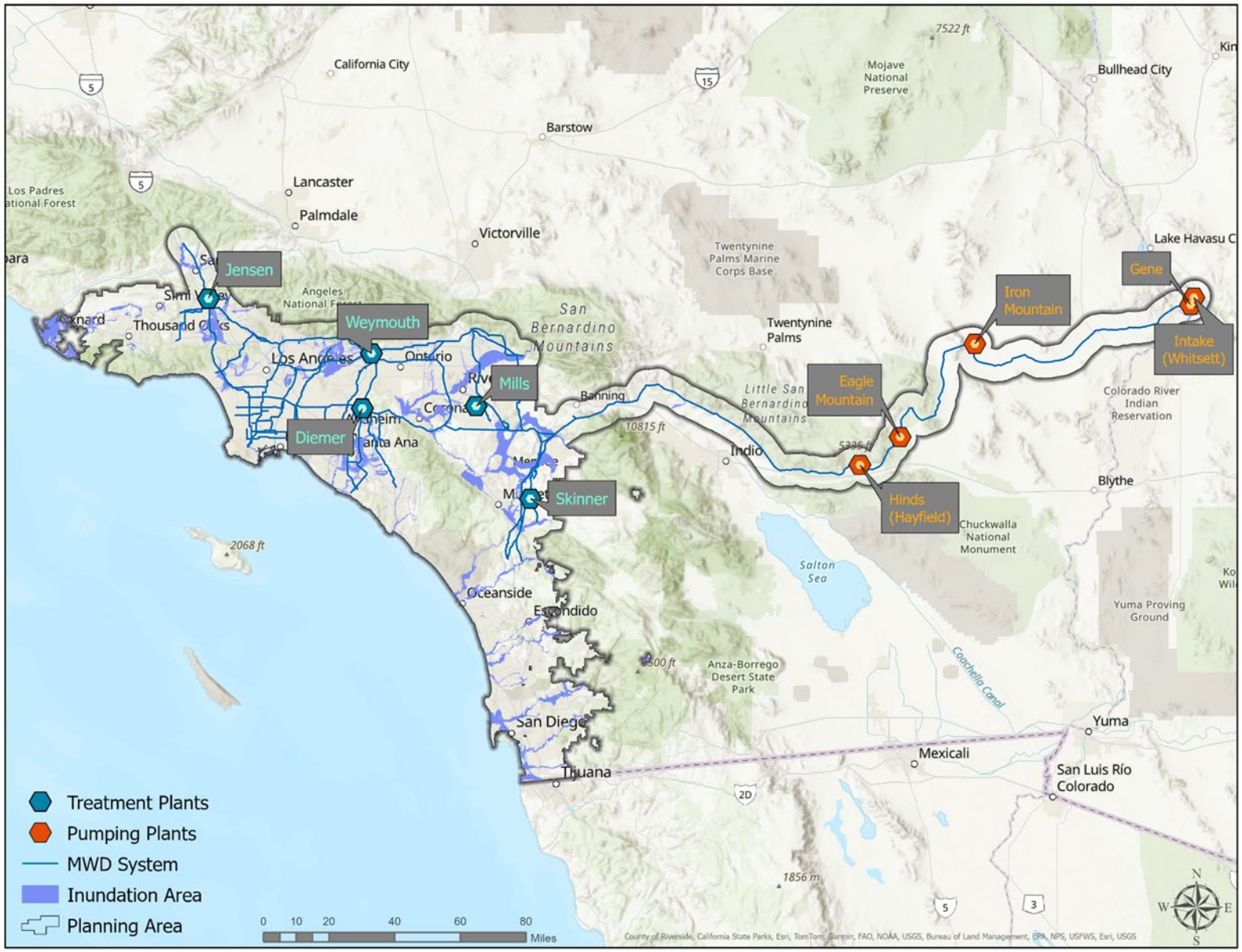


Figure 7-1. Dam Locations and Combined Dam Inundation Area

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.

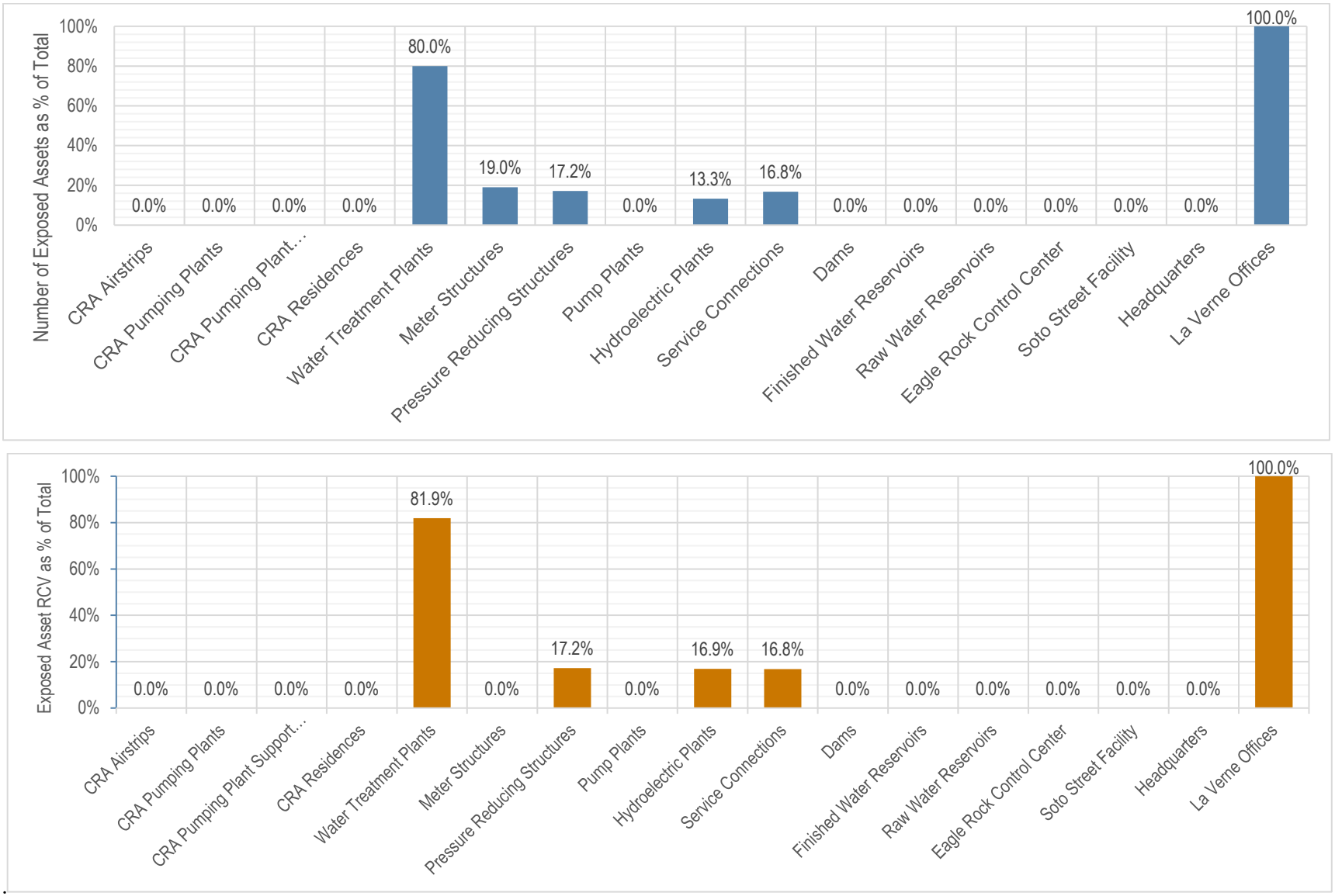
Table 7-8. Metropolitan Non-linear Assets in the Combined Dam Failure Hazard Area

	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.

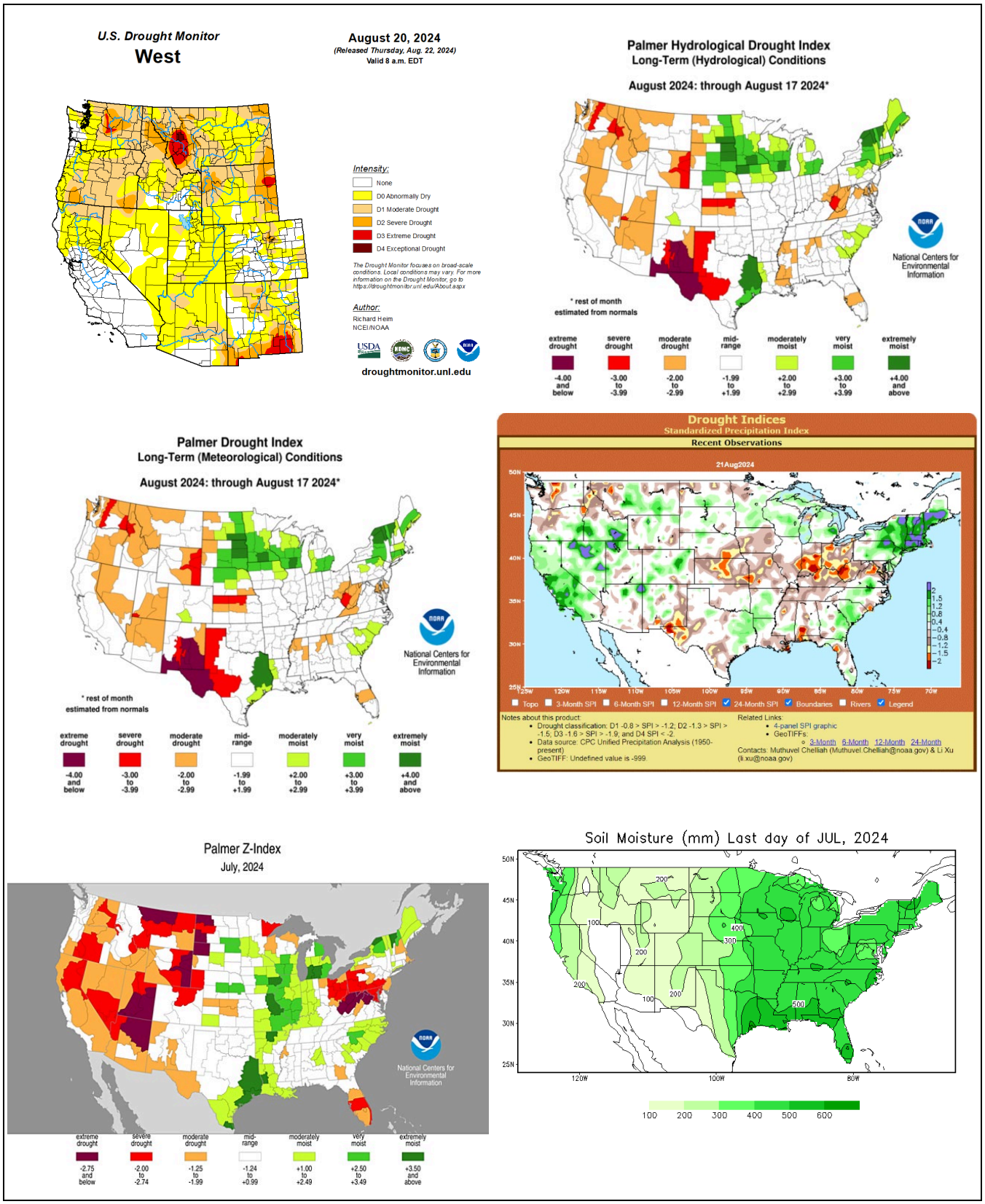


Figure 8-1. Example Drought Index and Drought Monitor Maps, Current as of August 2024

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.

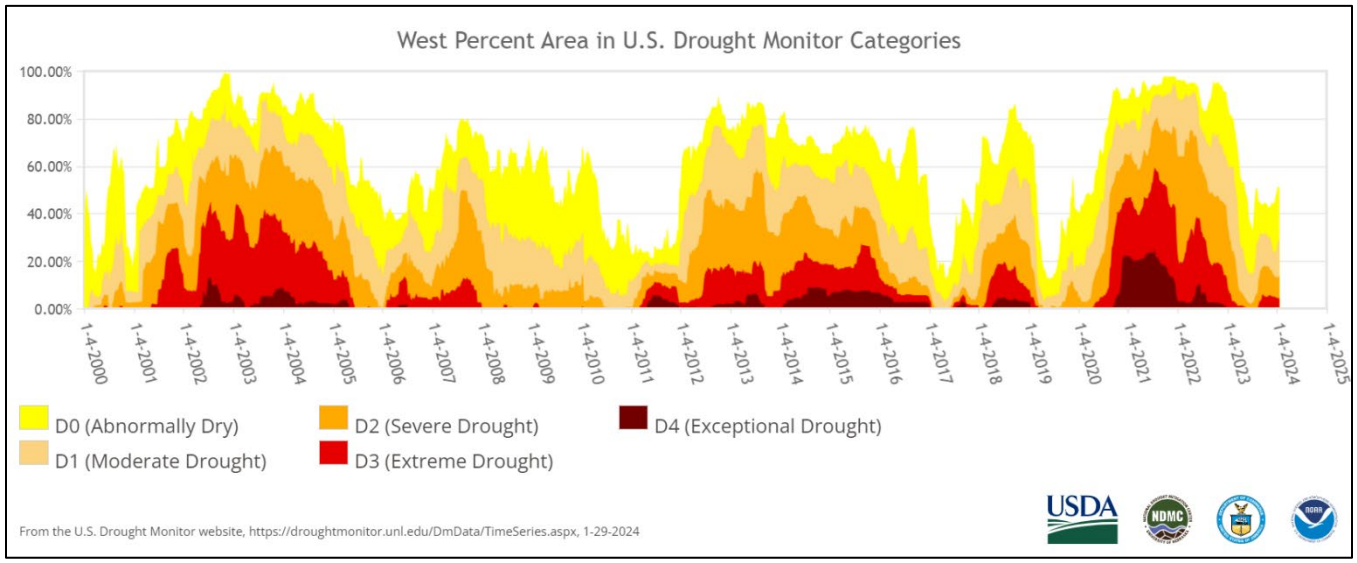


Figure 8-2. Percent of Land Area within California and the West Affected by Each USDM Rating since 2000

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

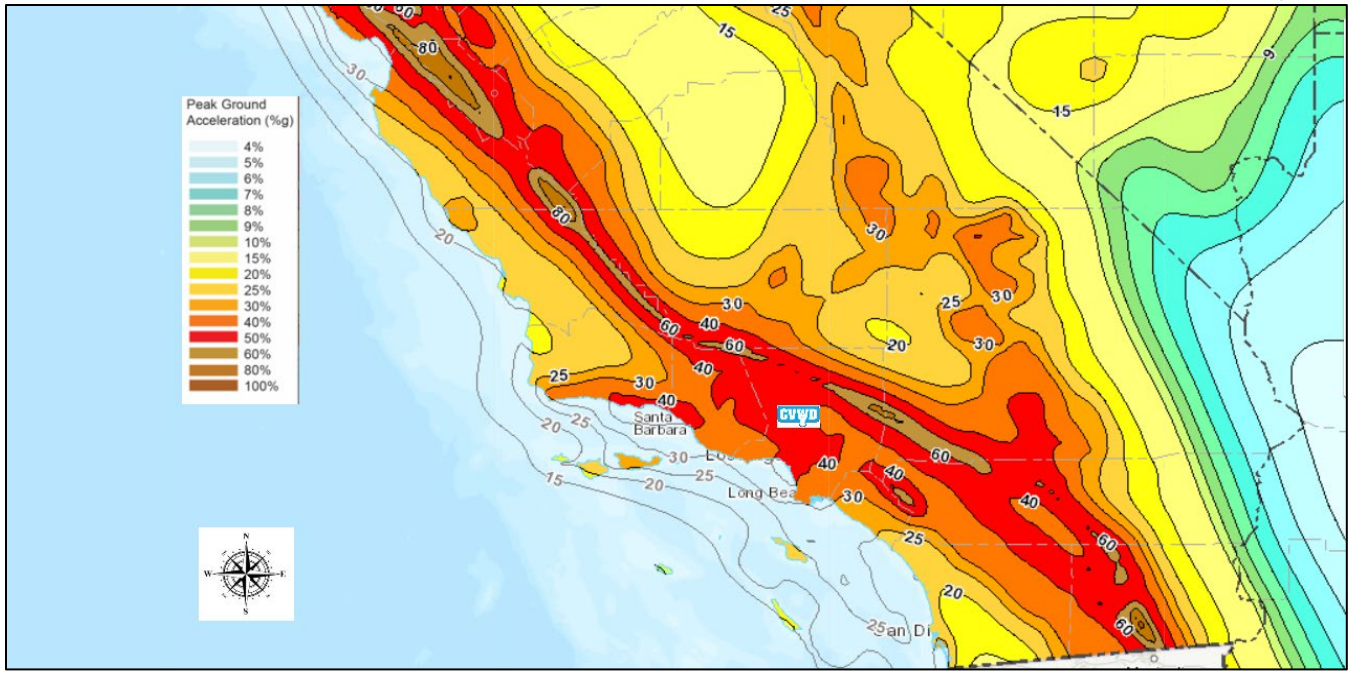


Figure 9-1. Peak Acceleration (%g) with 10% Probability of Exceedance in 50 Years in Southern California

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).

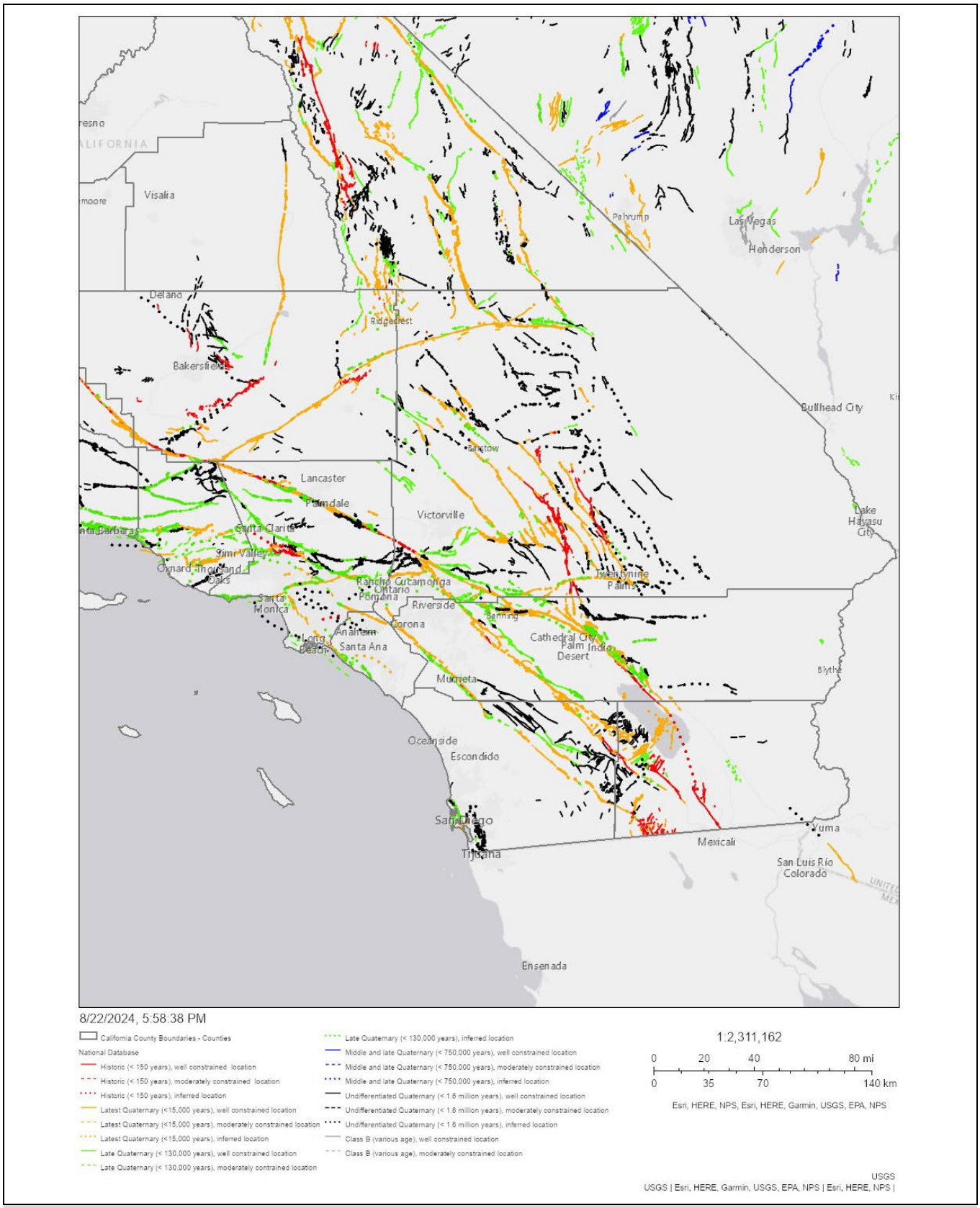


Figure 9-2. Earthquake Fault Zones in Southern California

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.

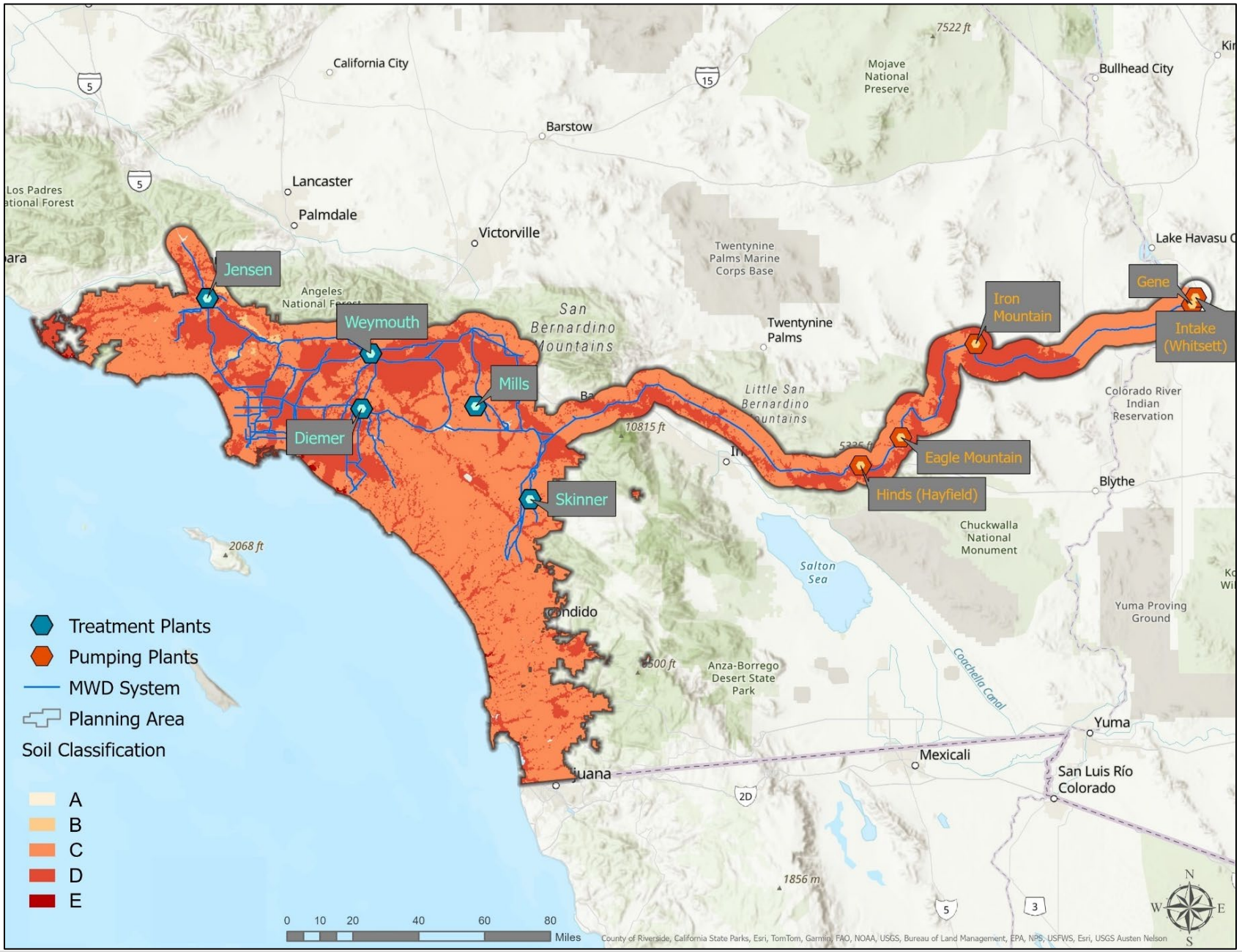


Figure 9-3. Planning Area NEHRP Soil Class

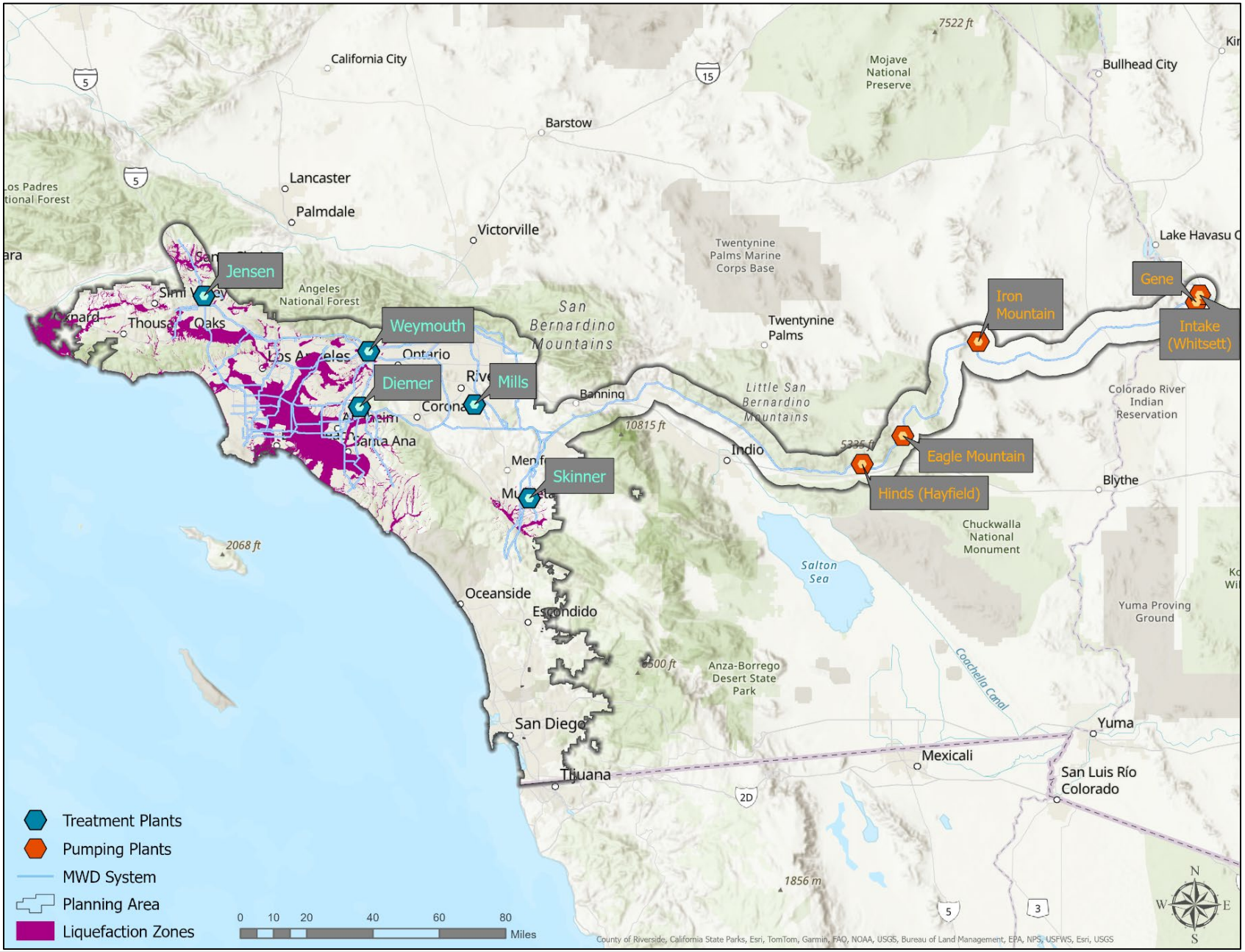


Figure 9-4. Planning Area Liquefaction Zones

Source: (WGCEP 2021)

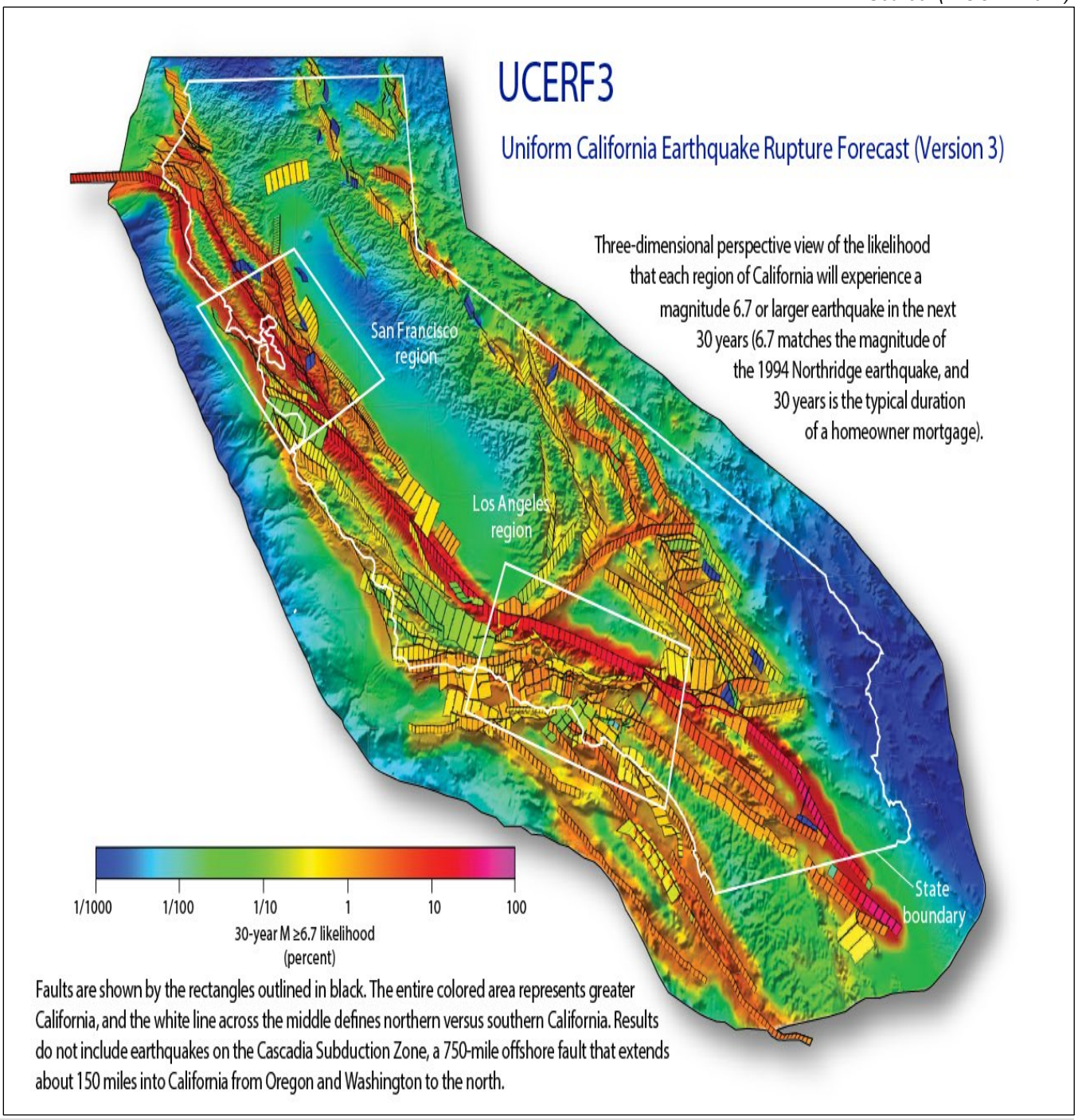


Figure 9-5. Uniform California Earthquake Rupture Forecast for Magnitude 6.7 or Larger Earthquake in the Next 30 Years

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).

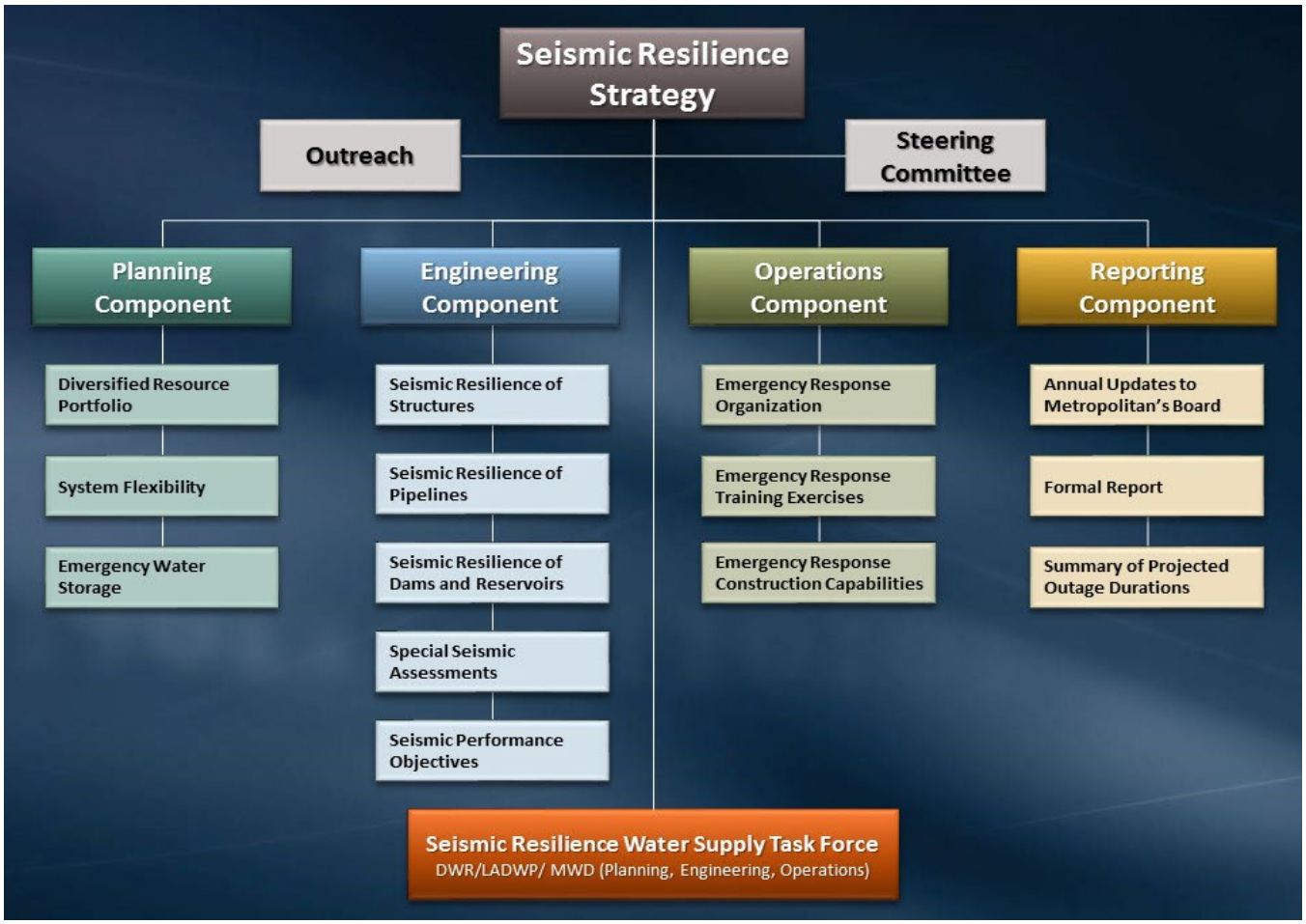


Figure 9-6. Metropolitan's Seismic Resilience Strategy

9.2.5 Warning Time

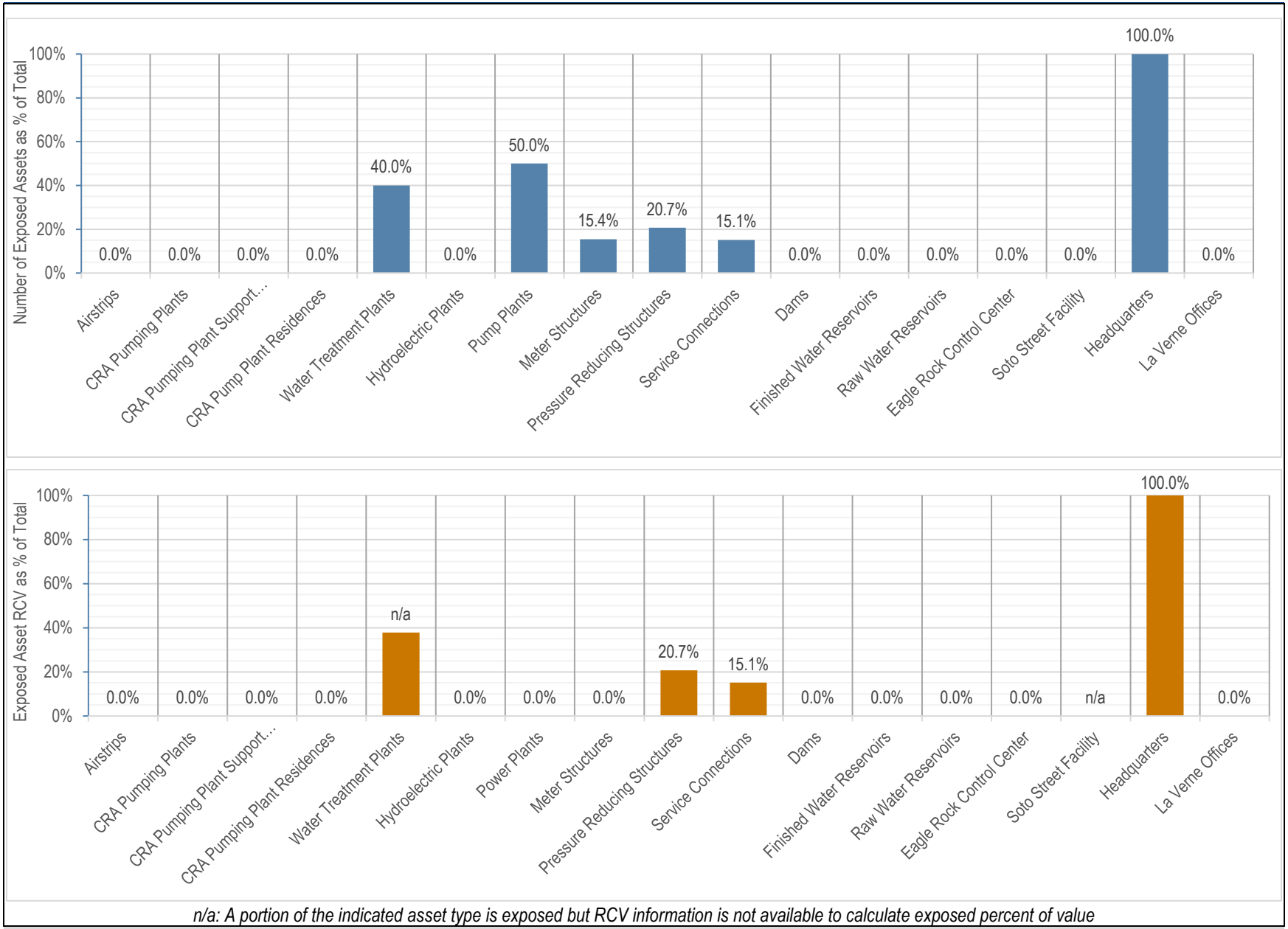
There is no current reliable way to predict the day or month that an earthquake will occur at any given location. Southern California residents are being encouraged to download MyShake, the new statewide cell phone app from Earthquake Early Warning California that is powered by ShakeAlert and builds 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.

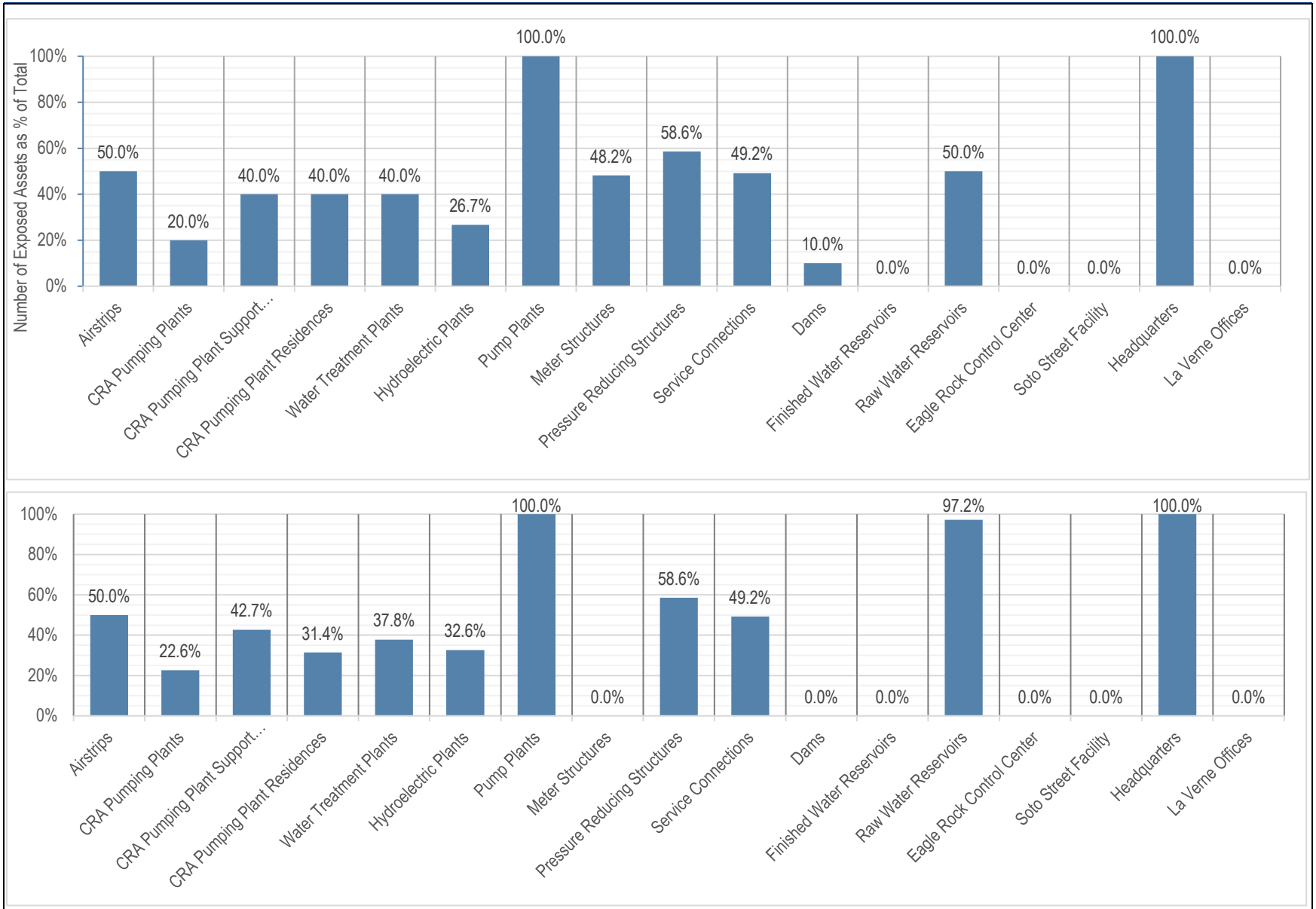
Table 9-3. Metropolitan Non-Linear Assets in the Mapped Seismic Hazard Areas

	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



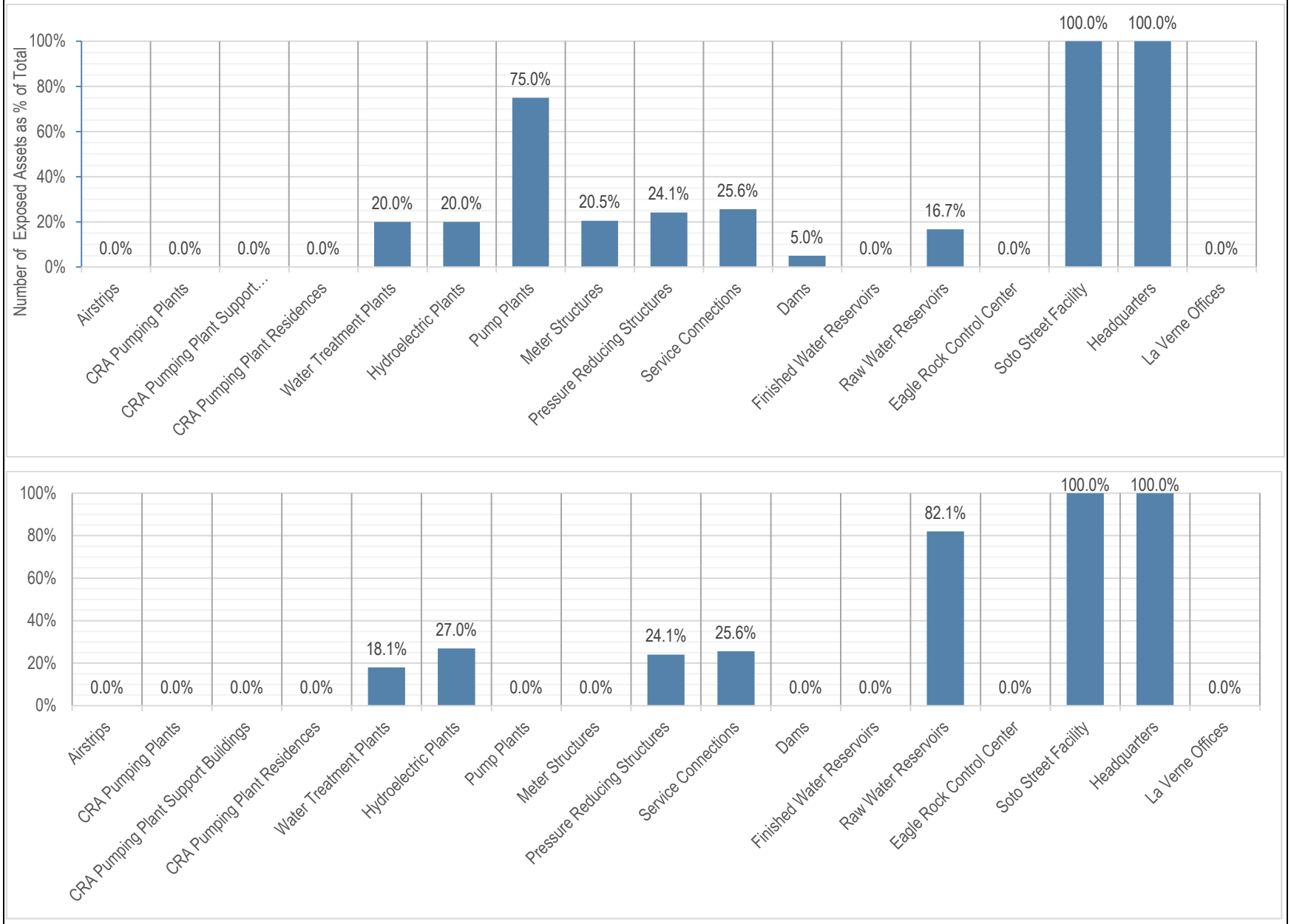
n/a: A portion of the indicated asset type is exposed but RCV information is not available to calculate exposed percent of value

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.

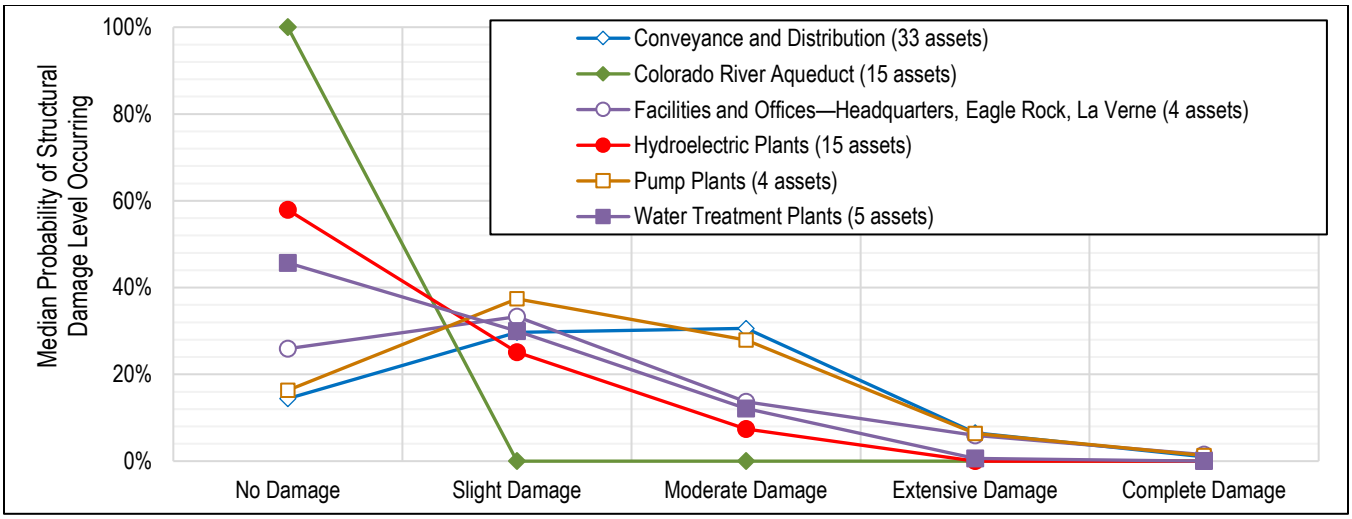


Figure 9-10. Estimated Structural Damage Probability for Compton M7.45 Earthquake Scenario

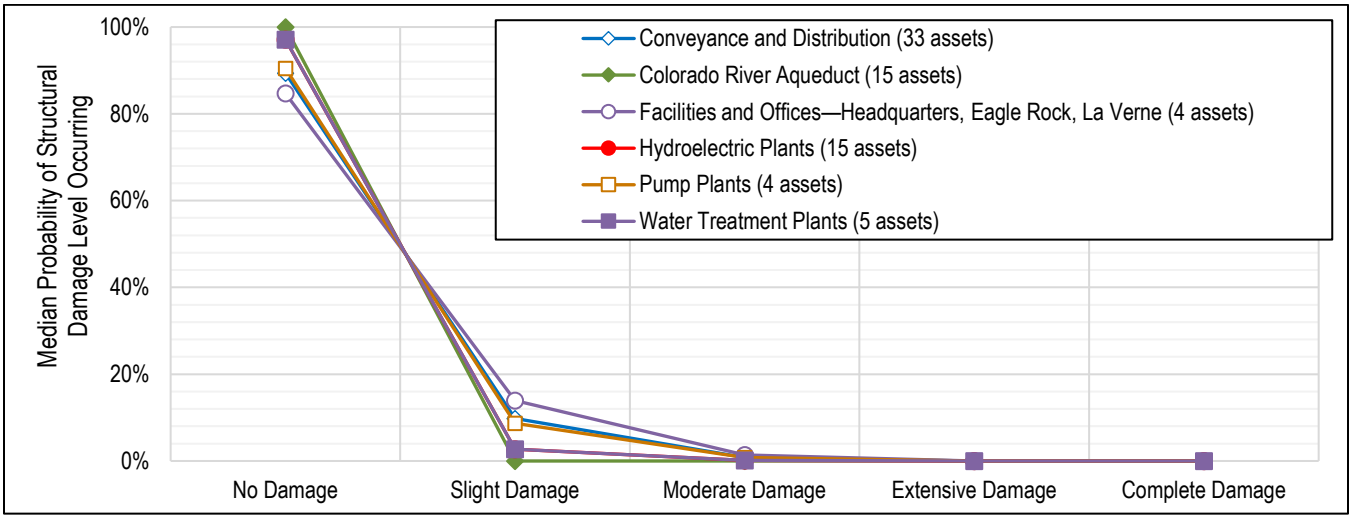


Figure 9-11. Estimated Structural Damage Probability for Cucamonga M6.88 Earthquake Scenario

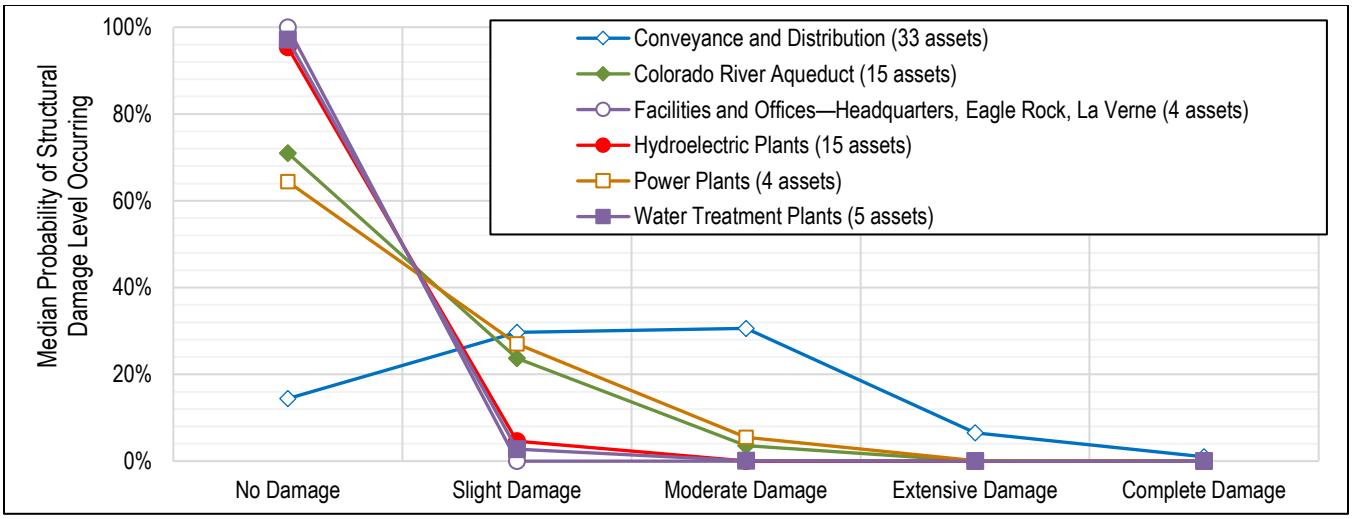


Figure 9-12. Estimated Structural Damage Probability for Elsinore M7.62 Earthquake Scenario

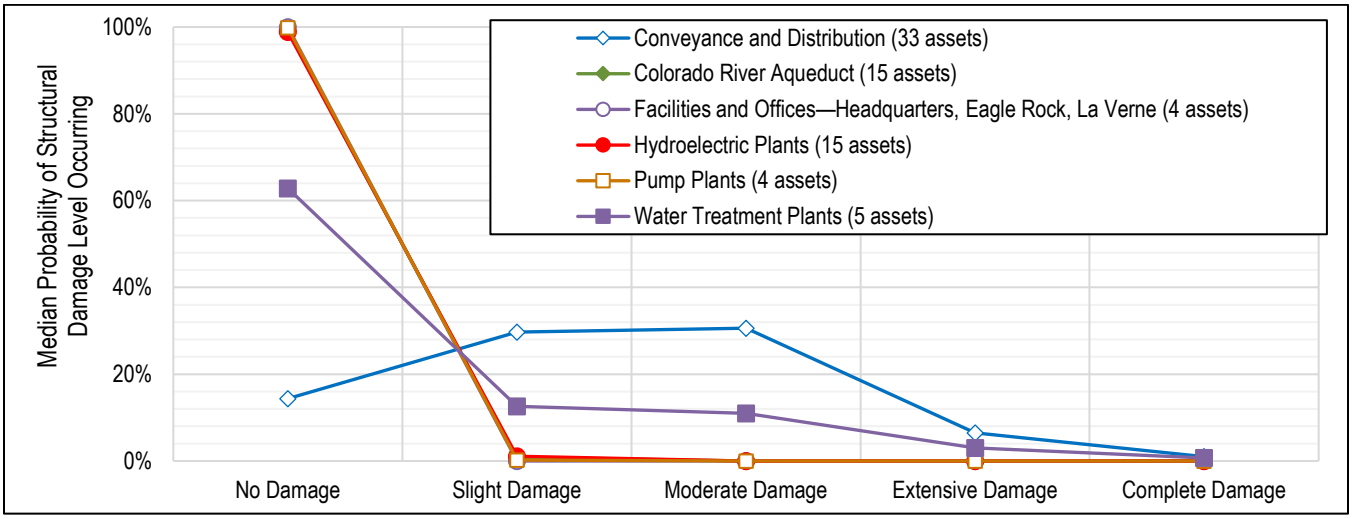


Figure 9-13. Estimated Structural Damage Probability for Mission Hills M6.52 Earthquake Scenario

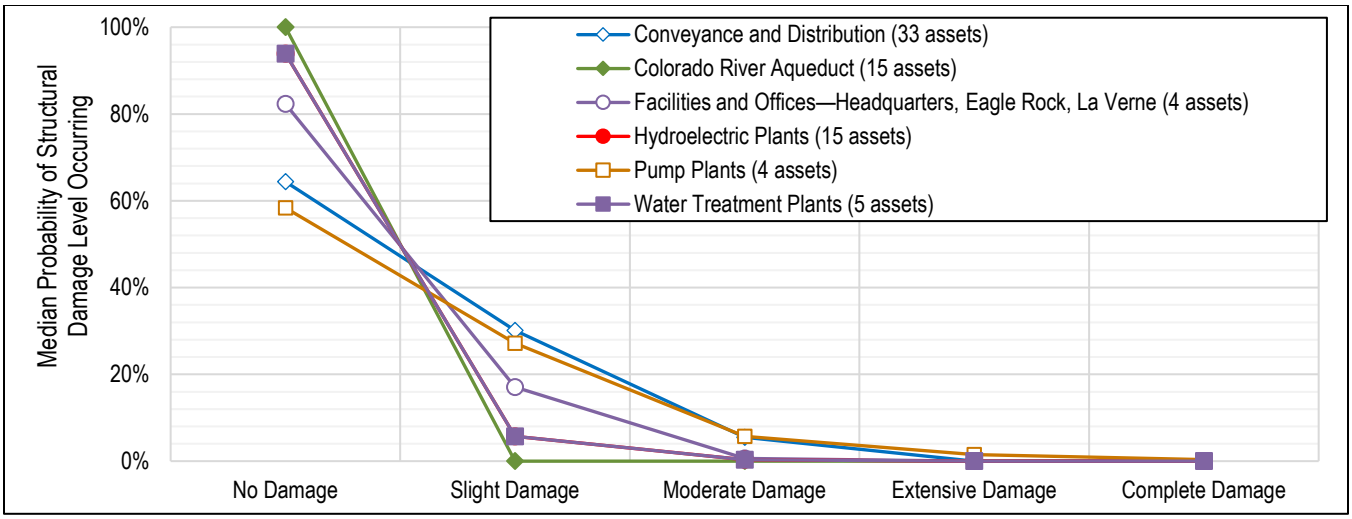


Figure 9-14. Estimated Structural Damage Probability for Newport/Inglewood Alternative 1 M7.2 Earthquake Scenario

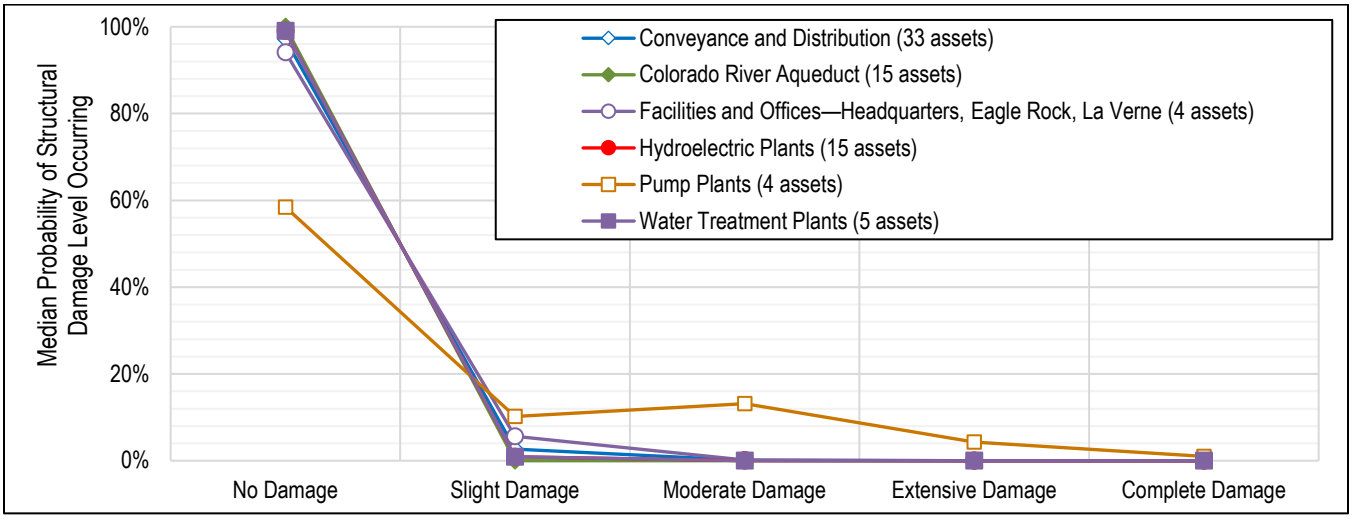


Figure 9-15. Estimated Structural Damage Probability for Northridge Hills M7.01 Earthquake Scenario

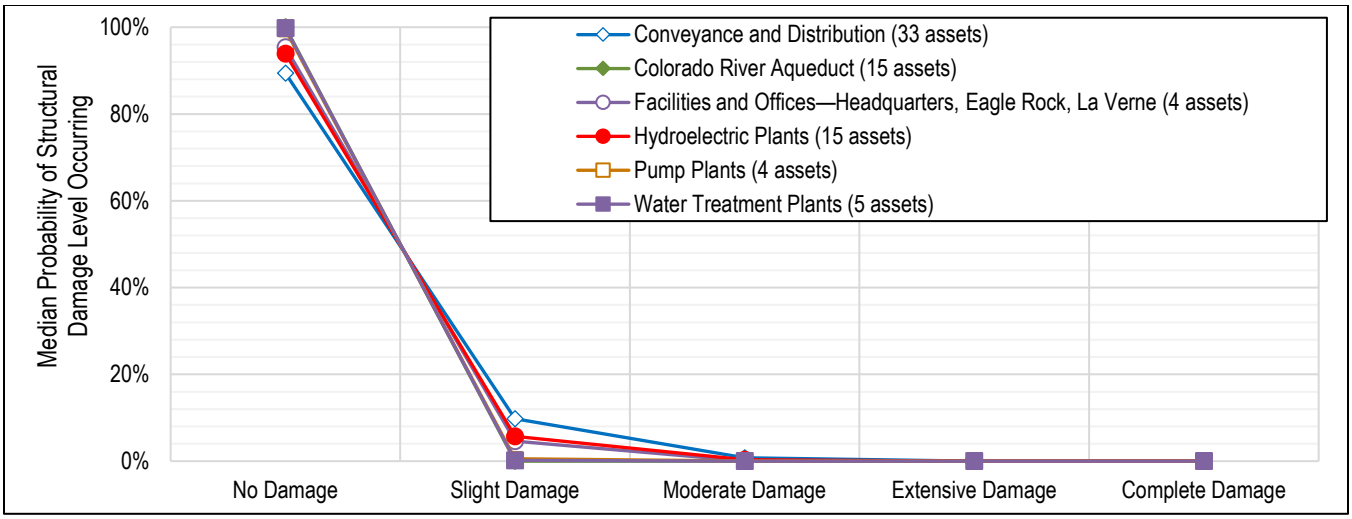


Figure 9-16. Estimated Structural Damage Probability for Peralta Hills M6.55 Earthquake Scenario

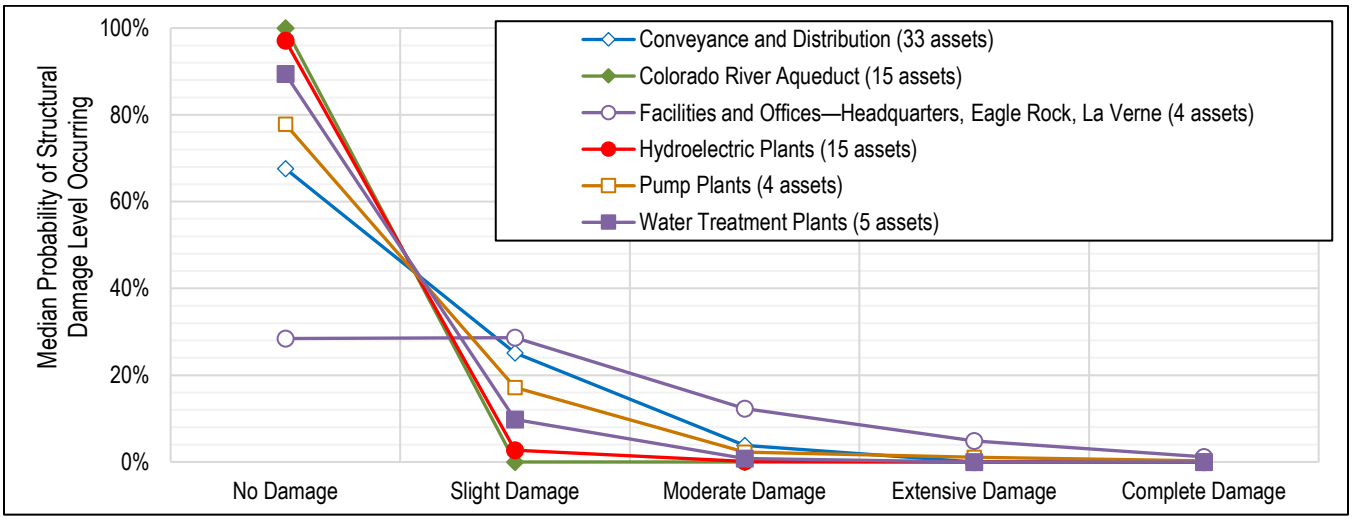


Figure 9-17. Estimated Structural Damage Probability for Puente Hills/Santa Fe Springs M6.61 Earthquake Scenario

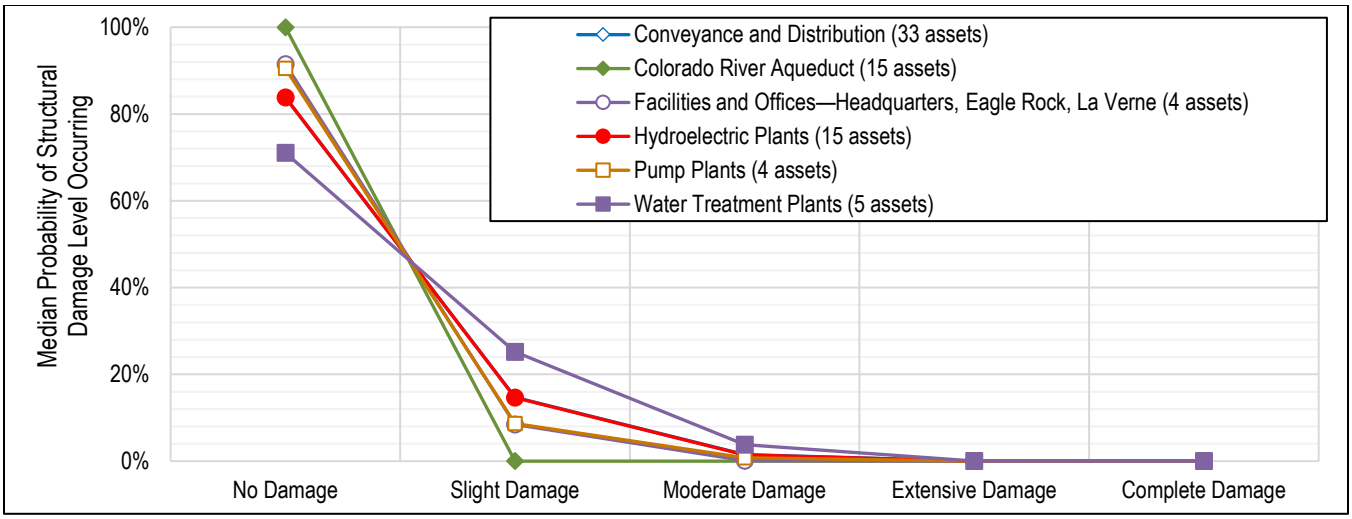


Figure 9-18. Estimated Structural Damage Probability for San Jacinto M7.7 Earthquake Scenario

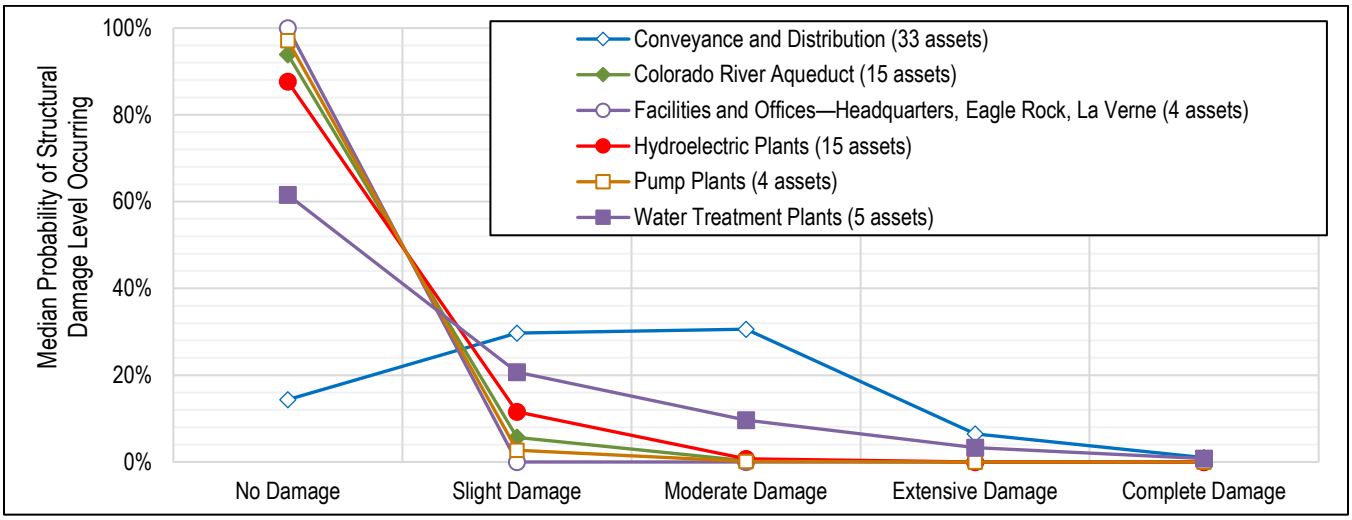


Figure 9-19. Estimated Structural Damage Probability for San Gabriel M7.23 Earthquake Scenario

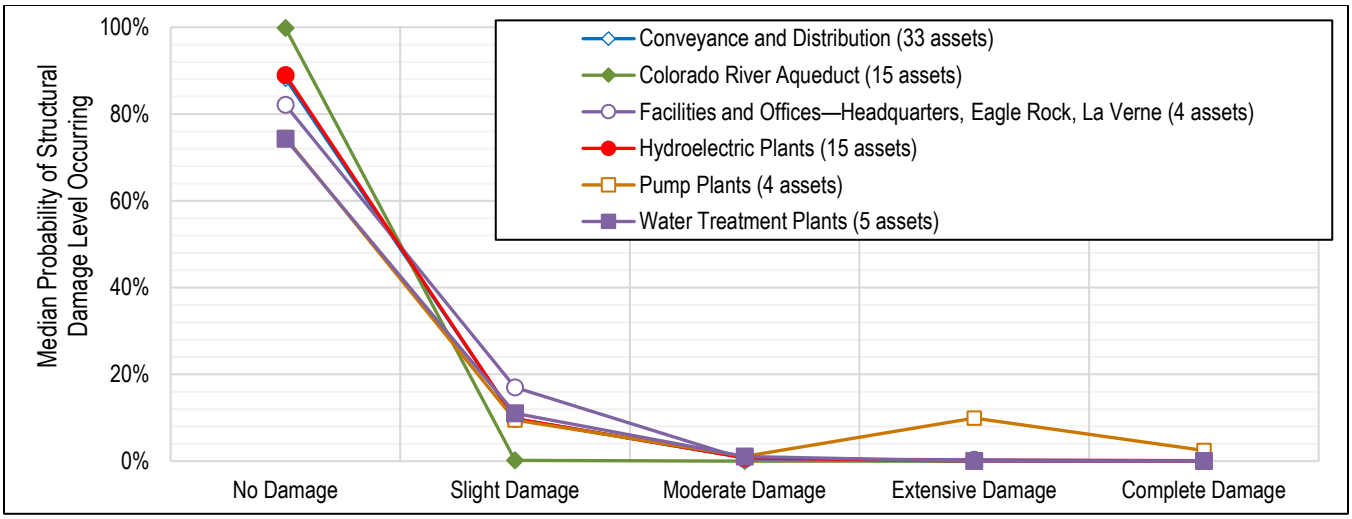


Figure 9-20. Estimated Structural Damage Probability for Southern San Andreas M7.8 Earthquake Scenario

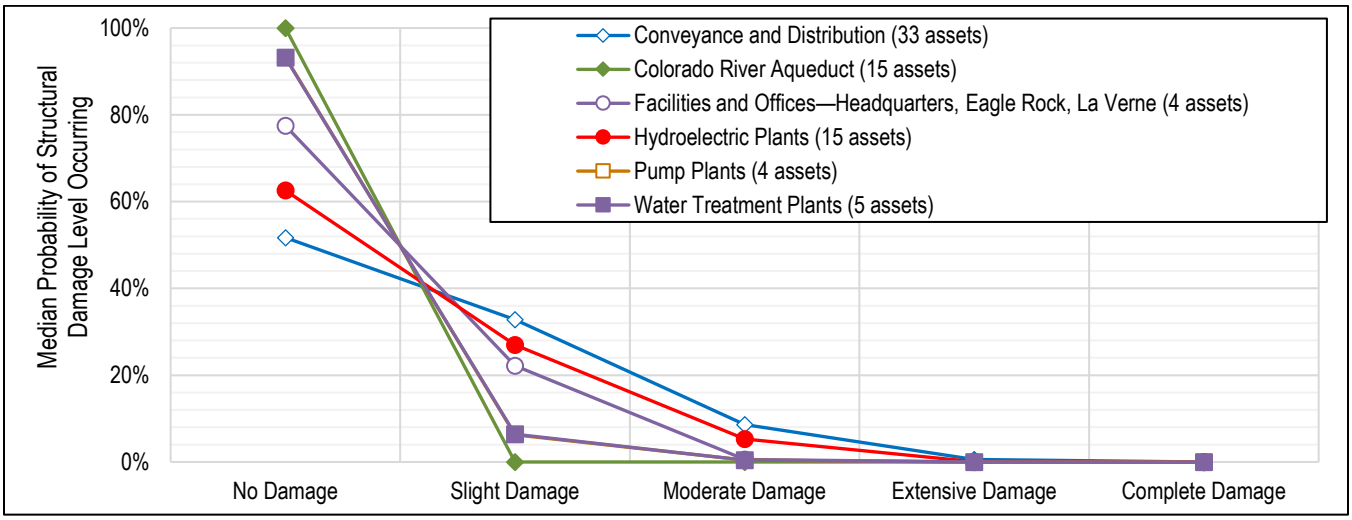


Figure 9-21. Estimated Structural Damage Probability for Whittier Alternative 2 M7.0 Earthquake Scenario

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)

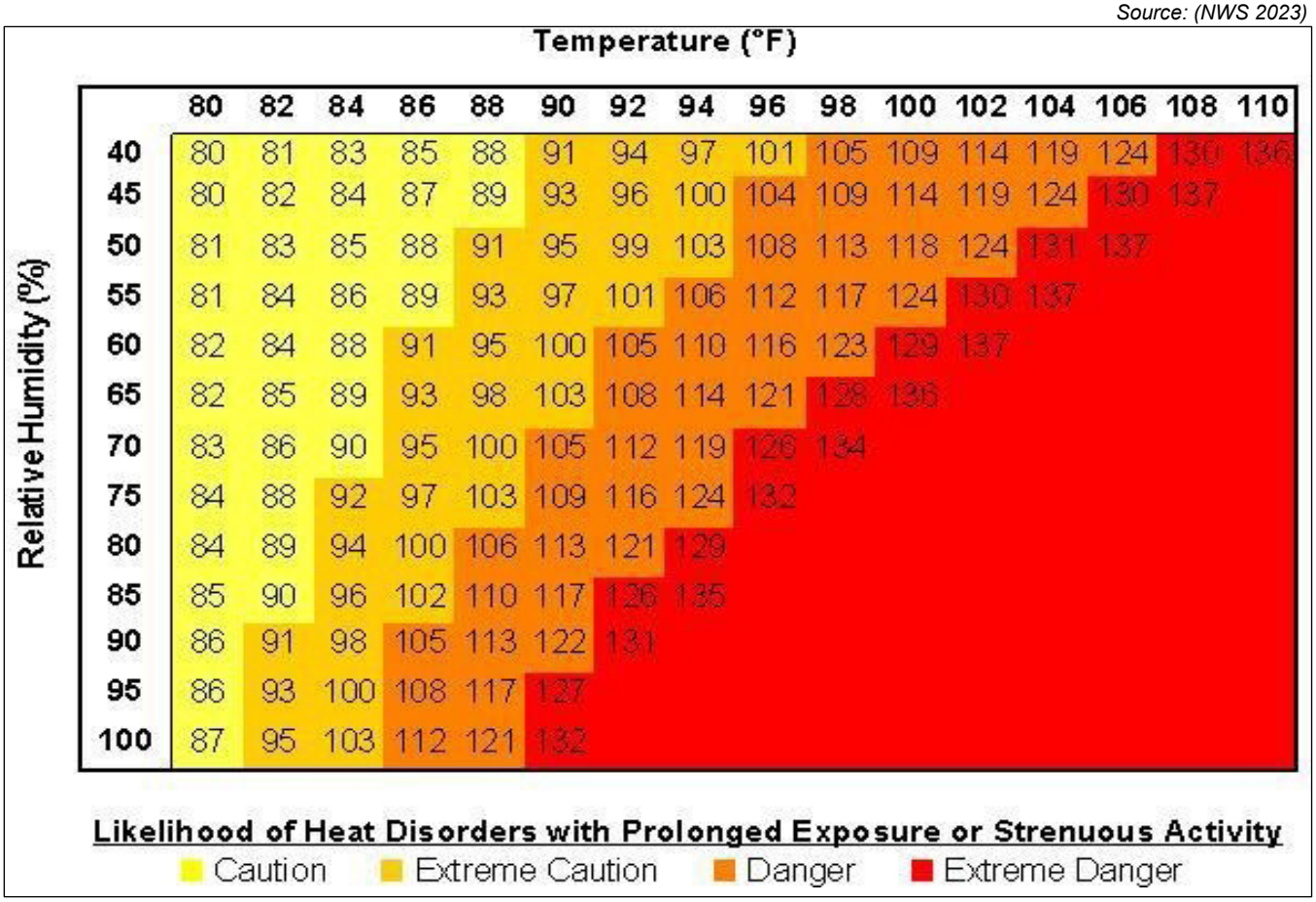


Figure 10-1. Extreme Heat Index

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)

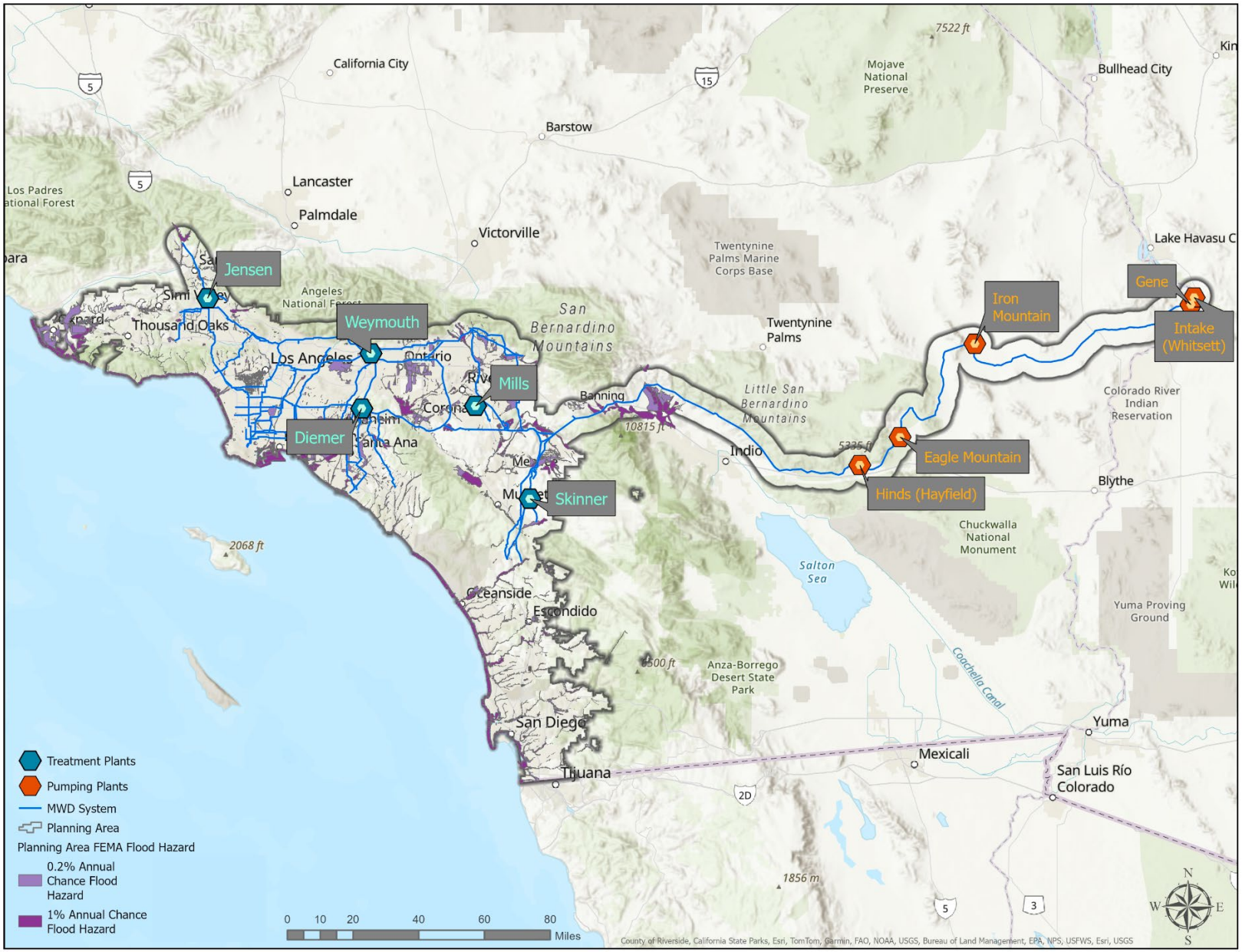


Figure 11-1. FEMA Floodplain Mapping for the Planning Area

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.

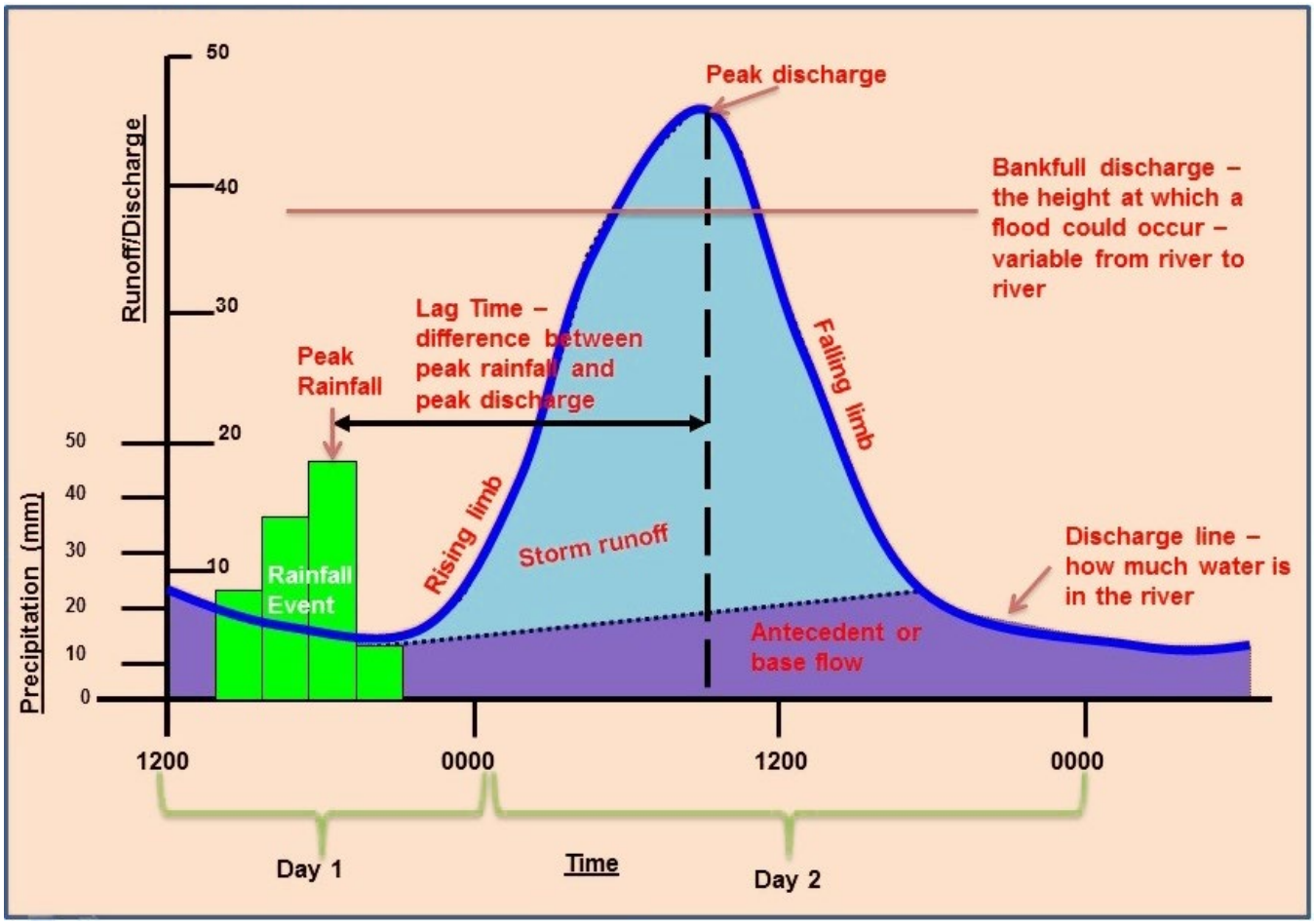


Figure 11-2. Example Hydrograph

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.

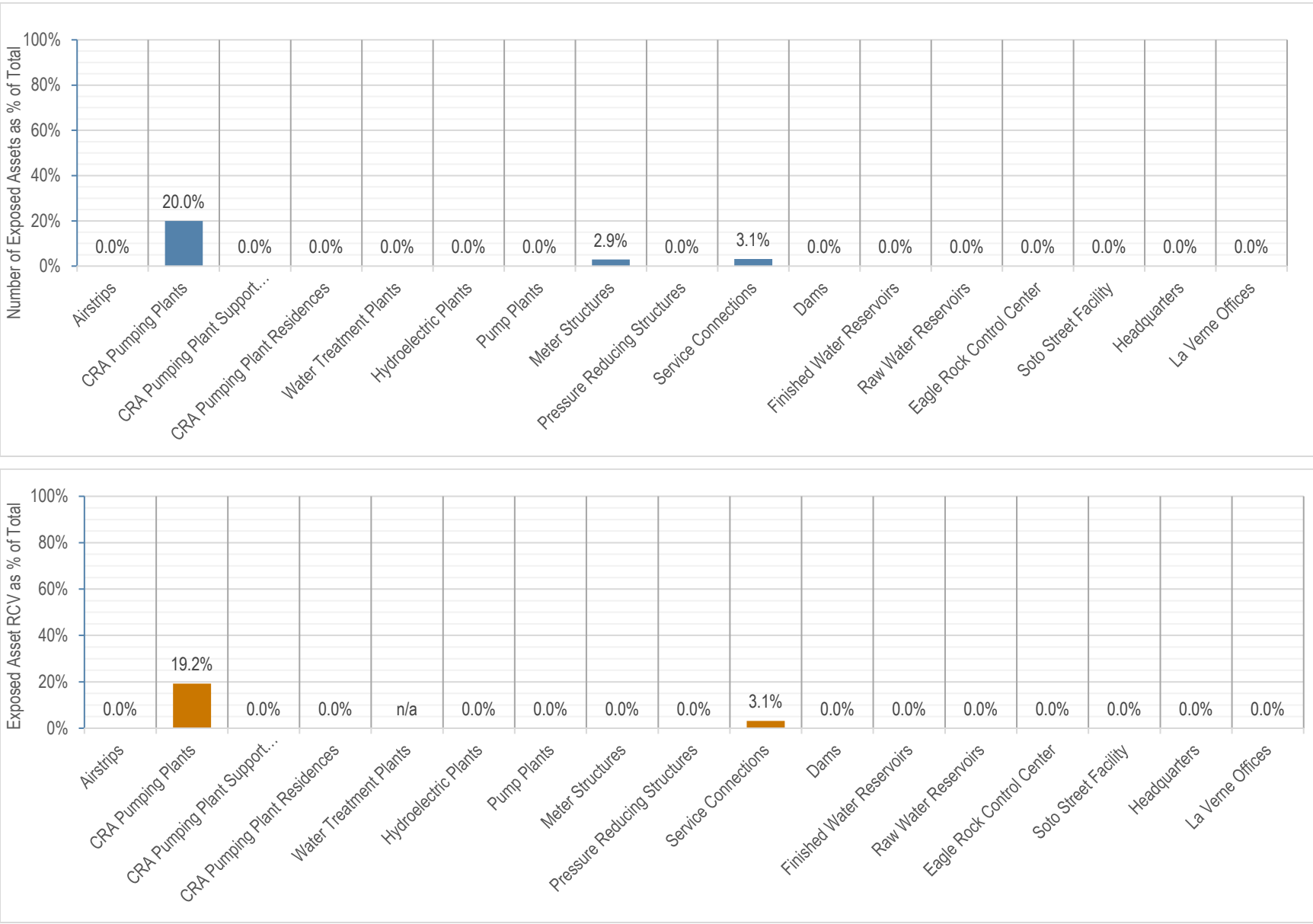
Table 11-2: Metropolitan Non-Linear Assets in the Mapped Flood Area

	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*

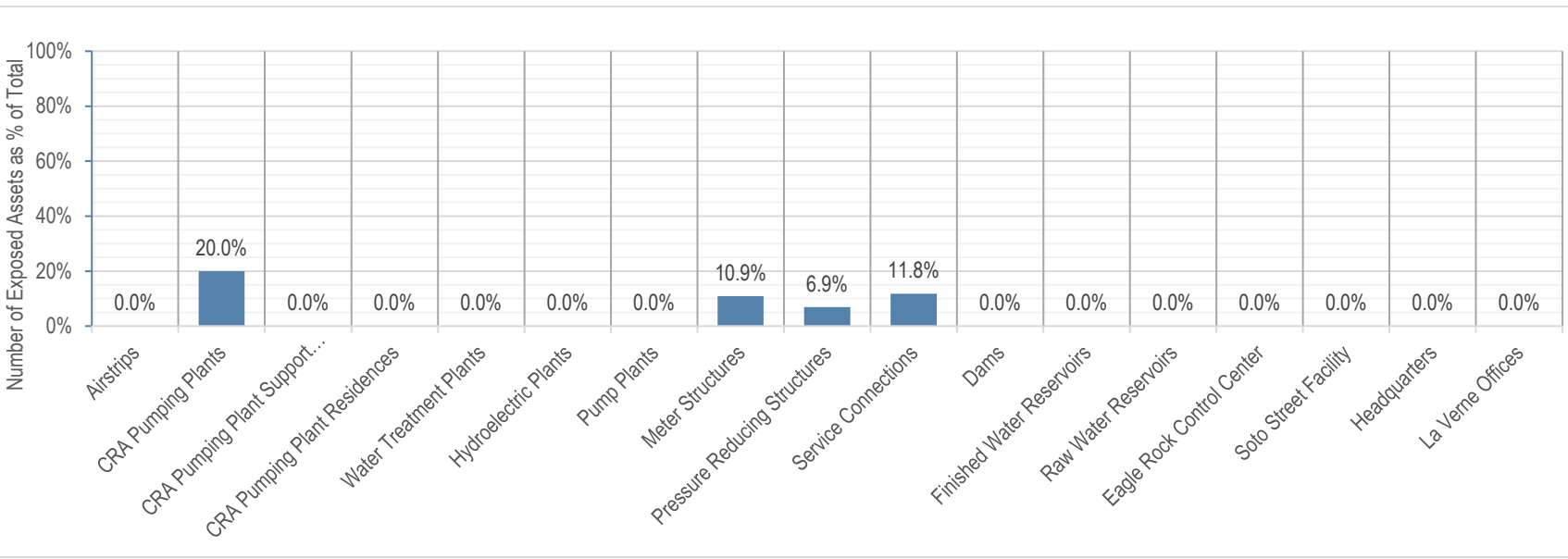
	Length Within in the 1% Annual Chance Flood Zone		Length Within in the 0.2% Annual Chance Flood Zone		Length Within in the Flood Awareness Zone	
	Length (miles)	Replacement Cost Value	Length (miles)	Replacement Cost Value	Length (miles)	Replacement Cost Value
Colorado River	0	$0	0	$0	0.27	$5,932,562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

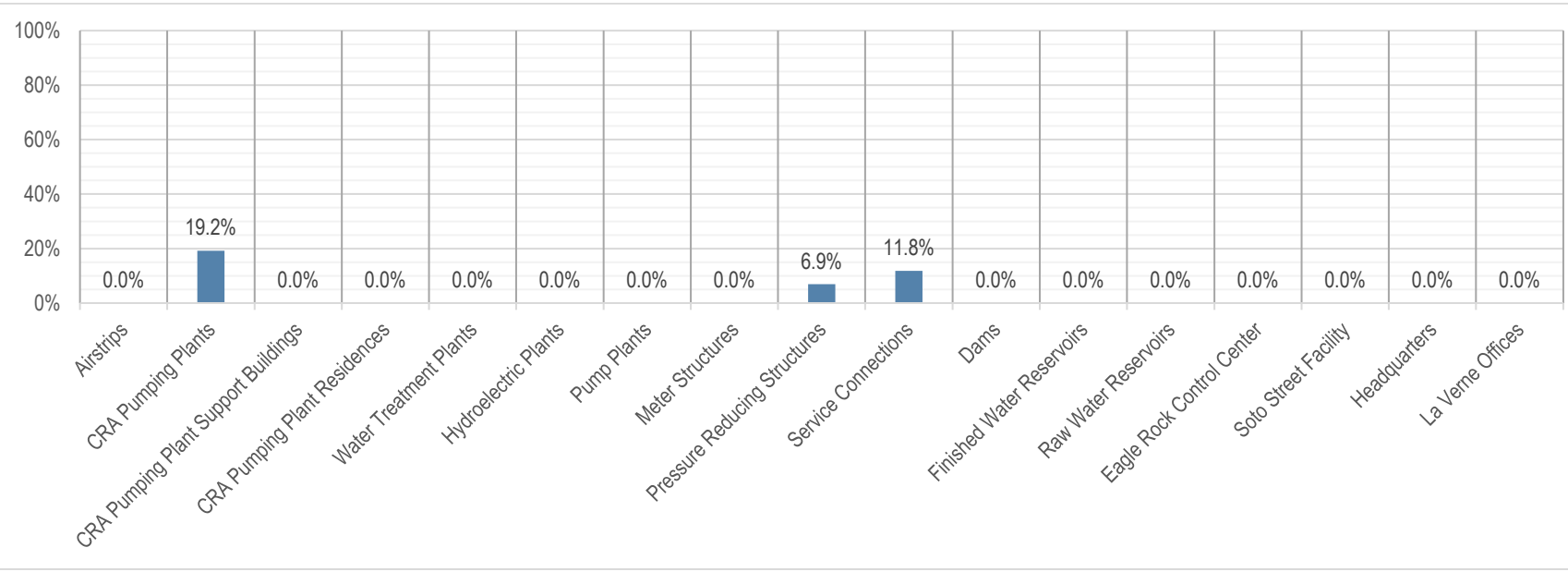
*Only above ground sections are considered for the flood hazard analysis



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

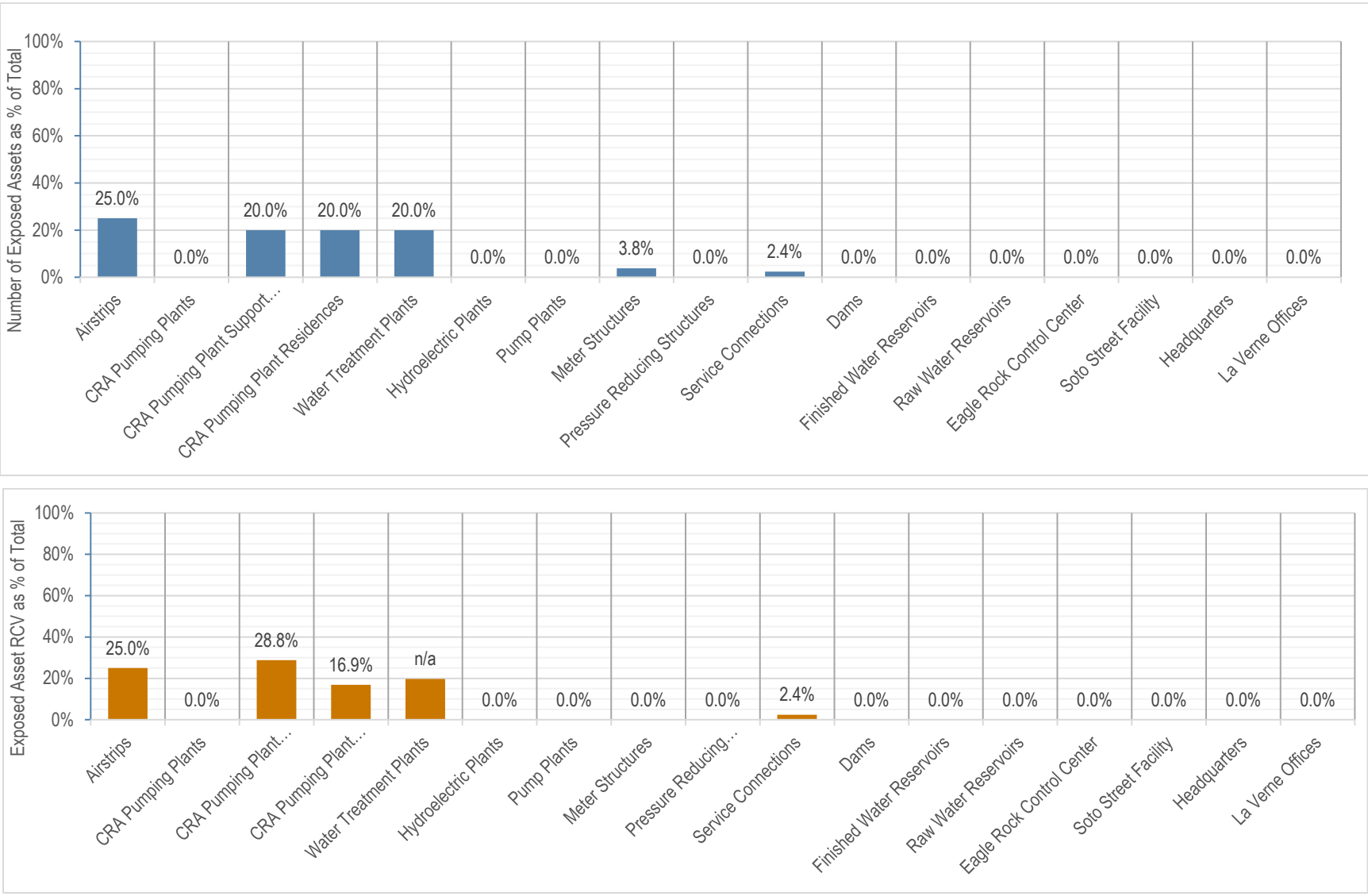
Figure 11-3. Percent of Total Assets (Number and Value) in the 1% Annual Chance Flood Hazard Areas





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

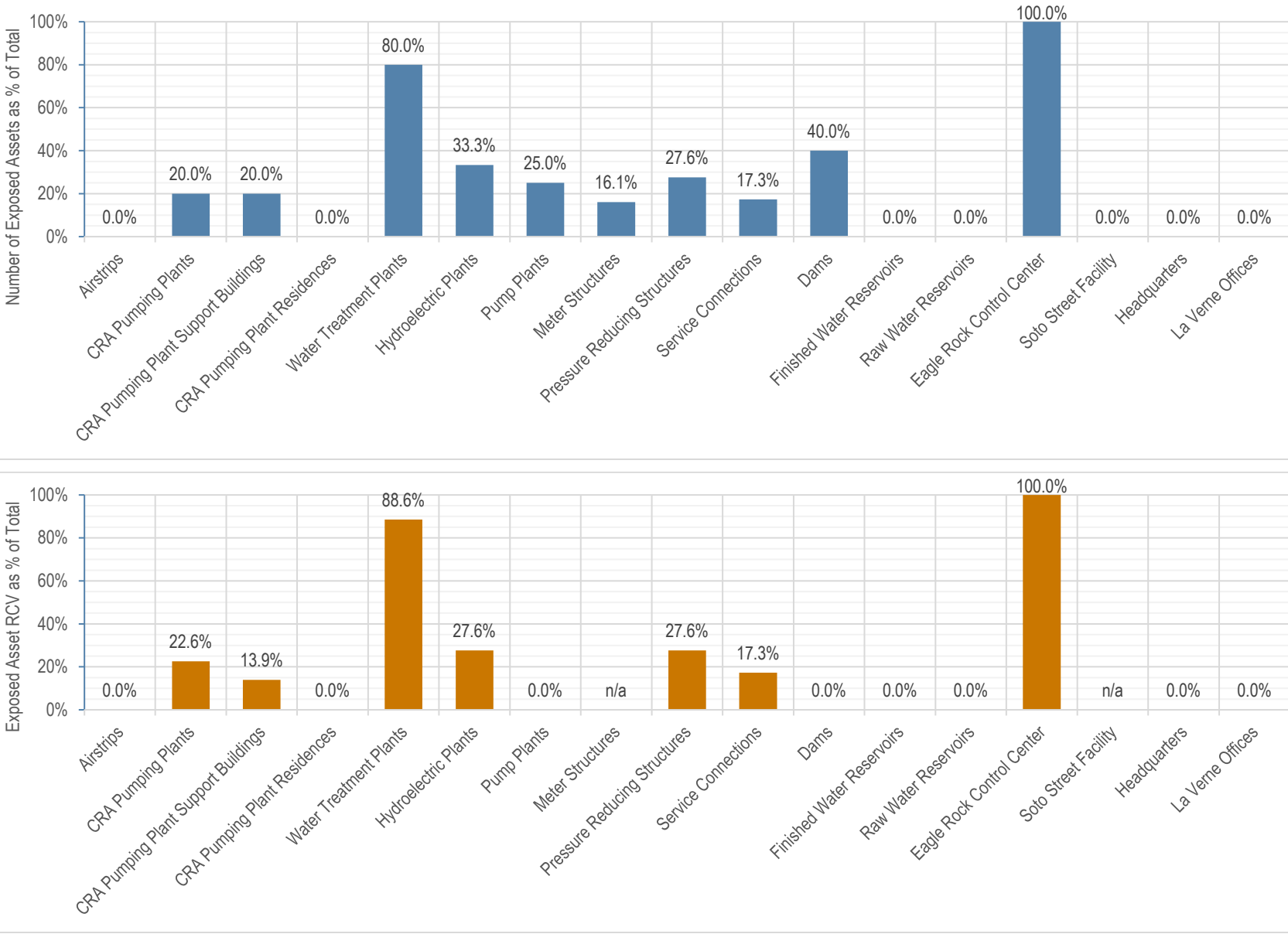
not have land use authority. Metropolitan coordinates with the emergency services agencies in the six counties as they are the lead on providing information for public safety during a major landslide event.

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.

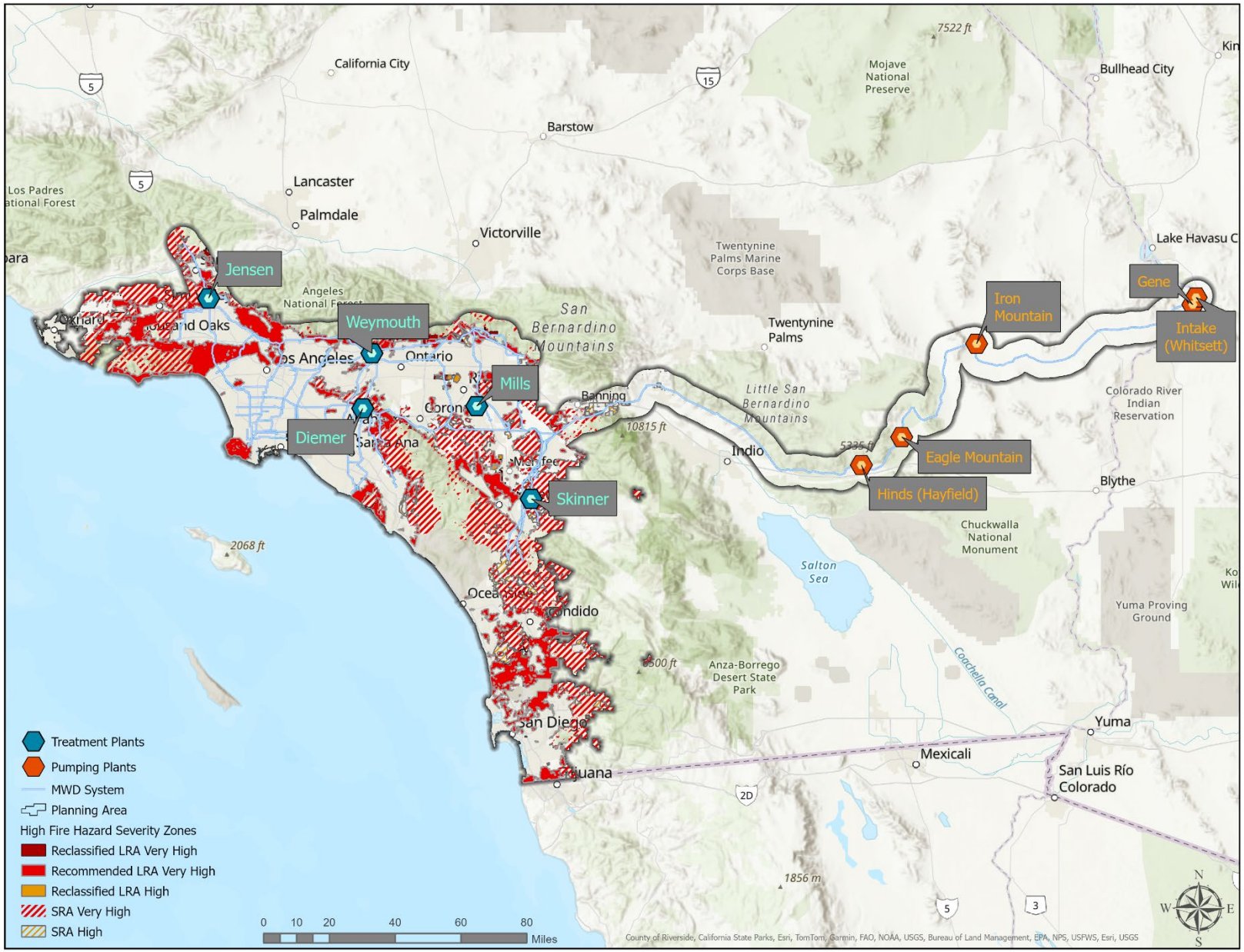


Figure 13-1. Regional Water System - Wildfire Hazard Severity Zones

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.

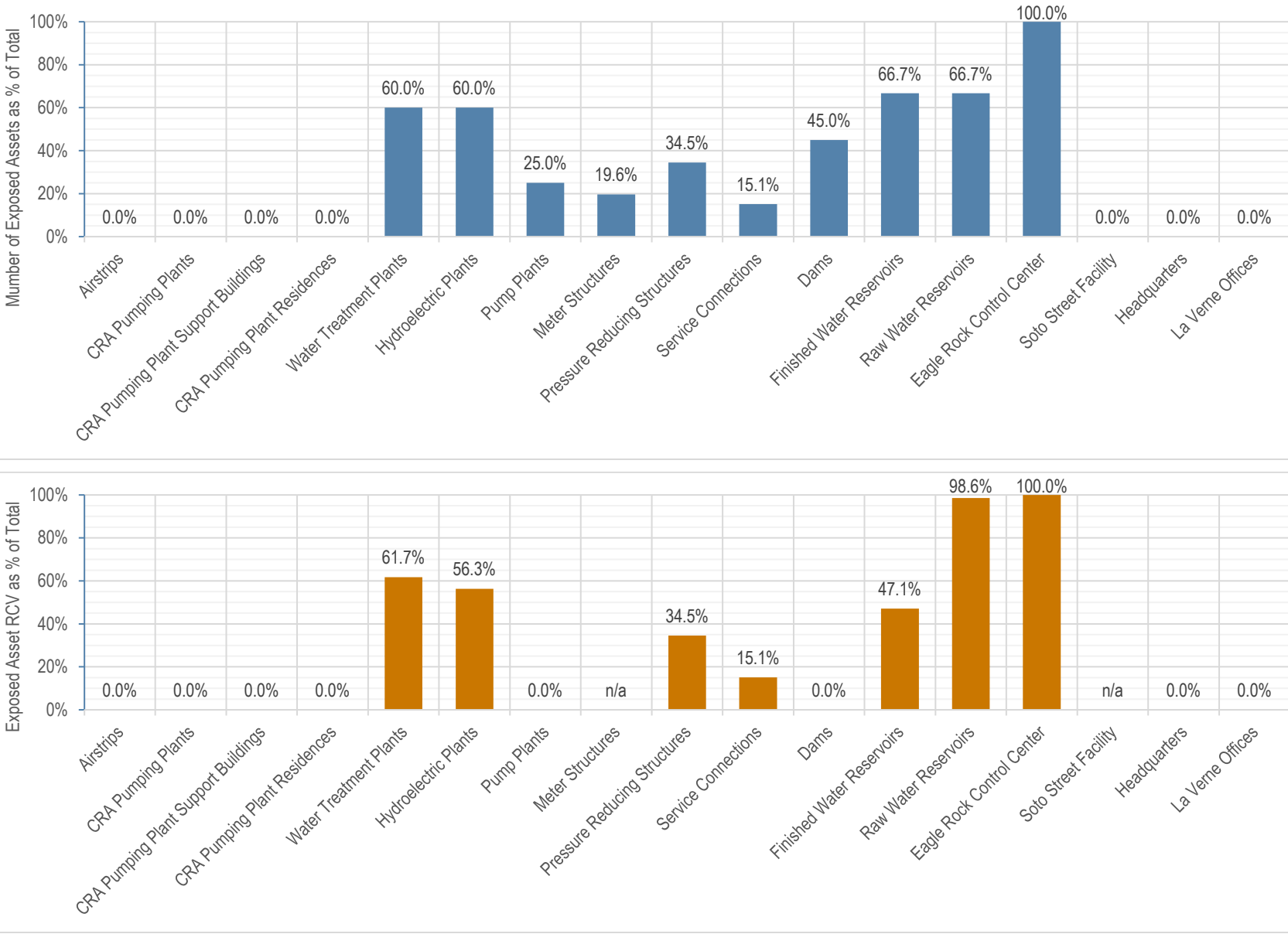
Table 13-2. Metropolitan Non-Linear Assets in the High or Very High Wildfire Hazard Severity Zones

	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.

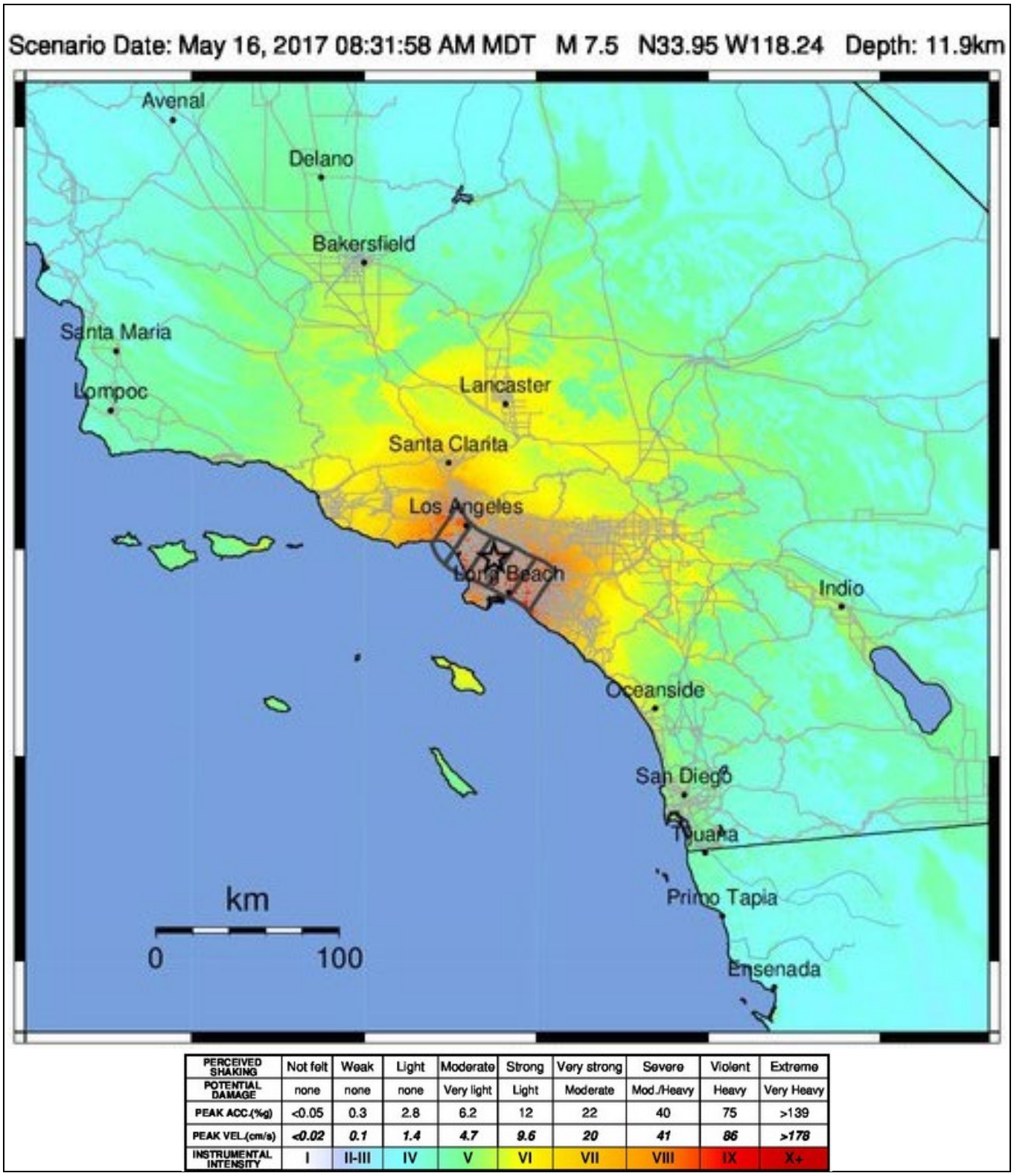
Senate Bill 97: Guidelines for Greenhouse Gas Emissions

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.

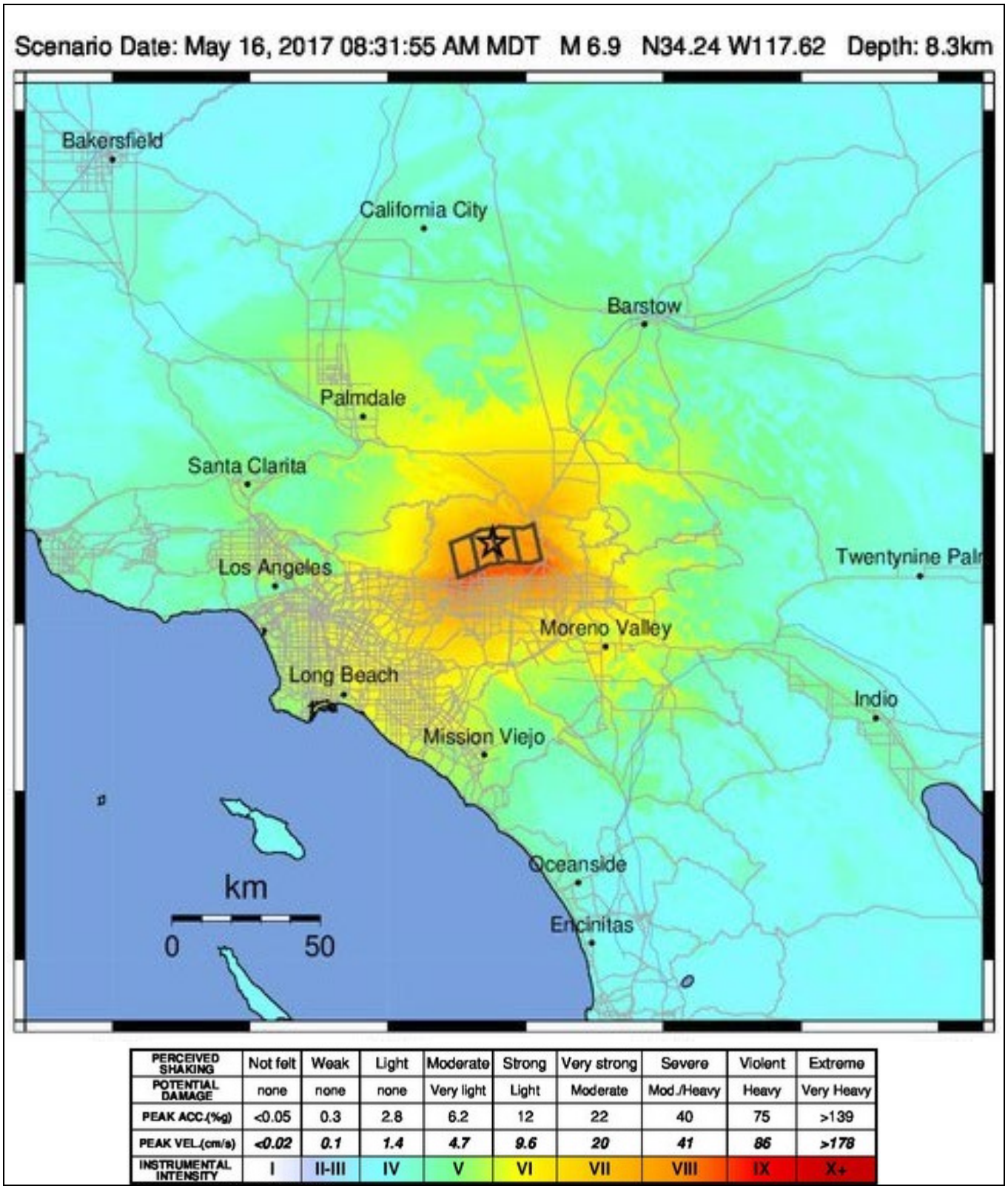
Standardized Emergency Management System

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

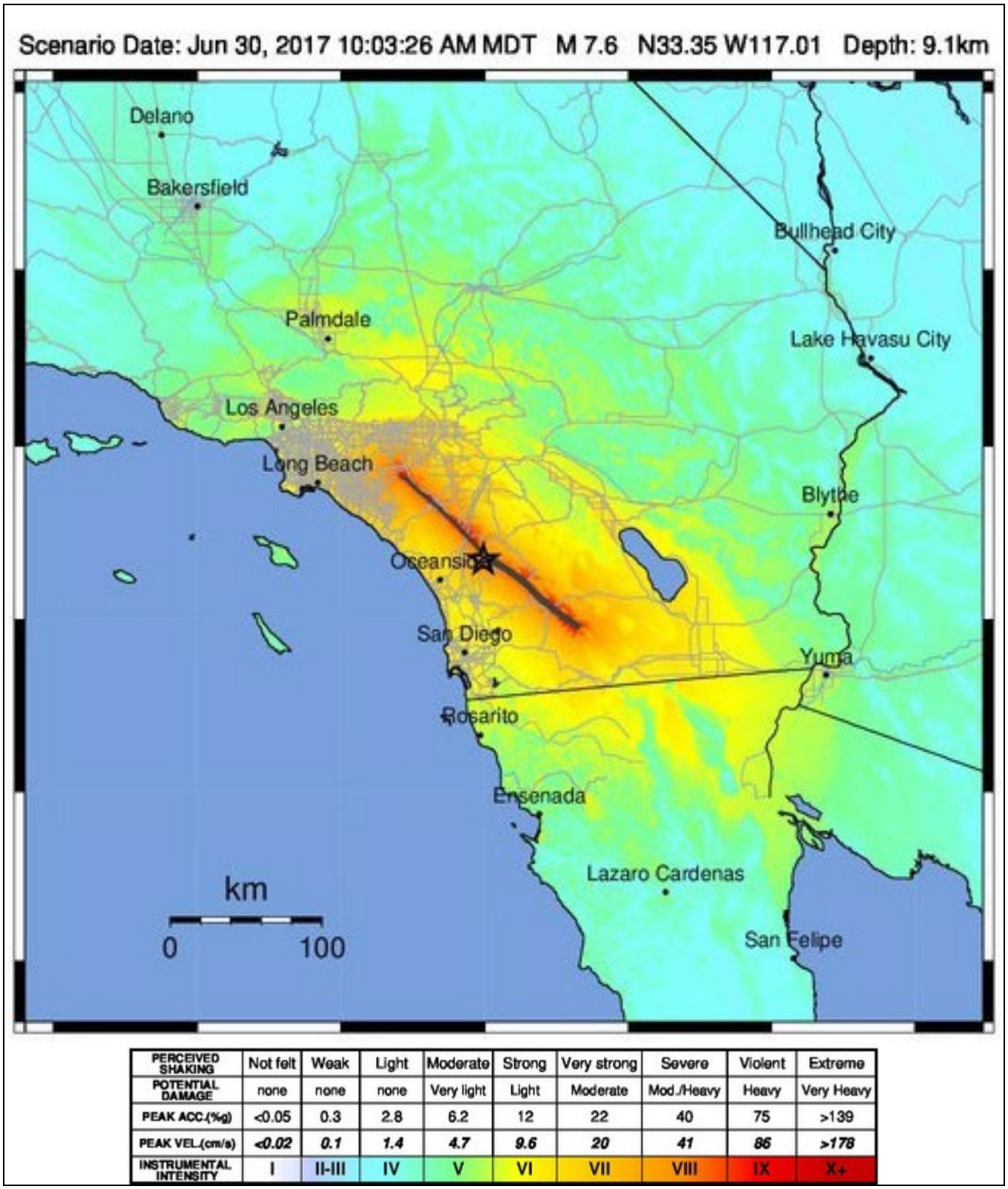


USGS Intensity Mapping for the M7.5 Compton Earthquake Scenario



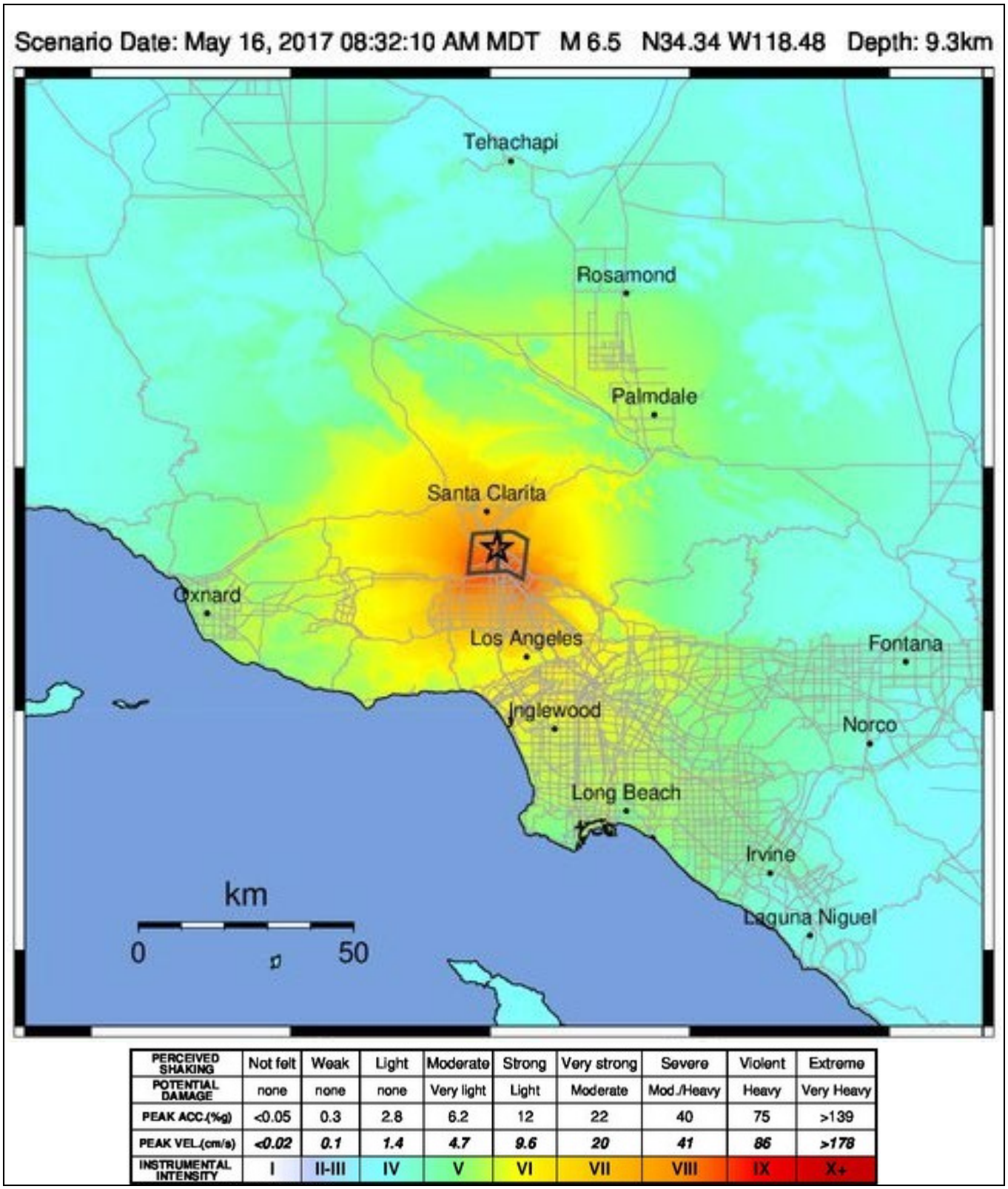
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.9 Cucamonga Earthquake Scenario



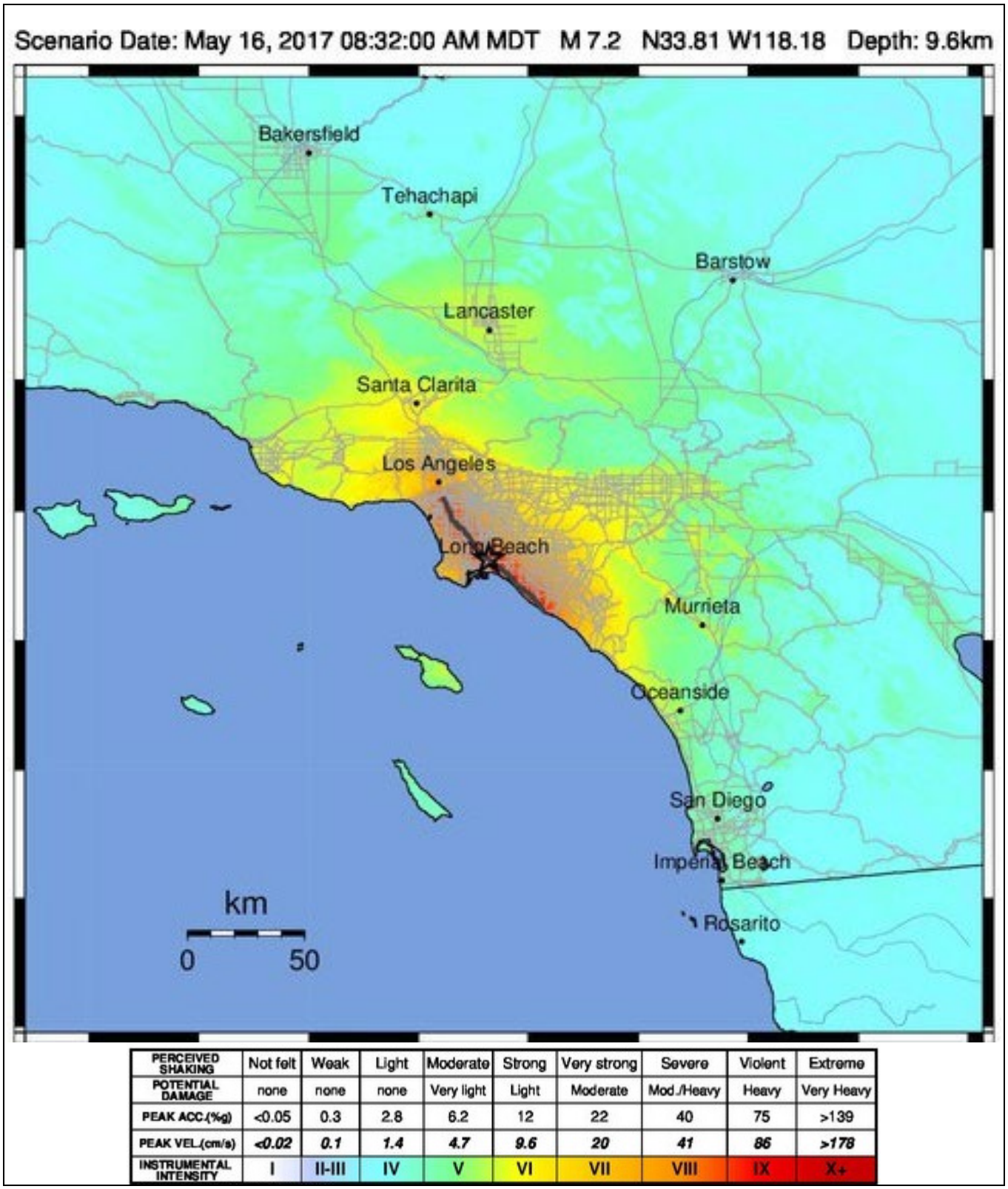
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.6 Elsinore Earthquake Scenario



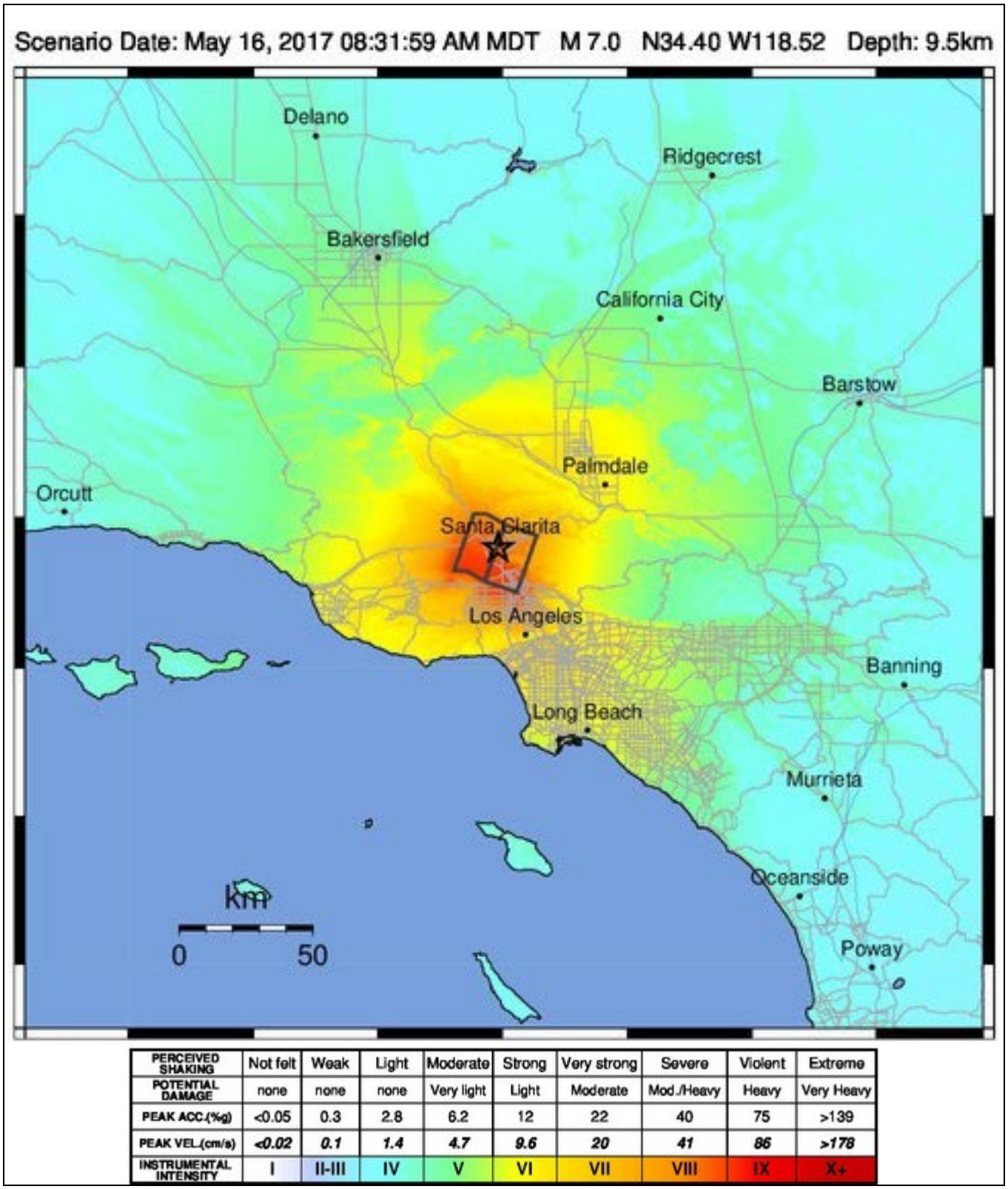
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.5 Mission Hills Earthquake Scenario



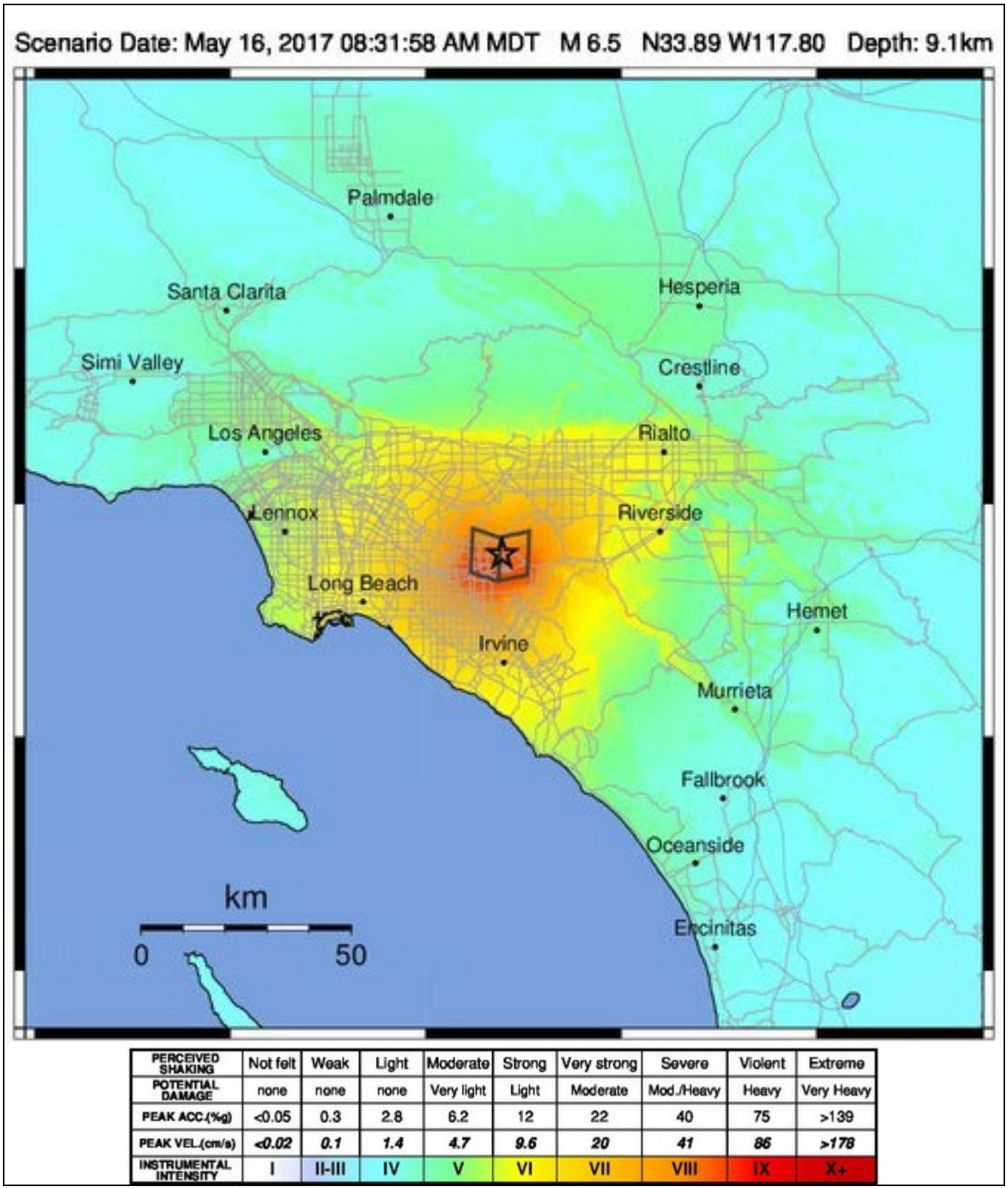
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.2 Newport-Inglewood Earthquake Scenario

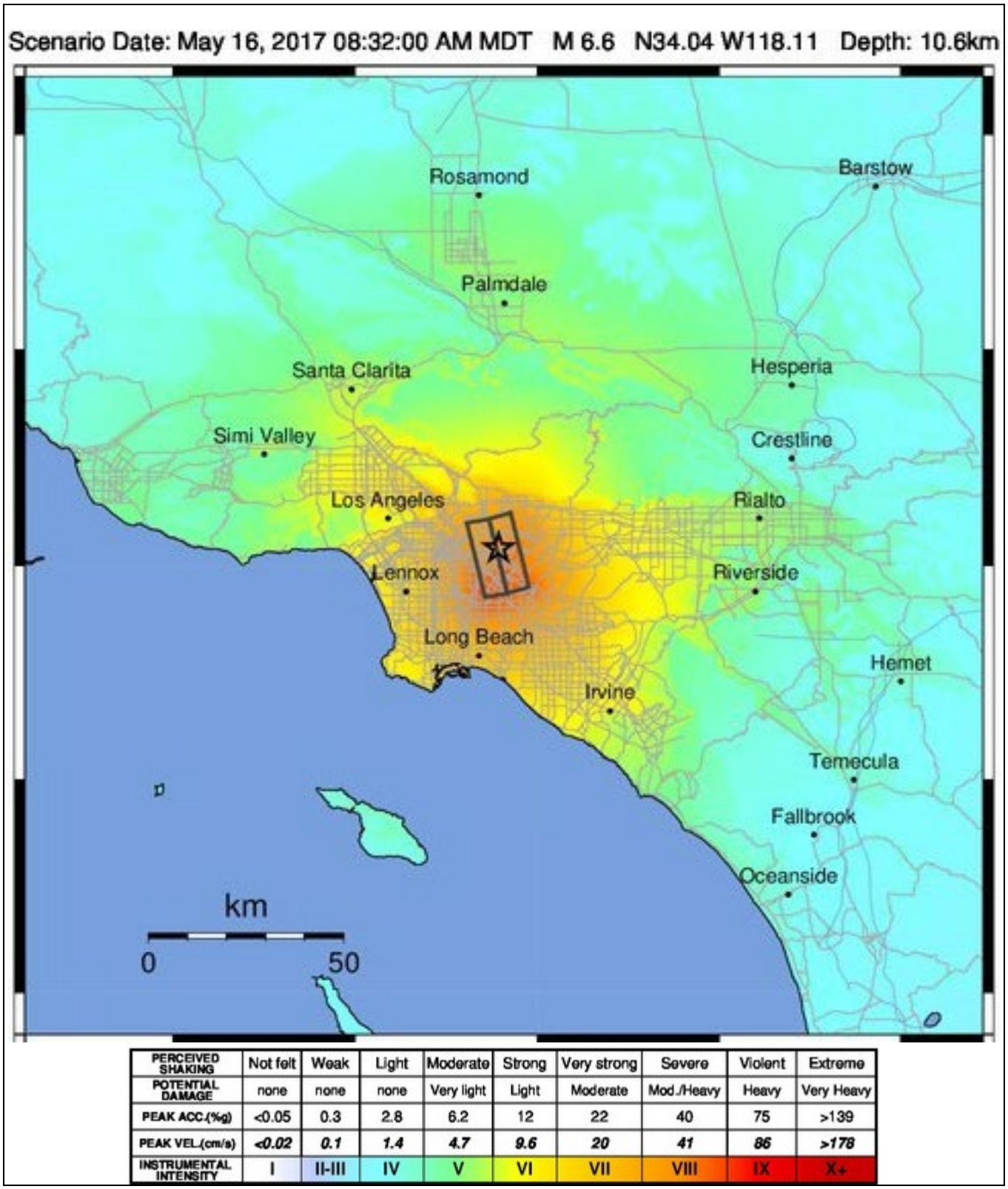


PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.0 Northridge Hills Earthquake Scenario

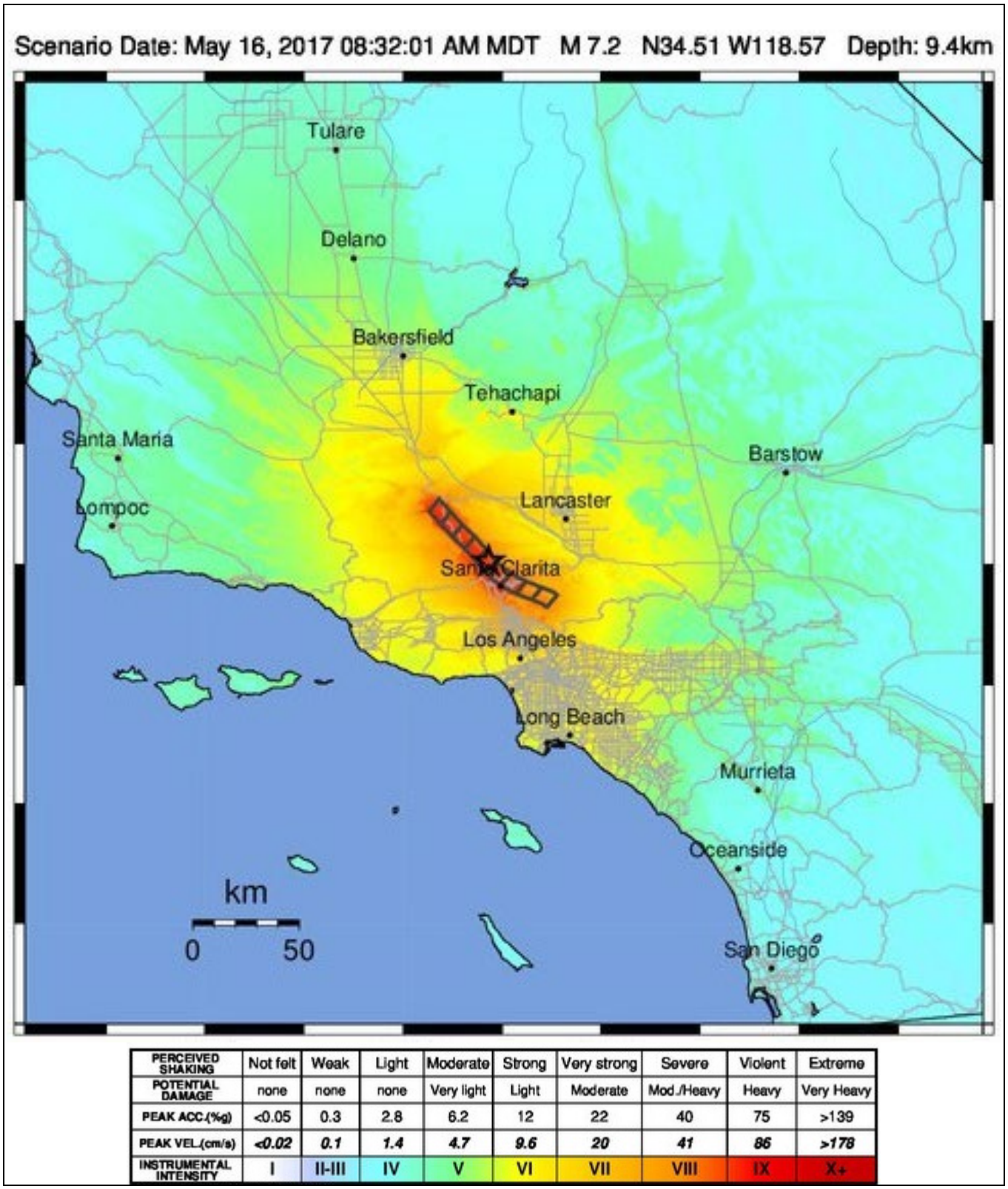


USGS Intensity Mapping for the M6.5 Peralta Hills Earthquake Scenario



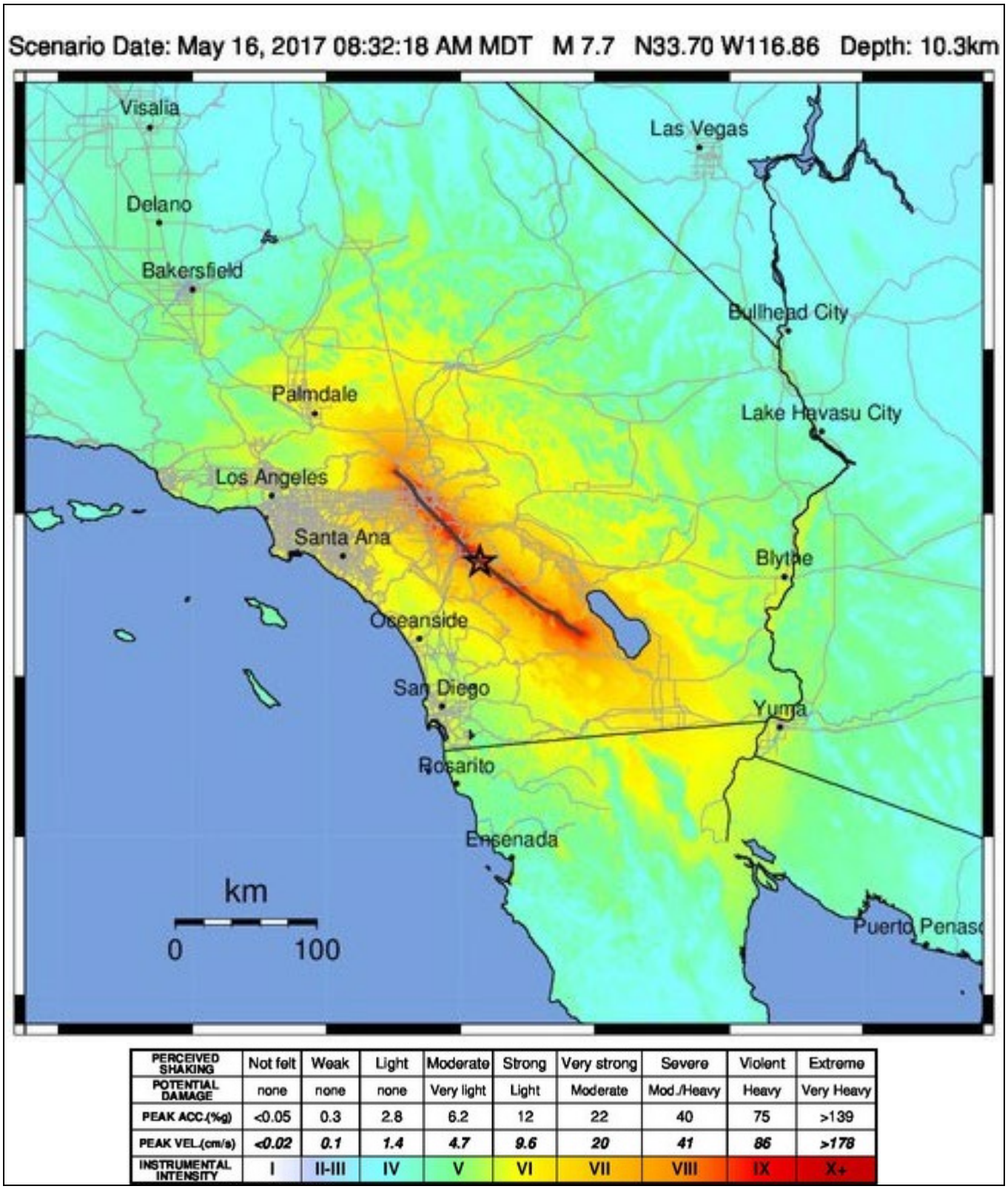
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M6.6 Puente Hills Earthquake Scenario



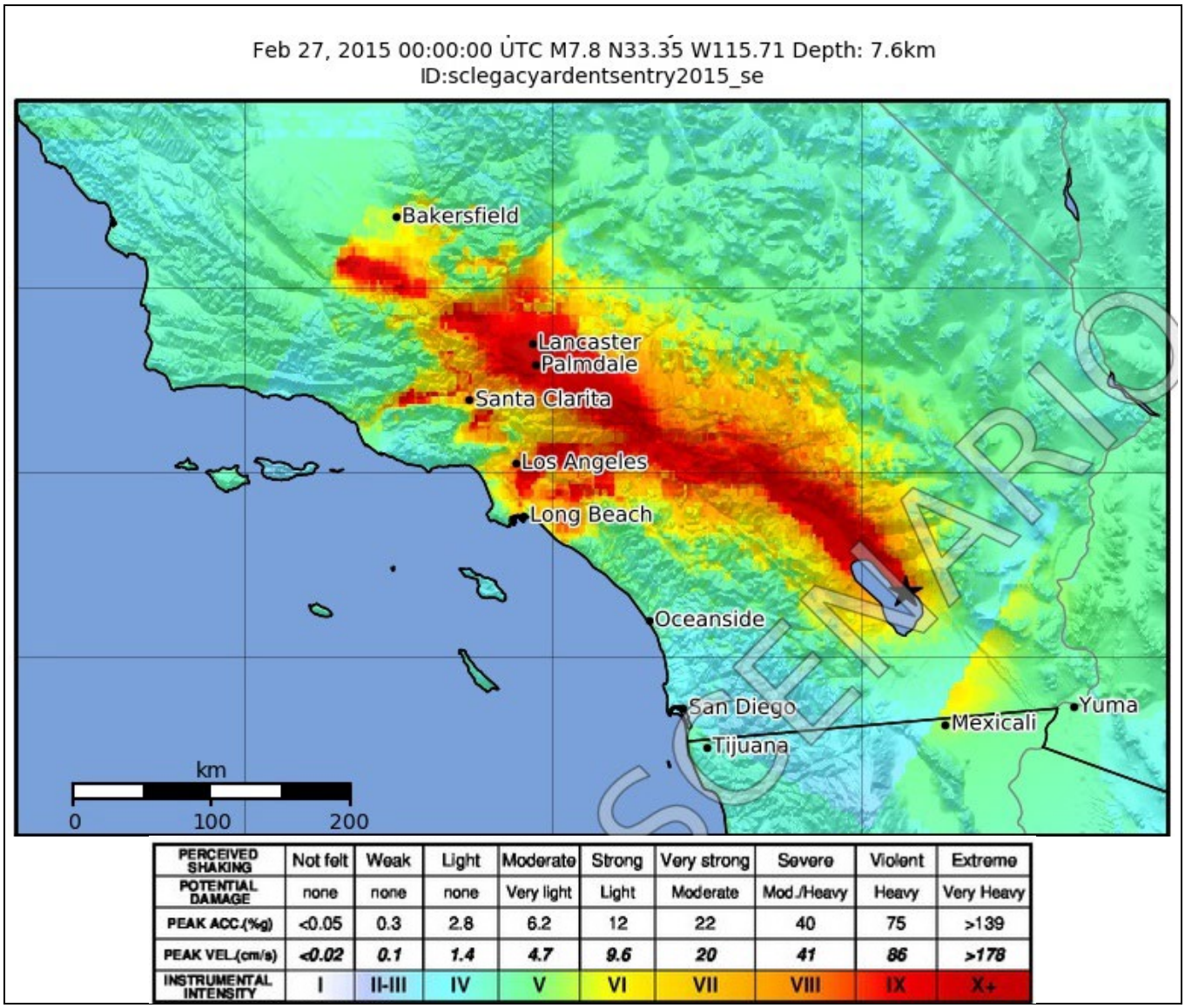
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

USGS Intensity Mapping for the M7.2 San Gabriel Earthquake Scenario



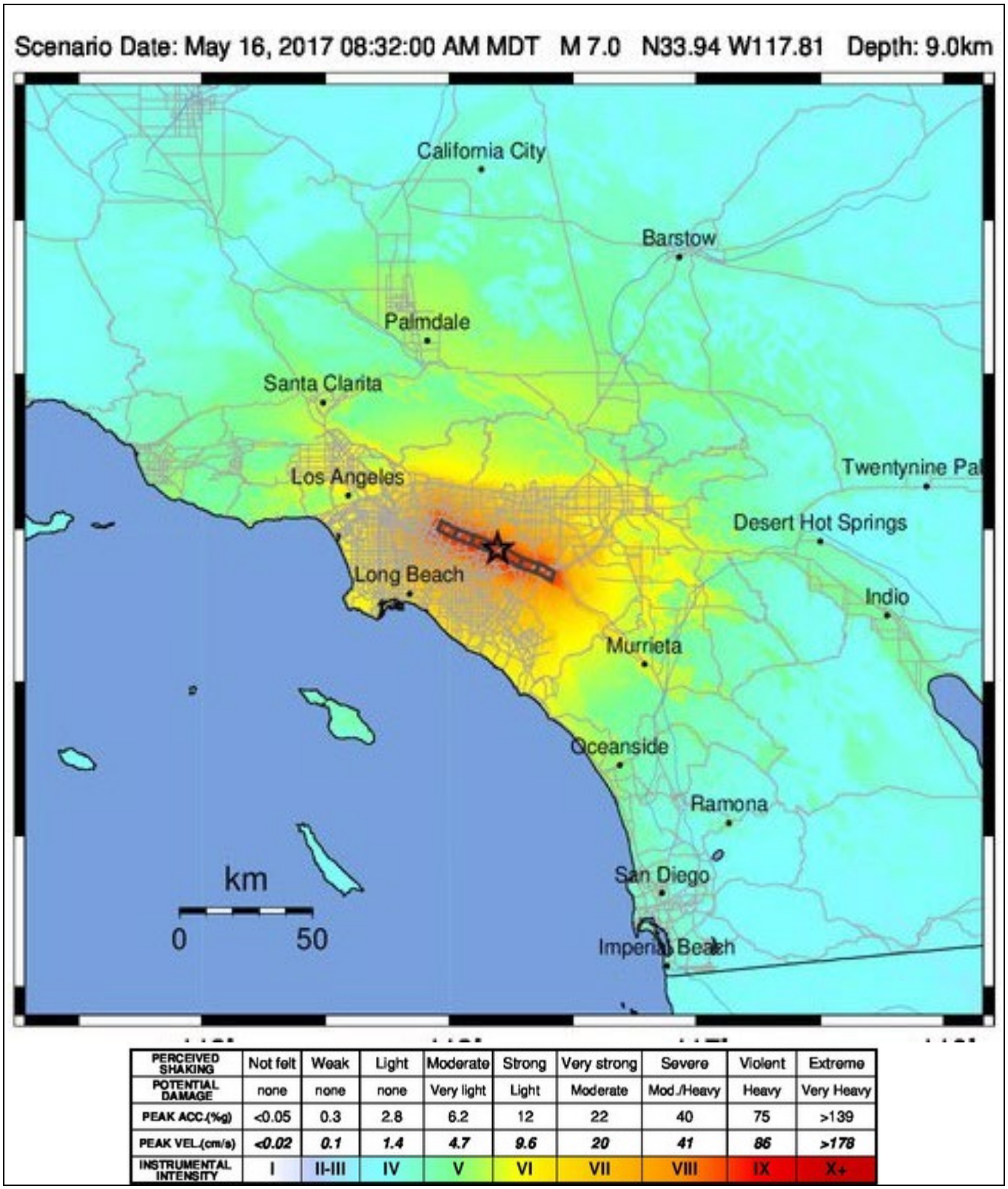
PERCEIVED SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Mod./Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	<0.05	0.3	2.8	6.2	12	22	40	75	>139
PEAK VEL.(cm/s)	*<0.02*	*0.1*	*1.4*	*4.7*	*9.6*	*20*	*41*	*86*	*>178*
INSTRUMENTAL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

DRAFT

Engineering, Operations, and Technology Committee

4/13/2026 Committee Meeting

6c

Subject

Pure Water Southern California Quarterly Update

Executive Summary

Pure Water Southern California (PWSC) continues to make steady progress to advance the environmental planning, engineering studies, Climate Adaptation Master Plan for Water (CAMP4W) assessment, financial analysis, and collaboration with member agencies and program partners to prepare for upcoming board decisions. This report provides updates on various activities and next steps to advance PWSC.

Fiscal Impact

Not applicable

Applicable Policy

Not applicable

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

February 2026 – Certify the PWSC environmental impact report and approve PWSC for California Environmental Quality Act (CEQA) purposes

Mid-2026 – Award equipment procurement contracts to furnish major process equipment for the direct potable reuse demonstration testing facility

Fall 2026 – Consider starting the initial program stage following CAMP4W assessment; and amend program management consulting agreement for AECOM and Brown & Caldwell Joint Venture to support PWSC

Details and Background

Background

PWSC is a large regional recycled water program that will provide a new local source of safe and reliable drinking water for Southern California. PWSC currently focuses on five key areas: program management, environmental planning, planning for an advanced water purification facility (AWPF), demonstration testing, and preliminary design of the initial pipeline reaches. Staff is also engaged in collaboration with member agencies and other program partners to develop agreements for water purchase.

PWSC will produce up to 150 million gallons per day of purified water from the AWPF in Carson for indirect potable reuse (IPR) and direct potable reuse (DPR) applications. The AWPF will purify treated wastewater from the Los Angeles County Sanitation Districts' (Sanitation Districts) A. K. Warren Water Resource Facility using membrane bioreactors (MBRs), reverse osmosis (RO), and ultraviolet/advanced oxidation (UV/AOP). With its expertise in biological wastewater treatment, the Sanitation Districts will be responsible for implementing pretreatment, including the MBR facilities. The PWSC conveyance system consists of the backbone pipeline that would extend approximately 39 miles from the AWPF to the Main San Gabriel Basin, multiple pump stations,

repurposing an existing pipeline, and constructing a new DPR pipeline to convey water from the backbone eastward for raw-water augmentation at Metropolitan's Weymouth plant.

Program Updates

The PWSC team was engaged in the following key activities during this reporting period:

- **Environmental Planning** – In February 2026, the Board certified the final environmental impact report and approved PWSC for CEQA purposes. The notice of determination was also filed with the State's Office of Planning and Research and the County Clerk to initiate a 30-day statute of limitations for legal challenges.
- **Grant Status** – Staff continued coordination and grant reporting efforts with the United States Bureau of Reclamation for the $125,472,855 Large-Scale Water Recycling Program grant and the $5 million WaterSMART Title XVI Planning Grant. Metropolitan has received approximately $25.5 million to date from these grants. The $80 million state appropriation is also used to support the current phase of program work; as of the end of January, approximately $51 million of the state appropriation has been spent.
- **2025 Program Cost Update** – A technical memorandum was prepared (**Attachment 1**), summarizing the updated program cost information presented to the Board in September 2025. It includes the detailed cost estimates for the treatment and conveyance facilities, cash flows for various program staging options, and Metropolitan's response to comments from the City of Anaheim.
- **Demonstration Testing** – Staff continued testing the IPR processes. Five equipment procurement packages were advertised for DPR testing, including membrane filtration/reverse osmosis, UV/AOP, ozone with granular and biological activated carbon, lime stabilization system, and carbon dioxide system. Staff is evaluating the bids received and plans to return to the Board this summer to award one or more of these procurement contracts. Construction and installation are anticipated to commence in 2027. Information from this DPR testing will allow Metropolitan to assess both treated-water augmentation and raw-water augmentation alternatives.
- **DPR Planning** – Staff has conducted a focused DPR study to assess the implementation strategies. Potential options were identified to match system demands, optimize infrastructure requirements, and minimize potential operational impacts. The preliminary findings will be presented at a board workshop currently scheduled for mid-2026.
- **Design Development** – The PWSC Conveyance Facilities Conceptual Design Report for the entire conveyance system has been completed and is available on Metropolitan's public website: https://www.mwdh2o.com/building-local-supplies/pure-water-southern-california/technical-resources/. Preparation of bid documents for the AWPF progressive design builder (PDB) and one or more Construction Manager/General Contractors (CM/GC) for the first two reaches is also underway. Staff would be ready to advertise these packages after the CAMP4W assessments have been completed, if the Board decides to proceed with the design of the initial stage of PWSC.

Upcoming Technical Studies

Several technical studies are underway to address PWSC planning needs, as well as the specific questions previously raised by the Board, including:

- Operating Scenario Analysis
- Envision/LEED Certification Analysis
- DPR Implementation Analysis
- Pump-in Policy Considerations for DPR

Next Steps

The CAMP4W assessment will continue, including assessments of staged program implementation, in parallel with other ongoing PWSC efforts. Subsequent board informational items on PWSC will report on technical studies, the CAMP4W assessment, and responses to board information requests. These activities are designed to provide the key information necessary for the Board to make informed implementation and funding decisions regarding PWSC.

3/24/2026

Mai M. Hattar *Date*
Chief Engineer
Engineering Services

3/24/2026

Shivaji Deshmukh *Date*
General Manager

Attachment 1 – Pure Water Southern California Program 2025 Cost Update Technical Memorandum

Ref# es12709360

Pure Water Southern California

2025 Program Cost Update

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

Prepared for:

The Metropolitan Water District of Southern California
700 North Alameda Street
Los Angeles, CA 90012-2944

Prepared by:

AECOM and Brown & Caldwell, a Joint Venture Program Management Consultant

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Executive Summary

Pure Water Southern California (PWSC) is a proposed partnership between the Metropolitan Water District of Southern California (Metropolitan) and the Los Angeles County Sanitation Districts (Sanitation Districts) to provide a new, high-quality local water source that would be reliable, cost-effective, and climate-change resilient. PWSC would include the Advanced Water Purification Facility (AWPF), owned and operated by Metropolitan, and the Pretreatment and Membrane Bio-Reactors Facility (Pretreatment and MBR), owned and operated by the Sanitation Districts. PWSC would deliver purified water for indirect and direct potable reuse applications.

PWSC program delivery would be developed in two phases—Phase 1 (115 million gallons per day [MGD]) and Phase 2, the ultimate buildout to 150 MGD. In addition, Metropolitan is considering additional staging options as a subset of Phase 1, which would include 45 MGD, 75 MGD, Hybrid 45/75 MGD, and 115 MGD. Both phases, as well as the staging options for Phase 1, are addressed in this document.

Metropolitan's PWSC program management consultant (PMC), a joint venture between AECOM and Brown and Caldwell, has prepared this 2025 Program Cost Update to document the basis for the 2025 revisions to the PWSC cost estimates, which were presented at the Board Workshop on September 23, 2025. This document identifies the project delivery schedules tied to cost estimates and cash flow projections that were used for planning under the potential staging options mentioned above. The revised cost estimates will inform both Metropolitan and the Sanitation Districts for a staging decision, the preparation of AWPF Progressive Design Builders (PDBs) and Conveyance System Construction Manager/General Contractor (CM/GC) procurement process, and capital and operations and maintenance (O&M) budget planning.

This 2025 Baseline Budget establishes program/project delivery schedules, cashflow needs, spending curves, and overall program delivery financial needs for each of the staging options. It also compares prior 2018 and 2023 Baseline Budget estimates for Phase 1 and Phase 2, highlighting cost estimate changes primarily related to inflation, design refinements, materials, supply chain costs, regulatory compliance requirements, and COVID-19 cost impacts.

The cost estimates were reviewed independently by the PMC and benchmarked against historical data, vendor quotes, and comparable large-scale water reuse projects. Sensitivity analyses were performed to account for escalation, market volatility, and scope adjustments.

The cost estimate for Phase 1 reflects an increase from the 2023 estimate, from $4.9 billion to $8.3 billion, and from $5.8 billion to $9.8 billion for the full program build-out (Metropolitan costs only). The key drivers for this cost increase are highlighted below and detailed in later sections of this document.

Key 2025 Cost Increase Drivers

- **Conveyance System:** Costs increased from $1.8 billion to $3.7 billion in Phase 1, primarily related to the higher cost of steel and trenchless operations, as well as to design refinements and adjustments to contractor markups to be consistent across the program.
- **Advanced Water Treatment (AWT):** Costs increased from $0.9 billion to $1.1 billion primarily because of scope refinements, escalation since 2023, materials costs, and market conditions.
- **Indirect Costs, Allowances and Contingencies:** Costs increased from $1.8 billion to $3.4 billion because of an increase in the assets' capital costs and allowances for contingency, program management, and engineering, which are all calculated as percentages of the higher construction costs. In addition, allowances have been included for tariffs and Build America/Buy America Act (BABAA) compliance as a percentage of the total program costs.

Methodology and Assumptions:

The Baseline Budget cost estimates were developed in accordance with Association for the Advancement of Cost Engineering International (AACE) Class 4 and 5 standards, based on the design maturity level of each asset (AWT, Pretreatment/MBR, Conveyance System, and Recharge Facilities). The conceptual design efforts to date for each asset resulted in setting the AWT's maturity level between 10 and 12 percent, and the conveyance system's maturity level between 5 and 10 percent. This resulted in a 30 percent contingency used for AWT and Conveyance Reaches 1 and 2 (R1 and R2) and a 35 percent contingency for the Pretreatment/MBR, Conveyance Reaches 3–8 (R3–R8), and Recharge Facilities. The 2025 Baseline Budget was calculated using the PWSC Asset's Costing Accuracy Ranges, adjusting previous cost estimates that were performed in 2023 and 2022, using the Construction Cost Index for the City of Los Angeles to 2025 dollars, and adding allowances (25 percent for engineering, construction management, and indirect costs; and 5 percent for program management [a typical range is 5 to 15 percent]).

Additional costs were factored in for BABAA and regulatory compliance requirements under federal, State, and local guidelines. However, Metropolitan may be able to apply for a BABAA waiver for specialized equipment primarily manufactured outside the United States, including much of the Pretreatment/MBR, Ultraviolet (UV), Ozone, and other specialty process equipment. If appropriate, this waiver application would be completed by the AWPF PDBs and Conveyance System CM/GCs, because the waivers would be design-specific and typically would take up to a year or more to be approved. Any cost reductions because of BABAA waiver approval would be reflected in the Guaranteed Maximum Price proposals.

Capital Cost Development

The 2025 Baseline Budget capital cost modeling that was used to develop delivery schedules, cash flows, and spending curves incorporated new bottom-up engineering conceptual construction cost estimates, prepared by the conveyance conceptual design consultant for the entire PWSC Conveyance System. For the AWT, the 2023 construction cost estimate, previously prepared by the AWT conceptual design consultant based on the Conceptual Facilities Plan, was escalated to 2025 dollars, based on the construction cost index for the City of Los Angeles, which is the basis for the updated 2025 Baseline Budget. The cost model built on and validated changed and unchanged AWT design and scope elements, using peer installations, current cost estimating manuals, and actual built construction data. A summary of the design criteria, cost estimation responsibilities, and methodologies that were applied across major program components is shown in Table ES-1.

O&M Cost Development

AWPF O&M costs include power, chemical, maintenance, and consumables; equipment replacement; labor; and other costs. The O&M costs were prepared in collaboration with the Sanitation Districts and are summarized in the *Updated Opinion of Probable Cost for the Nitrification-Denitrification Tertiary MBR Base Advanced Water Treatment Facility* (Stantec 2022). The updated O&M estimates were prepared by escalating the previous estimates to May 2025 dollars.

The conveyance facilities O&M costs include labor, maintenance and repair, and energy costs for the pump stations. The updated O&M estimates were prepared by the conveyance conceptual design consultant, who escalated the previous estimates from June 2022 to May 2025 dollars, as the O&M cost assumptions remained generally unchanged since the previous estimate.

Phase 1 Staging Options

Detailed capital and O&M cost estimates are presented for each of the four staging options for Phase 1—45 MGD, 75 MGD, Hybrid 45/75 MGD, and 115 MGD, as well as for Phase 2—150 MGD full build-out. Metropolitan's capital costs would range from $2.88 billion for 45 MGD to $9.84 billion for 150 MGD, with annual O&M costs ranging from $89 million to $245 million. Construction completion dates range from 2035 to 2041.

Phase 1 (115 MGD) Cash Flow and Schedule

For Phase 1 (115 MGD), peak annual expenditures of $1.6 to $1.7 billion are anticipated during the major construction phases for combined assets, which is estimated between Fiscal Year (FY) 2031/2032 and FY 2033/2034. The cumulative cost is estimated to be $8.3 billion by 2036 for Phase 1 (115 MGD) and $9.8 billion by 2041 for Phase 2 (150 MGD)—Metropolitan cost only. The schedule incorporates phased delivery strategies, risk float allowances, and critical dependencies, such as the availability of conveyance service connections, the power infrastructure, and regulatory approvals.

Table ES-1 summarizes the PWSC Program costs under various phasing/staging options in 2025 dollars. The table consolidates capital cost and total program cost by agency, Metropolitan's annual O&M cost, and project completion milestones.

Table ES-1: PWSC Staged Program Cost Summary

Phasing/Staging Option	Metropolitan Capital Cost ($M)	Sanitation Districts Capital Cost ($M)	Total Program Cost ($M)	Metropolitan Annual O&M Cost ($M)	Planned Completion Year
45 MGD	2,881	697	3,578	89	2035
75 MGD	7,139	962	8,101	125	2036
Hybrid 45/75 MGD	7,455	1,109	8,711	125	2037
115 MGD	8,311	1,085	9,396	167	2036
150 MGD	9,841	1,474	11,315	245	2041

The PMC also conducted a high-level cost comparison of PWSC and the Groundwater Replenishment System, built and operated by the Orange County Water District. The summary of this comparison is summarized in Section 1.5.4 and **Appendix E**.

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Key Acronyms and Abbreviations

AACE	Association for the Advancement of Cost Engineering International
AWPF	Advanced Water Purification Facility
AWT	Advanced Water Treatment
BABAA	Build America/Buy America Act
BIM	Building Information Modeling
CCI-LA	Construction Cost Index for the City of Los Angeles
CM/GC	Construction Manager/General Contractor
DPR	direct potable reuse
FY	Fiscal Year
GWRS	Groundwater Replenishment System
IPR	indirect potable reuse
kWh	kilowatt-hour
LADWP	Los Angeles Department of Water and Power
MBR	Membrane Bioreactor
Metropolitan	Metropolitan Water District of Southern California
MGD	million gallons per day
O&M	operation and maintenance
OCWD	Orange County Water District
PDB	Progress Design Build
PM/CM	project management/construction management
PMC	Program Management Consultant
PMIS	Program Management Information System
PWSC	Pure Water Southern California
R1-R8	Conveyance Reaches 1 through 8
RWA	raw water augmentation
Sanitation Districts	Los Angeles County Sanitation Districts
SCE	Southern California Edison
SGVMWD	San Gabriel Valley Municipal Water District
UV	Ultraviolet
Warren Facility	A. K. Warren Water Resource Facility

1. Introduction

Pure Water Southern California (PWSC) is a proposed partnership between the Metropolitan Water District of Southern California (Metropolitan) and the Los Angeles County Sanitation Districts (Sanitation Districts) to provide a new, high-quality local water source that would be reliable, cost-effective, and climate-change resilient. PWSC would include the Advanced Water Purification Facility (AWPF), owned and operated by Metropolitan, and the Pretreatment and Membrane Bio-Reactors (MBRs) facility, owned and operated by the Sanitation Districts. PWSC would deliver purified water for indirect potable reuse (IPR) and direct potable reuse (DPR) applications.

PWSC program delivery would be developed two phases—Phase 1 (115 million gallons per day [MGD]), and Phase 2, the ultimate buildout to 150 MGD. Both phases, as well as the staging options for Phase 1, are discussed in this document.

1.1 Purpose of this Program Cost Update

The purpose of the 2025 Program Cost Update is to document the basis and provide complementary background information for the PWSC Cost Update, presented to Metropolitan's Board on September 23, 2025. This document defines the delivery schedules tied to cost estimates and cash flow projections that were used for various AWPF and conveyance system staging options. This document conveys and enhances the presentation's information, highlighting the following:

- General cost estimate methodology and approach
- Cost parameters and assumptions that were used to develop the 2025 cost estimates
- Basis for the 2025 construction and O&M costs
- Implementation schedule for each phase/staging option
- Cash flow projections for each phase/staging option
- Appendices with supporting unit cost information and calculations
- Comparison of program costs between PWSC and the Groundwater Replenishment System (GWRS), built and operated by the Orange County Water District (OCWD)

A detailed summary of the PWSC program costs and backup information are provided in the appendices for the AWPF and conveyance system facilities. Cost breakdowns are provided for both Metropolitan and the Sanitation Districts.

This document also provides a comparative analysis of the 2023 and 2025 cost estimates, highlighting the principal variances and the underlying drivers of those changes.

1.2 Program Background

PWSC would include planning, design, and construction of facility improvements; an AWPF at the Sanitation Districts' A.K. Warren Water Resource Facility (Warren Facility) in Carson, California; an approximately 39-mile new conveyance backbone pipeline; multiple pump stations; connections to member agency systems or recharge facilities in three regional groundwater basins; and a 25 MGD satellite treatment facility for DPR via raw water augmentation (RWA). Phase 2 (150 MGD) would provide an additional 35 MGD of DPR via the RWA facility at Weymouth. For the 2025 cost estimate, the backbone pipeline is assumed to be 84 inches in diameter (reduced to 48 inches in diameter between the Santa Fe Pump Station and Canyon Spreading Grounds) and is divided into eight reaches.

The AWPF would include Membrane Bioreactor (MBR) processes operated by the Sanitation Districts and Advanced Water Treatment (AWT) processes operated by Metropolitan. The conveyance facilities would be owned and operated by Metropolitan, with the exceptions of member agency laterals and other infrastructure downstream from the service connections.

Figure 1 shows the following Phase 1 components:

- **Sanitation Districts' Pretreatment and MBR Facility:** Upgrades to the Warren Facility by the Sanitation Districts, including construction of a side-stream centrate treatment system and high-purity oxygen low-efficiency modifications to reduce the nitrogen load going into the AWPF. Construction of the MBR facility by Sanitation Districts.
- **Advanced Water Treatment Facility:** Construction of AWT facility infrastructure by Metropolitan at the Warren Facility (including the product water clearwell and pump station), and a 25 MGD satellite DPR treatment facility at Metropolitan's Weymouth Plant for RWA, using ultraviolet disinfection and chlorine dioxide processes to meet regulatory requirements for less than 10 percent blending (would include ancillary facilities to support AWT operations, including operation, administration, and electrical buildings, a laboratory, a warehouse, parking, EV facilities, outreach facilities, battery storage, tour galleries, a visitor center, street beautification, a demonstration garden, and a workforce training center)
- **Conveyance System:** Construction of a 39-mile conveyance backbone pipeline from the AWPF to the Main San Gabriel Basin, repurposing the existing 30-inch-diameter Azusa pipeline to convey up to 25 MGD from the backbone pipeline east to Metropolitan's Weymouth facility for RWA, as well as four pump stations, and nine service connections
- **Recharge Facilities:** Connections to partner systems or recharge facilities across three regional groundwater basins

Additional facilities to be added for Phase 2 would consist of the following:

- Expansion of pretreatment and treatment facilities at the AWPF with an additional 35 MGD capacity, for a total capacity of 150 MGD
- Construction of a 60 MGD satellite DPR facility at Metropolitan's Weymouth facility for RWA, using ozone and biological activated carbon and ultraviolet disinfection processes to meet regulatory requirements for greater than 10 percent blending
- Construction of a new 54-inch-diameter DPR pipeline to convey 60 MGD from the backbone pipeline east to Metropolitan's Weymouth facility for RWA and one additional pump station (the cost estimate assumes that the Azusa pipeline no longer would be used in Phase 2)

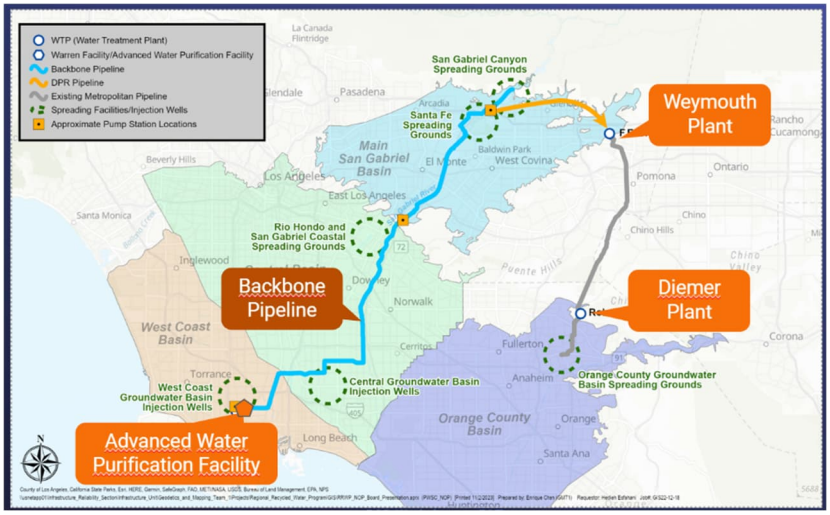


Figure 1: PWSC Facilities

1.3 Methodology/Approach

The 2025 cost estimates were developed using a structured, multi-step approach for accuracy, transparency, and alignment with industry standards (**Table 1**).

Table 1: Methodology and Approach by Asset Type

Program Component	Design Criteria Developed By	Cost Estimate Prepared By	Methodology/Approach
Advanced Water Treatment (AWT)	Stantec (2023)	Stantec	Updated cost estimates using May 2025 cost data, based on refined design criteria. For project scope and design criteria that remained unchanged, an inflation factor of 8.4% was used to escalate cost estimates from December 2023 to May 2025.
Pretreatment/Membrane Bioreactor (MBR)	Stantec/ Jacobs (2023)	PMC (AECOM/BC)	Updated cost estimates using May 2025 cost data, based on refined design criteria. For project scope and design criteria that remained unchanged, an inflation factor of 8.4% was used to escalate cost estimates from December 2023 to May 2025.
Direct Potable Reuse (DPR) Satellite Facility (Weymouth)	Stantec (2023)	PMC (AECOM/BC)	Updated cost estimates for DPR treatment infrastructure; applied escalation and allowances for regulatory compliance
Conveyance Facilities	Black & Veatch (2025)	Black & Veatch	A bottom-up construction cost estimate was developed by Black & Veatch for the entire conveyance system, for both phases of the program. An inflation factor of 18.4% was used to escalate previous O&M cost estimates from June 2022 to May 2025, because the O&M assumptions remained generally unchanged.
Recharge and Local Facilities	Metropolitan (2025)	PMC (AECOM/BC) and Metropolitan	The cost estimate was calculated using updated unit rates that were indexed to May 2025 dollars, applied to the projected laterals length.
Real Property, Environmental, and Community Benefits	Metropolitan (2025)	PMC (AECOM/BC) and Metropolitan	Escalated to May 2025

Basis of Estimates

All detailed cost estimates and basis of estimates for the AWT and conveyances system, prepared by conceptual design consultants Stantec and Black & Veatch, respectively, are attached as appendices to this document.

Cost Parameters and Assumptions

Some of the basic assumptions included the percentage allowances to be used for program management (5%) and design project management/construction management (PM/CM) (25%). A program contingency of 30% to 35% was included to cover unknowns.

Additional allowances to meet Build America/Buy America Act (BABAA) requirements, tariff allowances, and community benefit commitments also are included. However, Metropolitan may be able to apply for a BABAA waiver for specialized equipment that primarily is manufactured outside the U.S., including much of the pretreatment/MBRs, ultraviolet, ozone, and other specialty process equipment. If appropriate, this waiver application would be completed by the AWPF progressive design-builds and Conveyance System Construction Manager/General Contractors (CM/GCs), because the waivers would be design-specific and typically would take up to a year or more to be approved. Any cost reductions because of BABAA waiver approval would be reflected in the Guaranteed Maximum Price proposals.

The cost estimates were developed in accordance with the Cost Estimate Classification System, established by the Association for the Advancement of Cost Engineering International (AACE), which served as the guiding framework. **Table 2**Error! Reference source not found. shows the cost estimation classification matrix for process industries.

The classification of the cost estimate update varied, depending on the level of design maturity. Components that would have a greater level of project definition were considered a Class 4 estimate, while components that would have lower levels of project definition were considered a Class 5 estimate. Class 4 estimates would have a level of accuracy of 30% to +50%, while Class 5 estimates would have a level of accuracy of -50% to +100%. The classification levels are as defined by the AACE.

As the PWSC program becomes more defined, contingencies likely would be reduced, and the range of accuracy would narrow. For example, with Reaches 1 and 2 further along in preliminary design, Metropolitan and the project management consultant applied a contingency of 30% to these reaches, while a contingency of 35% was maintained for the remaining reaches, which were evaluated at a conceptual design level only.

Table 2: Cost Estimate Classification Matrix for Process Industries

	Primary Characteristic	Secondary Characteristic		
Estimate Class	**Maturity Level of Project Definition Deliverables** *Expressed as % of complete definition*	**End Usage** *Typical purpose of estimate*	**Methodology** *Typical estimating method*	**Expected Accuracy Range** *Typical variation in low and high ranges at an 80% confidence interval*
Class 5	0% to 2%	Concept screening	Capacity factored, parametric models, judgment, or analogy	L: -20% to -50% H: +30% to +100%
Class 4	1% to 15%	Study or feasibility	Equipment factored or parametric models	L: -15% to -30% H: +20% to +50%
Class 3	10% to 40%	Budget authorization or control	Semi-detailed unit costs with assembly level line items	L: -10% to -20% H: +10% to +30%
Class 2	30% to 75%	Control or bid/tender	Detailed unit cost with forced detailed take-off	L: -5% to -15% H: +5% to +20%
Class 1	65% to 100%	Check estimate or bid/tender	Detailed unit cost with detailed take-off	L: -3% to -10% H: +3% to +15%

The estimates incorporated the key elements that are discussed next.

Conceptual Design Basis

Each major program component—AWPF, conveyance system, and recharge facilities—was advanced to a conceptual design level by specialized engineering firms. These design criteria served as the foundation for cost development and were validated by the program management consultant.

Estimates were prepared in accordance with the AACE guidelines, primarily at the Class 4 level (accuracy range of 30% to +50%), with some less-defined scope items at the Class 5 level (accuracy range of 50% to +100%), as shown in **Figure 2**.

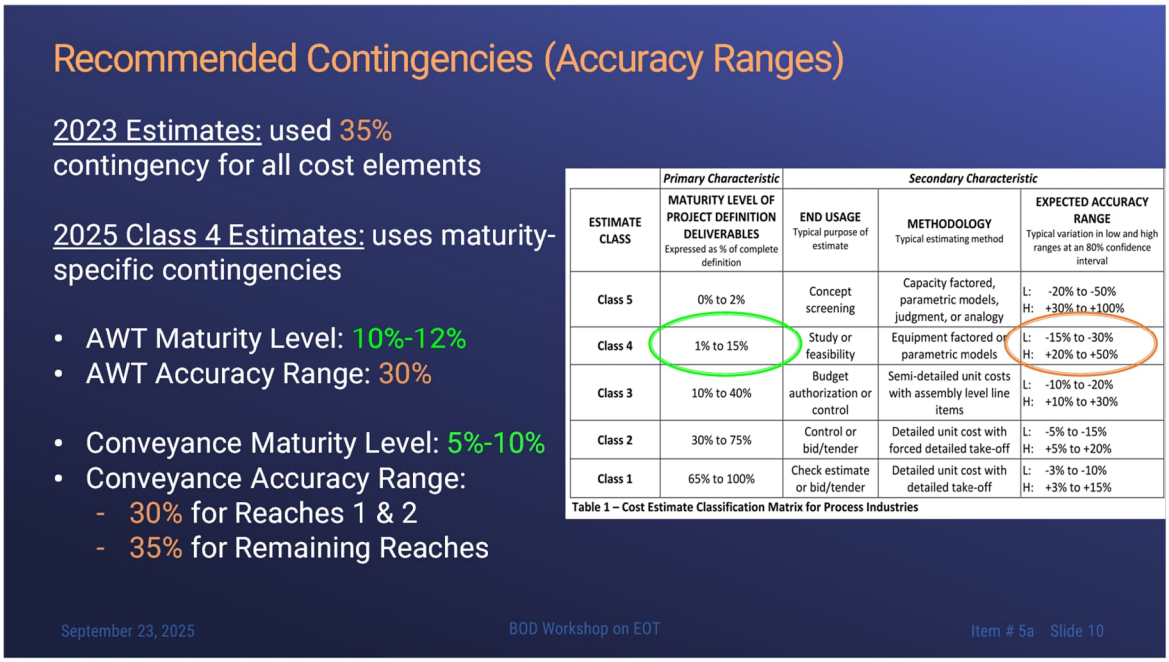


Figure 2: Recommended Estimate Contingencies

Allowances and Contingencies

- **Program Management and Engineering**: 5% for program management and 25% for engineering/indirect costs
- **Contingency**: 30% applied to the AWPF and conveyance reaches 1 and 2; 35% for MBR pretreatment and remaining conveyance and recharge facilities
- **Regulatory Compliance**: Additional allowances for BABAA and tariff impacts

Validation and Benchmarking

The cost estimates were reviewed independently by the program management consultant and benchmarked against historical data, vendor quotes, and comparable large-scale water reuse projects. Sensitivity analyses were performed to account for escalation, market volatility, and scope adjustments.

Phase 1 - Staged Delivery Considerations

For staged program implementation (e.g., Hybrid 45/75 MGD), cost modeling included additional allowances for duplicate mobilization, commissioning, and extended overhead, recognizing that staged delivery introduces higher costs and longer delivery schedule compared to single-phase construction.

1.4 Cost Estimates

Both capital and O&M cost estimates were included for the program cost update.

1.4.1 Staged Program Implementation

Table 3 shows a cost summary with staged program implementation. All cost estimates are in May 2025 dollars. Facilities, cash flow projections, estimated capital costs, implementation schedules, and O&M costs for each program stage are provided in separate sections in this document. Detailed capital cost estimates, broken down by agency, are provided in **Appendix A**.

Table 3: PWSC Staged Program Cost Summary

Capacity	Sanitation Districts Share of Cost* ($Million)	Metropolitan's Share of Costs ($ Million)	Total * Program Cost ($Million)	Online Year
45 MGD	697	2,881	3,578	2035
75 MGD	962	7,139	8,101	2036
Hybrid 45/75 MGD	1,109	7,455	8,711	2037
115MGD	1,085	8,311	9,396	2036
150 MGD	1,474	9,841	11,315	2041

Note:
* The Sanitation Districts' property value of the Joint AWPF treatment site and Workforce Training facility site is not included (valued at $164 million).

1.4.2 Operation and Maintenance Costs

Operation and maintenance (O&M) costs would be a critical component not only for long-term O&M planning and budgeting, but also in determining the life-cycle cost of purified water. These costs were estimated for treatment, conveyance, and recharge facilities and included Metropolitan labor, major equipment repair or replacement, chemicals, energy, and other consumables. Energy costs were estimated based on $0.15 per kilowatt-hour (kWh). The energy rate was based on the average electricity costs in California (ranging from $0.05 to $0.15 per kWh). Furthermore, the project management consultant has used some historical data from other similar programs to validate the rate for the 2025 cost estimates. **Table 4** summarizes the estimated O&M costs, inclusive of contingency, and a detailed breakdown is provided in **Appendix B**.

Table 4: PWSC Annual O&M Costs

	45	75	Hybrid 45/75	115	150
Assets	*Costs ($ M)*	*Costs ($ M)*	*Costs ($ M)*	*Costs ($ M)*	*Costs ($ M)*
Treatment Facilities *	61	86	86	115	170
Conveyance Facilities	16	22	22	30	42
Recharge Facilities	0	0.4	0.4	1	1
Contingency	**12**	**16**	**16**	**22**	**32**
Metropolitan Grand Total	**89**	**125**	**125**	**167**	**245**
Sanitation Districts Grand Total	**14**	**20**	**20**	**27**	**40**

Note:
*Includes costs for Program Management Information System (PMIS) and Building Information Modeling (BIM).

Treatment Facilities O&M Costs

The O&M costs for AWPF would include power, chemical, maintenance, consumables, equipment replacement, labor, and other costs for the AWT, MBR, and DPR satellite facilities. These costs were prepared in collaboration with the Sanitation Districts and are summarized in the *Updated Opinion of Probable Cost for the Nitrification-Denitrification Tertiary MBR Base Advanced Water Treatment Facility* (Stantec 2022) technical memorandum. The updated O&M estimates were prepared by escalating the previous estimates to May 2025 dollars.

Conveyance Facilities O&M Costs

The conveyance facilities O&M costs would include labor, maintenance and repair, and energy costs primarily for the pump stations. The updated O&M estimates were prepared by the conveyance conceptual design consultant Black & Veatch, by escalating the previous estimates by 18.4% from June 2022 to May 2025 dollars, using the Construction Cost Index for the City of Los Angeles (CCI-LA), because the O&M assumptions remained generally unchanged since the previous 2022 estimate. The details are provided in **Appendix D**.

Recharge Facilities O&M Costs

The recharge facilities O&M costs were estimated based on experience with similar projects in the region.

1.5 Program Cost Escalation

1.5.1 Increase of Phase 1 Program Cost

Figure 3 shows the current and previous Phase 1 PWSC program cost estimates. However, the 2018 estimates were based on a 100 MGD Phase 1 capacity. This 2025 estimate includes the Sanitation Districts' $1.1 billion Phase 1 (115 MGD) investment in pretreatment and MBR facilities, as well as shared facility costs. The "Other" category in green includes recharge facilities, shared infrastructure with the Sanitation Districts at the AWPF, and program contingency allowances not otherwise captured. **Appendices C and D** provide detailed cost estimates for the AWPF and conveyance system, respectively.

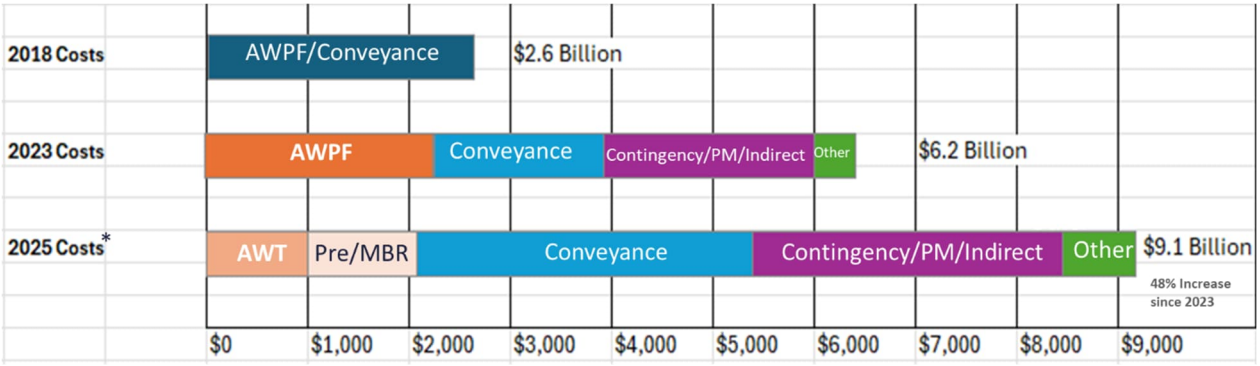


Figure 3: Phase 1 Program Comparison

The Phase 1 program costs have increased by approximately 48% since 2023. Several factors have contributed to the increase in total program costs. Inflation and supply chain disruptions have continued to exert significant pressure on material and labor costs, with regional construction indices showing persistent increases beyond CCI-LA trends. In addition, the program scope has been refined since 2023, incorporating updated design assumptions for major treatment processes, scope refinements, trenchless operations, and market conditions. Compliance with DPR regulations adopted in 2024, BABAA requirements, tariff allowances, and anticipated community benefit commitments have added further to the costs. These refinements, combined with contingency adjustments and phased delivery considerations, have resulted in increases across all major assets cost categories.

1.5.2 Increase of Phase 1 Program Cost—Metropolitan Facilities Only

The updated 2025 cost estimate for the PWSC Phase 1 program reflects an increase from $4.9 billion to $8.3 billion (Metropolitan costs only) since 2023. As shown in **Figure 4**, the largest cost increase (from $1.8 billion to $3.7 billion) was the cost of the conveyance system, primarily because of the higher cost of steel and trenchless operations, as well as design refinements and adjustments to contractor markups, to be consistent across the program.

The AWT costs increased from $858 million to $1.1 billion, attributable mainly to design refinements. Contingency, engineering, and indirect costs rose by $2 billion, to $3.1 billion, while other facilities and shared costs doubled to $0.4 billion.

The 2025 estimates also incorporated other program facilities, such as the Workforce Training Center ($30 million), to be developed in partnership with the City of Carson, Sanitation Districts, and Metropolitan. The cost of this facility was assumed to be shared equally (50/50) with the Sanitation Districts. These adjustments reflect a more comprehensive understanding of anticipated project delivery needs and community commitments, as well as inflationary and market-driven cost escalations.

These changes reflect inflationary pressures, scope expansion, and regulatory compliance allowances, resulting in an overall program cost increase of approximately 70%.



Figure 4: Phase 1 Program Comparison, Metropolitan Facilities Only

1.5.3 Key Drivers for Program Cost Escalation

In summary, several factors have contributed to the escalation in program costs, including the following:

- **Economic Conditions**: Inflation and supply chain disruptions have continued to impact the program since 2023. The CCI-LA was 10% in Fiscal Year (FY) 2022/2023, followed by 4.2% in both FY 2023/2024 and FY 2024/2025, indicating persistent inflationary pressure.
- **Advanced Water Purification Facility Scope**: The AWPF design has been refined to meet more stringent water quality compliance requirements, resulting in higher costs.
- **Conveyance System Design Updates**: Costs increased primarily because of the higher cost of steel and trenchless operations, as well as design refinements and adjustments to contractor markups, to be consistent across the program.
- **Regulatory Compliance**: Updated cost allowances were added to meet BABAA guidelines and account for equipment and supply tariffs, following the receipt of the Federal Design Grant.

1.5.3.1 Key Drivers for AWT Cost Increase

Materials. This reflects several key infrastructure enhancements. These include the addition of an equalization tank and pump station to support reverse osmosis feed, as well as a larger finished water clearwell, surge tanks, and a pump station designed to accommodate full-capacity DPR, a work force training center, and

updated power substation estimates. Material cost updates also were applied to pipelines, lime, steel rebar, and various piping components, to reflect current market conditions.

Design criteria and assumptions. Several adjustments were made to align with increased construction demands. These included additional allocations for project management, engineering, and indirect costs. Additional site restoration efforts were identified, along with revised requirements for the power system. Updates also were made to the chemical system and design of the ancillary facilities, for operational efficiency and regulatory compliance.

Allowances and contingency. This included financial adjustments to account for future uncertainties and regulatory considerations. An escalation rate of 8.4% was applied to reflect anticipated cost increases over time. Full allowances (100%) were incorporated to address the BABAA and tariff-related impacts. Furthermore, a contingency of 3.8% was added to mitigate risks associated with design and construction variability.

1.5.3.2 Key Drivers for Conveyance Cost Increase

Materials and Market Conditions. This reflects increased costs primarily associated with steel pipe and trenchless material and installation. These adjustments are based on updated market rates and procurement expectations.

Scope Refinements. Several significant changes have been incorporated. These included the need for additional trenchless construction; deeper pipeline profiles and shafts, to avoid utility congestion and navigate complex subsurface conditions; a change in pipeline lining and coating to address anticipated AWPF product water quality, corrosive ground conditions, and separation requirements; concrete encasements required within Southern California Edison easements to meet utility protection standards; additional pump station appurtenances; and a power substation to support operational demands at the Whittier Narrows Pump Station.

Contractor Markups. This included markups on trenchless work for hybrid reaches, and indirect construction cost markups to be consistent across the program.

1.5.4 Program Cost Comparison with the GWRS

An inquiry was made to compare the program capital and O&M costs of the PWSC and OCWD's GWRS. A detailed cost comparison is provided in **Appendix E** and is summarized as follows:

- Capital costs for the two programs were not directly comparable because of the difference in time and capacity at which GWRS was implemented. However, a high-level comparison of the GWRS 70 MGD facility (in 2025 dollars) and the PWSC 75 MGD capacity scenario (for AWT facilities only) indicated that the cost difference would fall within the expected range for a Class 5 estimate (i.e., expected accuracy range between 50% and +100%). The PWSC's projected capital cost is approximately 34% higher than that of GWRS on a $/MGD basis. This is primarily due to early design maturity necessitating higher construction contingency costs, and the inclusion of allowances for a program management consultant (given the program size and complexity), BABAA requirements, and tariffs.
- O&M costs for the GWRS 70 MGD facility (in 2025 dollars) and the PWSC 75 MGD capacity scenario (for AWT facilities only) are within a reasonable cost range. The PWSC's projected O&M cost is approximately 78% higher than that of GWRS on an annual $/MGD basis. This is primarily because of the early design maturity necessitating higher O&M contingency costs, as well as higher projected plant maintenance costs related to the additional facilities needed for PWSC in comparison to GWRS (e.g., process buildings, ancillary facilities, public outreach facilities, workforce training center).

2. Construction Cost Estimate

This section presents the major cost components of the cost estimate, key assumptions, exclusions, and a cost breakdown.

2.1 Major Cost Component

This section discusses the construction costs for the AWPF, conveyance and recharge facilities, as well as related program costs, when taken together form the major cost component of the construction cost estimate.

2.1.1 Advanced Water Purification Facility

Figure 5 shows the Pretreatment facility (left) and the AWTF (right).

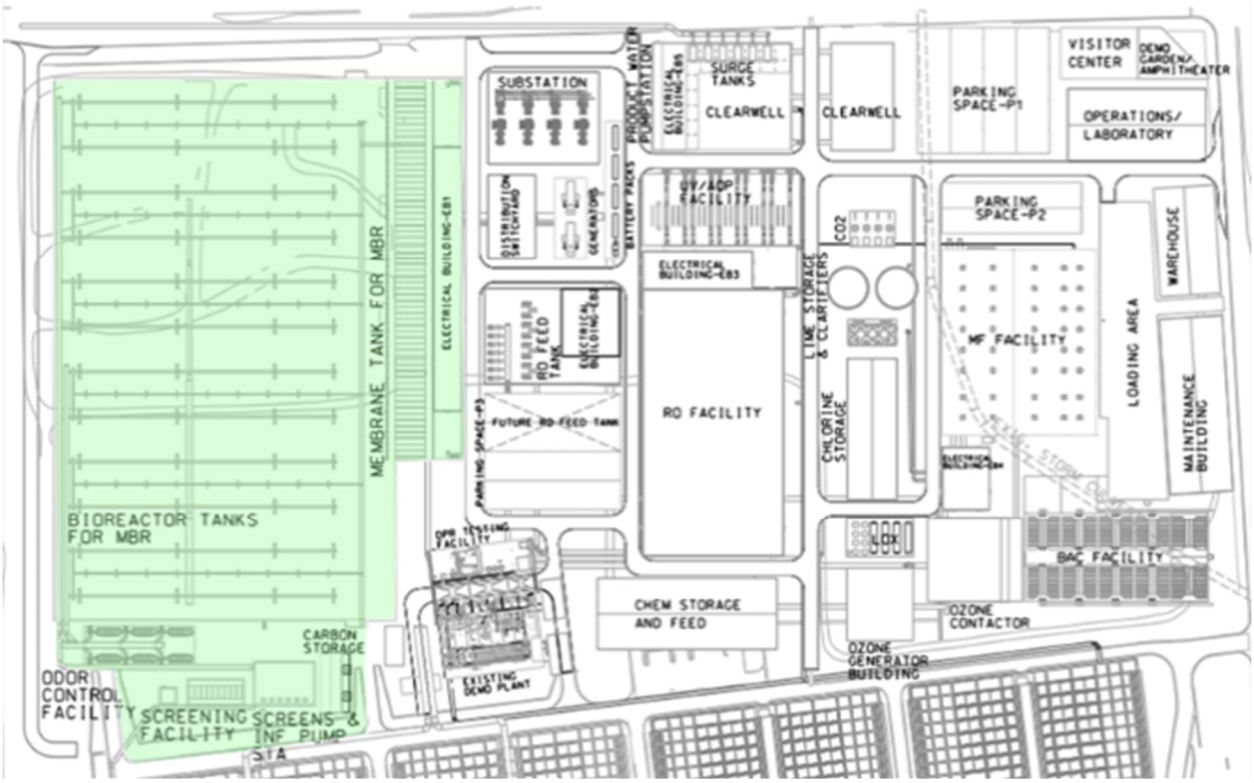


Figure 5: Pretreatment Facility and AWTF

The proposed AWPF would include the following major cost components:

- Site Preparation
- Process Equipment
- Chemical Feed Systems
- Power/Electrical Facilities
- SCE Substation
- Ancillary Facilities
- Outreach Facilities
- Workforce Training Center
- DPR Facilities

2.1.2 Conveyance and Recharge Facilities

The conveyance facilities would include the following major cost components:

- Pipelines (backbone, DPR)
- Service Connections and Laterals
- Pump Stations
- SCE Substation
- Azusa Pipeline Rehabilitation
- Property Easements and Acquisitions

The recharge facilities would include the following major cost components:

- Spreading Facility Improvements
- Well Relocations and Groundwater Monitoring
- Property Acquisitions

2.1.3 Other Program Costs

Other program costs would include the following major cost components:

- **Environmental Mitigation**: environmental impacts associated with the program and mitigation measures that would be implemented to offset those impacts (e.g., purchase of off-site mitigation credits for habitat impacts or property acquisition, habitat creation, mass installation of trees, striping for bike lanes, community and/or native gardens, potential curation facilities, and plaques, monuments or other markers).
- **Community Benefits Program**: as presented to Metropolitan's Board in October 2025, Metropolitan is exploring the development of a voluntary community benefits program for Pure Water, as a best practice for large infrastructure projects that may have residual impacts on underserved and disadvantaged communities located near project facilities. The purpose would be to complement required environmental mitigation efforts and help address impacts to the communities most affected by the program through voluntary, community-driven actions. The details of the program are not yet defined but are anticipated to include potential direct actions through Metropolitan-led projects and the creation of a community benefits fund, with oversight from community advisory groups to ensure funding aligns with local priorities and needs. An estimated allowance has been included in the program cost estimate for these potential benefits, which will be refined when more information becomes available regarding the community benefits program.
- **BABAA and tariff allowances:** Additional costs were factored in for tariffs and BABAA and regulatory compliance requirements under federal, State, and local guidelines. However, Metropolitan may be able to apply for a BABAA waiver for specialized equipment primarily manufactured outside the United States, including much of the Pretreatment/MBR, Ultraviolet (UV), Ozone, and other specialty process equipment. If appropriate, this waiver application would be completed by the AWPF PDBs and Conveyance System CM/GCs, because the waivers would be design-specific and typically would take up to a year or more to be approved. Any cost reductions because of BABAA waiver approval would be reflected in the Guaranteed Maximum Price proposals
- **Program management/engineering**: 25 percent for engineering, construction management, and indirect costs; and 5 percent for program management [a typical range is 5 to 15 percent].
- **Contingencies:** a 30% contingency was used for AWT and Conveyance Reaches 1 and 2 (R1 and R2) and a 35% contingency was used for the Pretreatment/MBR, Conveyance Reaches 3–8 (R3–R8), and Recharge Facilities.
- **AWPF Permitting**: estimated at 1% of the total AWPF construction costs, to cover AWT and MBR permitting costs (e.g., Title 22, local permits, and on-site permits)

2.2 Key Assumptions

The key assumptions that were used to develop the 2025 cost estimates were as follows:

- All costs are in May 2025 dollars.
- 5% program management allowance (typical range of 5% to 15%) was assumed.
- 25% allowance for engineering/program management/construction management support and indirect costs was assumed.
- Phase 1, 115 MGD was used as the baseline cost and schedule.
- The applied escalation CCI-LA was as follows:
  - 18.4% escalation (June 2022 to May 2025) for conveyance O&M costs only
  - 8.4% escalation (December 2023 to May 2025) for AWPF capital and O&M costs
- The AWT facility design was assumed to have a maturity level of approximately 10% to 12%, corresponding to a Class 4 cost estimate, in accordance with AACE guidelines.
- The conveyance system design was assumed to have a maturity level of approximately 5% to 10%, corresponding to a Class 4 cost estimate, in accordance with AACE guidelines.
- A 30% contingency was applied to AWT and conveyance reaches 1 and 2 construction costs.
- A 35% contingency was applied to MBR (Sanitation Districts pretreatment facilities), conveyance reaches 3 to 8, and recharge/local facilities.
- A 3.5% non-allocatable tariff allowance was applied for the AWPF (a 25% value of AWT was used as the basis for 3.5%, equating to an approximately 5% tariff on permanent materials and process equipment at AWT and MBR facilities).
- A 3% non-allocatable tariff allowance was applied for conveyance and recharge facilities (a 25% value for conveyance was used as the basis for 3%).
- A 1% BABAA allowance was applied to the estimated construction cost.

2.3 Exclusions

The following exclusions were assumed for the 2025 cost update:

- Escalation to mid-point of construction
- Upsizing of the backbone pipeline or pump station expansions to accommodate water from other programs
- Potential grants and contribution revenues.

2.4 Potential Program Stages

With a program of this magnitude, consideration of smaller initial program stages is warranted to minimize implementation and financial risks. Staged implementation of the program would allow Metropolitan to build stages that match water supply needs and would avoid over-building. This also could reduce the initial resource needs, provide a stronger revenue generation base, and potentially reduce Metropolitan's risk exposure. This section summarizes the potential staging options and establishes the facility requirements and associated implementation schedule, costs, and cashflow projection for each option.

2.4.1 45 MGD Program Facilities

The 45 MGD program facilities are shown in **Figure 6**.

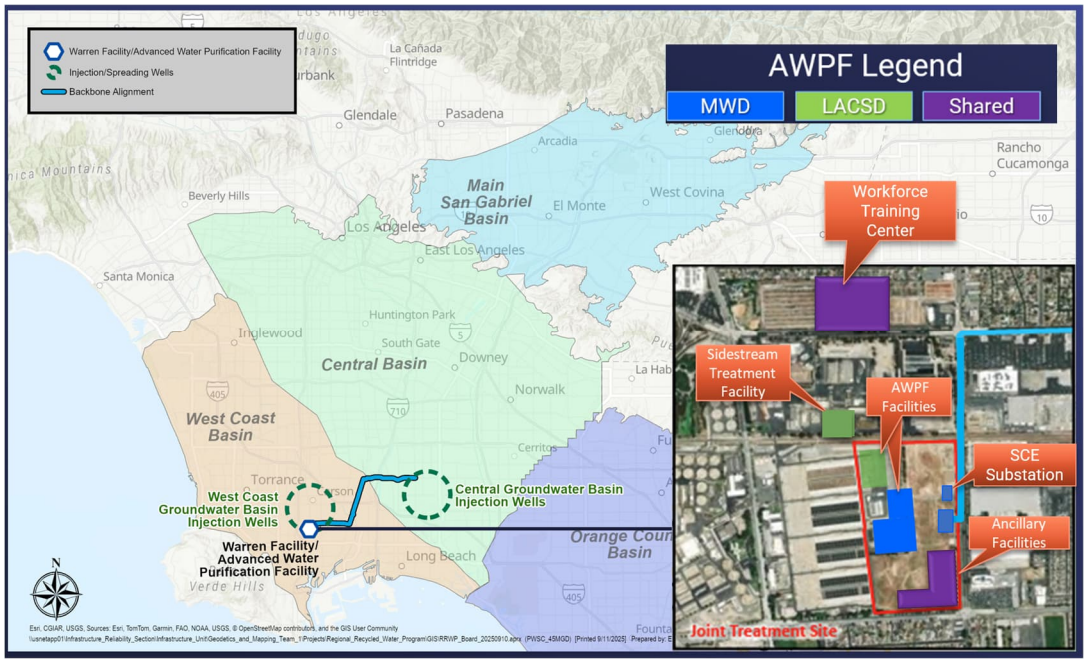
Planned Completion Year: 2035

Facilities Included:

- AWPF
- Conveyance infrastructure: reaches 1 and 2A (approximately 10 miles)
- Three service connections
- No backbone pump stations

Delivery Locations:

- Los Angeles Department of Water and Power (LADWP)
- West Basin Municipal Water District
- Long Beach Utilities



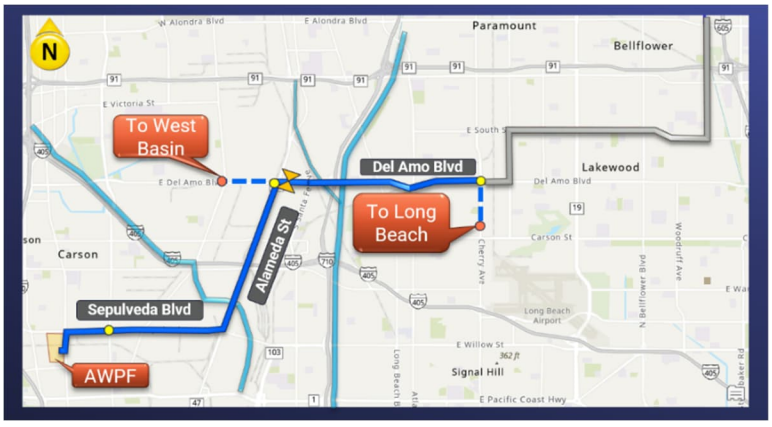


Figure 6: 45 MGD Program Facilities

2.4.1.1 Program Capital Costs—45 MGD

Table 5 shows a breakdown of the estimated capital cost for the 45 MGD program facilities in May 2025 dollars.

Table 5: 45 MGD Program Facility Costs

Assets	Cost ($M)
Advanced Water Treatment (AWT): 45 MGD, Site Preparation, Process Facilities, Ancillary Facilities, Workforce Training Center, and Substation	654
Conveyance Facilities: Backbone Pipeline (Reaches 1 through 2A)	1,118
Recharge Facilities Improvements (groundwater monitoring)	1
Program Management (PM), Engineering and Indirect Costs: PM (5%), Engineering and Indirect Cost Allowance (25%)	532
Program Contingency: AWT (30%), Conveyance (30% Reach 1 & Reach 2; Remaining 35%) and Local/Recharge Facilities (35%)	486
Other Allowances: BABAA (1%), Non-Allocatable Tariff Allowance (3.5% for AWT and 3% for Conveyance and Recharge)	34
Other Shared Program Costs: Environmental Mitigation Measures, Community Benefits, and AWPF Permits	56
Metropolitan Grand Total	**2,881**
Sanitation Districts Grand Total	**697**
PWSC Grand Total	**3,579**

Note:
* Property value of Sanitation Districts' joint treatment site and Workforce Training Facility site (valued at $164M) is not included.

2.4.1.2 Cashflow—45 MGD

Figure 7 shows the cash flow projections for the 45 MGD program facility. The cash flow was developed based on the assumption that the Requests for Qualifications for the AWT PBD and Reaches 1 and 2 CM/GCs would be released in April 2026.

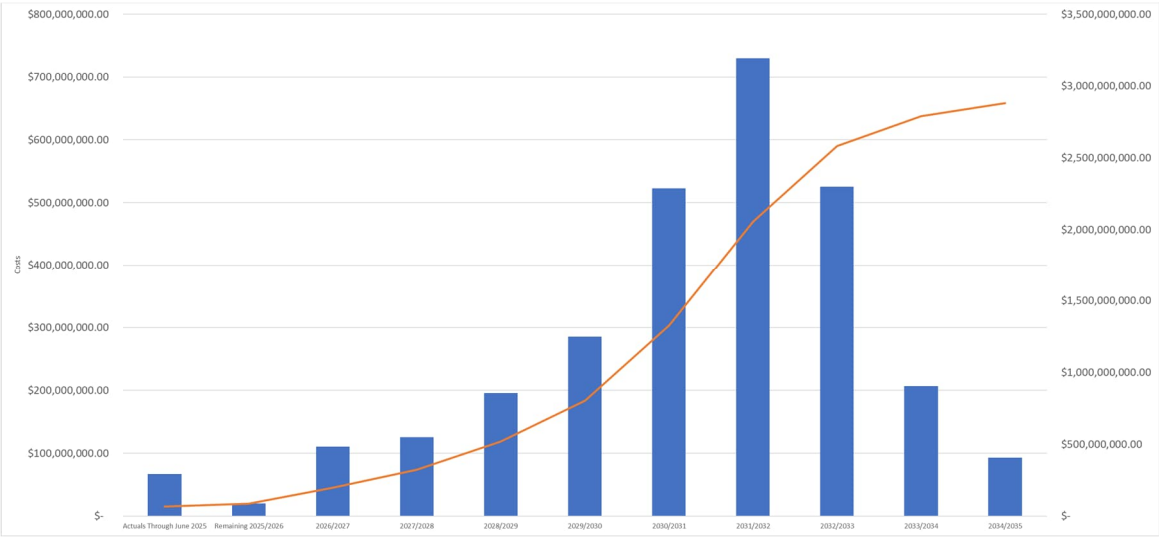


Figure 7: Cash Flow Projections—45 MGD

2.4.1.3 Schedule—45 MGD

Figure 8 shows the implementation schedule and key milestones for the 45 MGD staging option, which is targeted for completion by 2035.

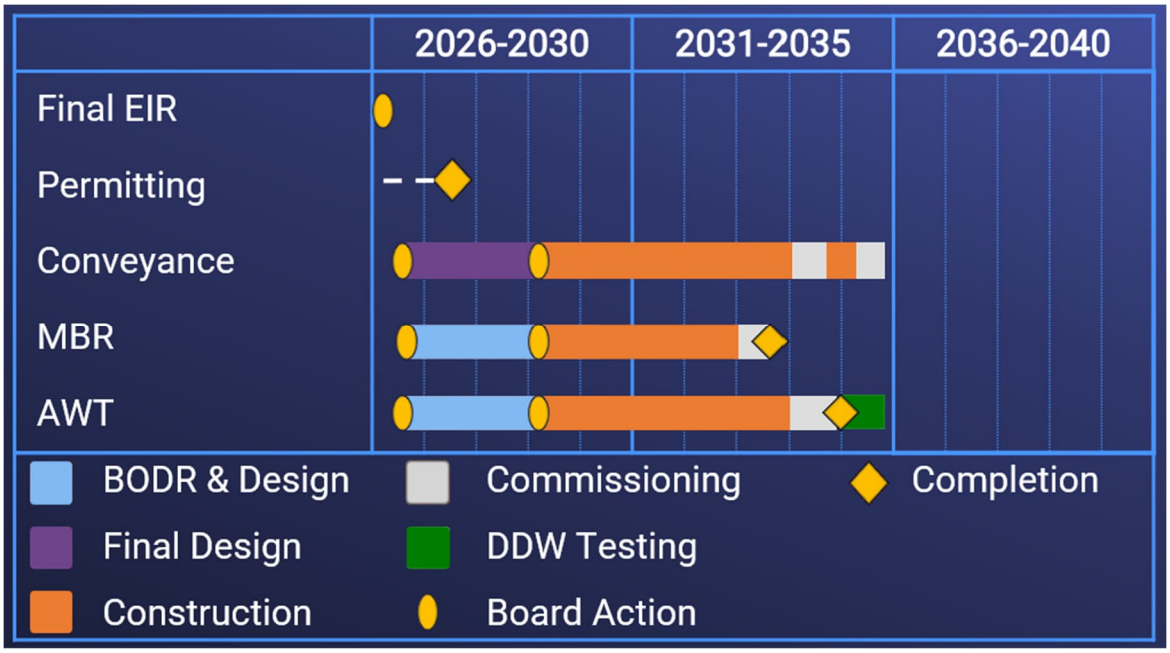


Figure 8: Implementation Schedule—45 MGD

2.4.1.4 O&M Costs—45 MGD

Table 6 shows the estimated annual O&M cost breakdown for the 45 MGD program facility in May 2025 dollars.

Table 6: Annual O&M Cost Breakdown, 45 MGD

Assets	Costs ($ M)
Treatment Facilities*	61
Conveyance Facilities	16
Recharge Facilities	0
Contingency	12
Metropolitan Grand Total	89
Sanitation Districts Grand Total	14

Note:
*Includes costs for the Program Management Information System (PMIS) and Building Information Modeling (BIM).

2.4.2 75 MGD Program Facilities

Figure 9 shows the 75 MGD program facilities.

Planned Completion Year: 2036

Facilities Included:

- AWPF
- Backbone conveyance pipeline: reaches 1 through 8A (approximately 37 miles)
- Eight service connections
- One backbone pump station

Delivery Locations:

- LADWP
- West Basin Municipal Water District
- Long Beach Utilities
- Central Basin Municipal Water District
- Upper San Gabriel Valley Municipal Water District
- Three Valleys Municipal Water District

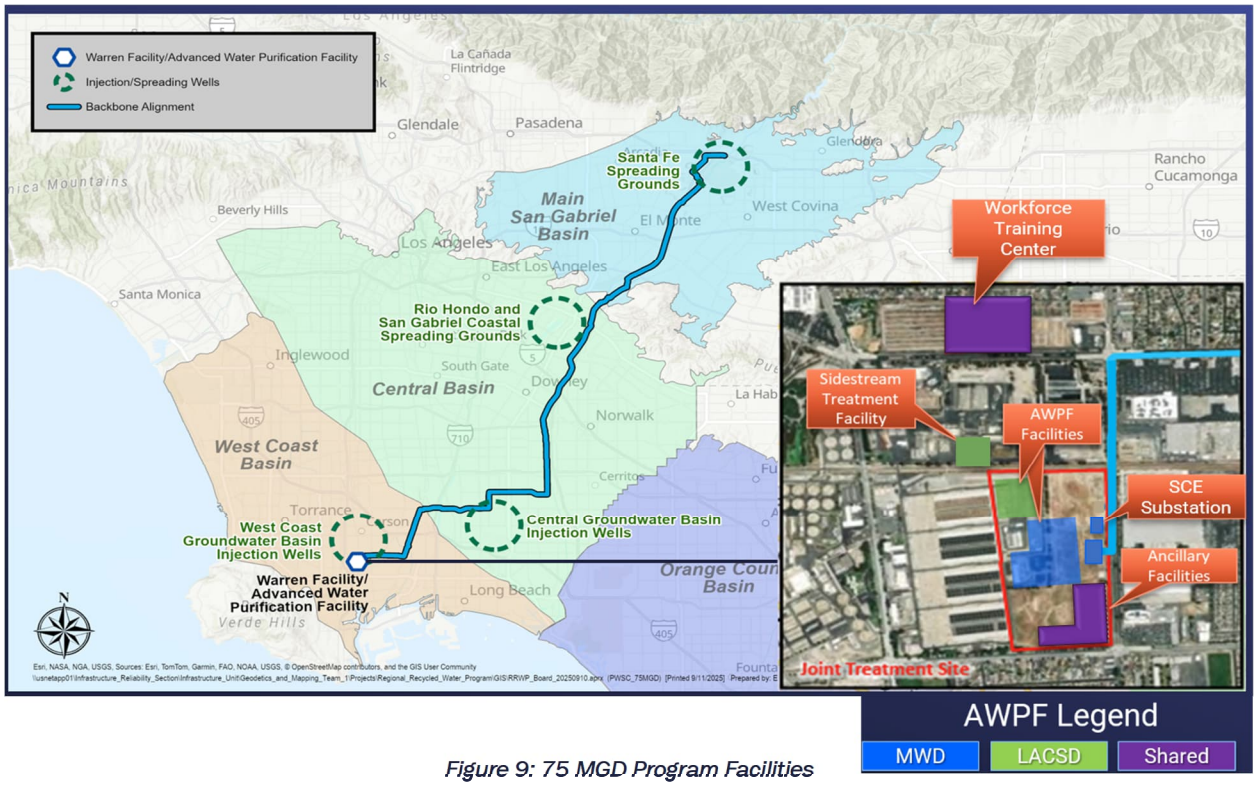


Figure 9: 75 MGD Program Facilities

2.4.2.1 Program Capital Costs—75 MGD

Table 7 summarizes the estimated capital costs for the 75 MGD program facilities in May 2025 dollars. Costs are categorized by major program components, including AWT, conveyance infrastructure, recharge facilities, program management and indirect costs, contingency allowances, regulatory compliance (BABAA and tariff allowances), and shared program costs. Table 7 also shows the Metropolitan and Sanitation Districts cost shares, as well as the total program cost for this staging option.

Table 7: 75 MGD Program Facility Costs

Assets	Cost ($M)
Advanced Water Treatment (AWT): 75 MGD, Site Preparation Process Facilities, Ancillary Facilities, Workforce Training Center, and Substation	826
Conveyance Facilities: Backbone Pipeline (Reaches 1 through 8a), Whittier Narrows Pump Station	3,373
Recharge Facilities (purchase, spreading facilities improvements, and groundwater monitoring)	101
Program Management, Engineering and Indirect Costs: PM (5%), Engineering and Indirect Cost Allowance (25%)	1,290
Program Contingency: AWT (30%), Conveyance (30% R1 and R2; Remaining 35%) and Local/Recharge Facilities (35%)	1,413
Other Allowances: BABAA (1%), Non-Allocatable Tariff Allowance (3.5% for AWT and 3% for Conveyance and Recharge)	78
Other Shared Program Costs: Environmental Mitigation Measures, Community Benefits, and AWPF Permits	58
Metropolitan Grand Total	**7,139**
Sanitation Districts Grand Total	**962**
PWSC Grand Total	**8,101**

Notes:
* Property value of Sanitation Districts' joint treatment site and Workforce Training Facility site (valued at $164M) is not included.

2.4.2.2 Cashflow—75 MGD

Figure 10 shows the cash flow projections for the 75 MGD program facility.

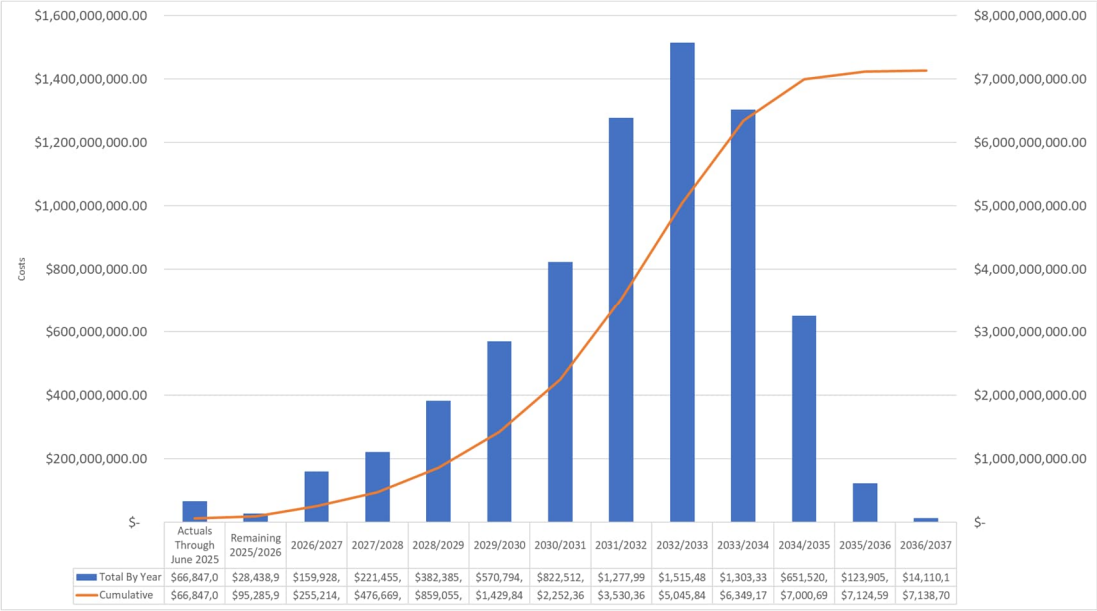


Figure 10: Cash Flow Projections—75 MGD

2.4.2.3 Schedule—75 MGD

Figure 11 shows the key milestones for the 75 MGD program facility, reflecting a staged approach to design and construction and targeting completion by 2036.

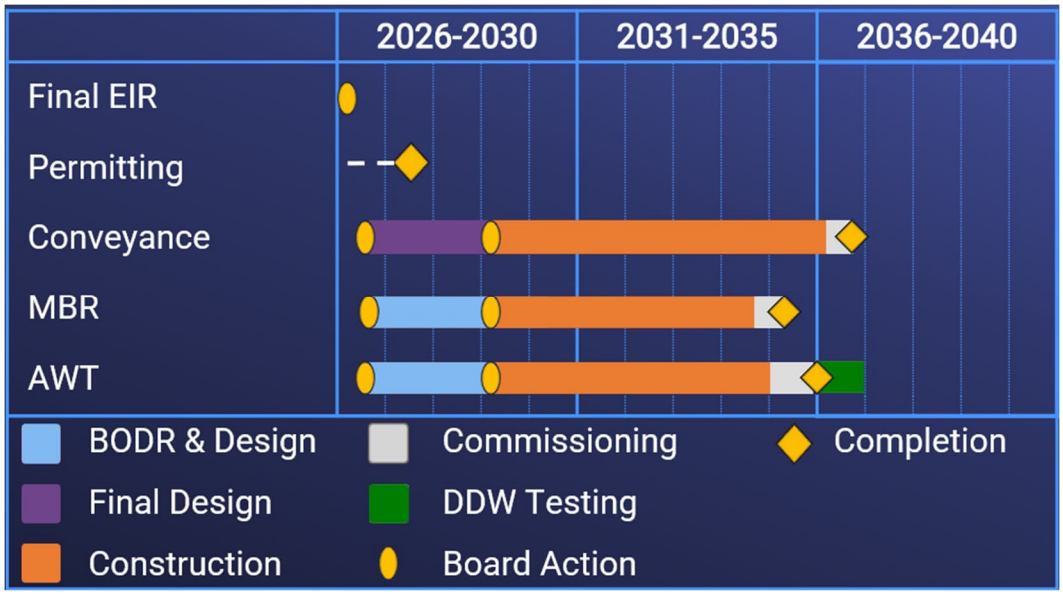


Figure 11: Implementation Schedule—75 MGD

2.4.2.4 O&M Costs—75 MGD

Table 8 shows the estimated annual O&M cost breakdown for the 75 MGD program facility in May 2025 dollars.

Table 8: Annual O&M Cost Breakdown, 75 MGD

Assets	Costs ($ M)
Treatment Facilities*	86
Conveyance Facilities	22
Recharge Facilities	0.4
Contingency	**16**
Metropolitan Grand Total	**125**
Sanitation Districts Grand Total	**20**

Note:
*Includes costs for the Program Management Information System (PMIS) and Building Information Modeling (BIM).

2.4.3 Hybrid 45/75 MGD Program Facilities

Under this hybrid staging option, the 75 MGD program facility would be built in two steps. Step 1 would involve constructing and commissioning the initial 45 MGD capacity, which would become operational first to provide early water deliveries and meet immediate regional needs. Step 2 then would build out the remaining infrastructure to expand the program delivery capacity to 75 MGD, including additional pipeline reaches, service connections, and one backbone pump station. This approach would allow for early benefits while continuing construction toward full capacity.

Planed Completion Year: 2037

Facilities Included:

- AWPF
- Backbone conveyance pipeline: reaches 1 through 8A (approximately 37 miles)
- Eight service connections
- One backbone pump station

Delivery Locations:

- LADWP
- West Basin Municipal Water District
- Long Beach Utilities
- Central Basin Municipal Water District
- Upper San Gabriel Valley Municipal Water District
- Three Valleys Municipal Water District

Delivery Approach

The 45/75 MGD staging option would be delivered in two steps:

- **Step 1: 45 MGD Commissioning**
  Initial construction would focus on the AWPF and approximately 10 miles of backbone pipeline (reaches 1 and 2A), along with three service connections. This would enable early delivery of 45 MGD to Los Angeles, West Basin, and Long Beach, providing immediate regional water supply benefits while full build-out would continue.
- **Step 2: Expansion to 75 MGD**
  Following commissioning of the 45 MGD segment, construction would proceed to complete the remaining backbone pipeline reaches to the Main San Gabriel Basin (approximately 37 miles total), add five additional service connections, and construct one backbone pump station. This expansion would increase capacity to 75 MGD and extend deliveries to the Upper San Gabriel Valley and Three Valleys Municipal Water Districts.

This approach would allow Metropolitan to accelerate water deliveries, reduce initial financial exposure, and optimize construction sequencing while maintaining flexibility for future program adjustments.

Although this hybrid approach would offer early water delivery and operational flexibility, it would introduce additional costs compared to constructing the full 75 MGD capacity in a single, continuous phase. The stop-and-restart nature of construction between Step 1 (45 MGD) and Step 2 (expansion to 75 MGD) would result in:

- Duplicate mobilization and demobilization costs for contractors and equipment
- Reduced productivity from re-establishing work sites and construction sequence
- Additional commissioning and testing expenses for two separate operational start-ups
- Extended overhead and indirect costs associated with prolonged project management and site supervision

These factors collectively would make the hybrid 45/75 MGD option more expensive than the single-stage 75 MGD implementation, despite its benefits in accelerating initial water deliveries.

2.4.3.1 Program Capital Costs—Hybrid 45/75 MGD

Table 9 summarizes the estimated capital costs for the Hybrid 45/75 MGD program facilities in May 2025 dollars. The costs are categorized by major program components, including AWT, conveyance infrastructure, recharge facilities, program management and indirect costs, contingency allowances, regulatory compliance (BABAA and tariff allowances), and shared program costs. Table 9 also shows the Metropolitan and Sanitation Districts cost shares, as well as the total program cost for this option.

Table 9: Hybrid 45/75 MGD Program Facility Costs

Assets	Cost ($M)
AWT/Conveyance/Recharge Facilities 75 MGD Baseline Total Costs	7,139
AWT 45/75 MGD Phasing Additional Costs	
• 45 to 75 MGD Equipment Escalation	123
• 45 MGD Progressive Design-Build (PDB) Mobilization/Demobilization	26
• 45/75 Double Commissioning	42
• 45 to 75 MGD PDB Negative Productivity, Added Safety Needs, and Additional General Site/Construction Conditions	126
Metropolitan Additional Phasing Costs Total:	**316**
Metropolitan Grand Total	**7,455**
Sanitation Districts Grand Total	**1,109**
PWSC Grand Total	**8,711**

Notes:
* Property value of the Sanitation Districts' Joint AWPF treatment site and Workforce Training Facility site (valued at $164M) is not included.

2.4.3.2 Cashflow—Hybrid 45/75 MGD

Figure 12 shows the cash flow projections for the 45/75 MGD option.

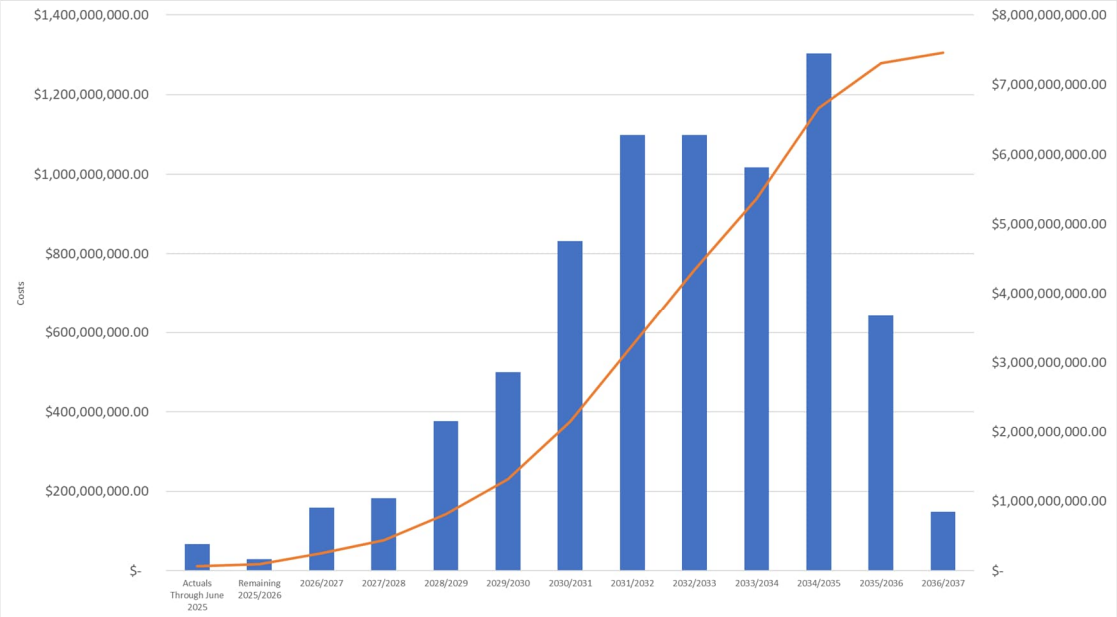


Figure 12: Cash Flow Projections—Hybrid 45/75 MGD

2.4.3.3 Schedule—Hybrid 45/75 MGD

Figure 13 shows the implementation schedule and key milestones for the Hybrid 45/75 MGD program facility, which would adopt a staged delivery approach to accelerate early water deliveries while completing full build-out by 2037.

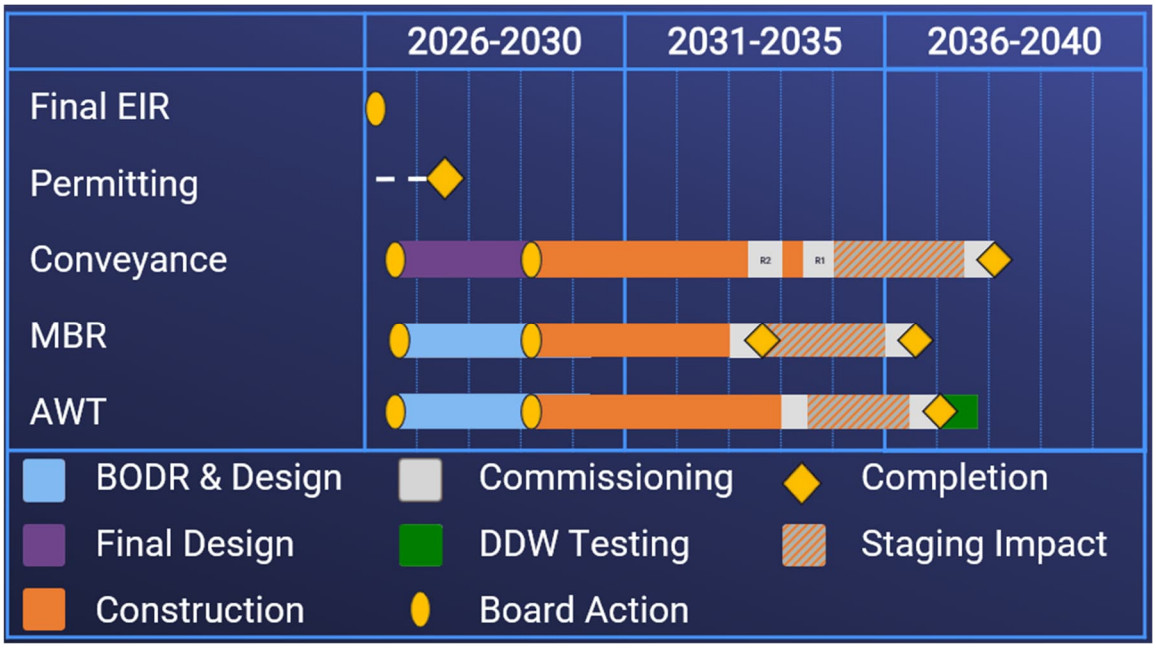


Figure 13: Implementation Schedule—Hybrid 45/75 MGD

2.4.3.4 O&M Costs—Hybrid 45/75 MGD

Table 10 shows the estimated annual O&M cost breakdown for the Hybrid 45/75 MGD program facility in May 2025 dollars.

Table 10: Annual O&M Cost Breakdown, Hybrid 45/75 MGD

Assets	Costs ($ M)
Treatment Facilities*	86
Conveyance Facilities	22
Recharge Facilities	0.4
Contingency	**16**
Metropolitan Grand Total	**125**
Sanitation Districts Grand Total	**20**

Notes:
*Includes costs for the Program Management Information System (PMIS) and Building Information Modeling (BIM).

2.4.4 115 MGD Program Facilities

Figure 14 shows the 115 MGD program facilities.

Program Facilities: 90 MGD IPR + 25 MGD DPR

Planned Completion Year: 2036

Facilities Included:

- AWPF
- Backbone conveyance pipeline: reaches 1 through 8B (approximately 39 miles)
- Nine service connections
- Two backbone pump stations
- Azusa pipeline with two pump stations
- Satellite DPR facility at Weymouth

Delivery Locations:

- LADWP
- West Basin Municipal Water District
- Long Beach Utilities
- Central Basin Municipal Water District
- Upper San Gabriel Valley Municipal Water District
- Three Valleys Municipal Water District
- San Gabriel Valley Municipal Water District (SGVMWD)
- Weymouth Water Treatment Plant

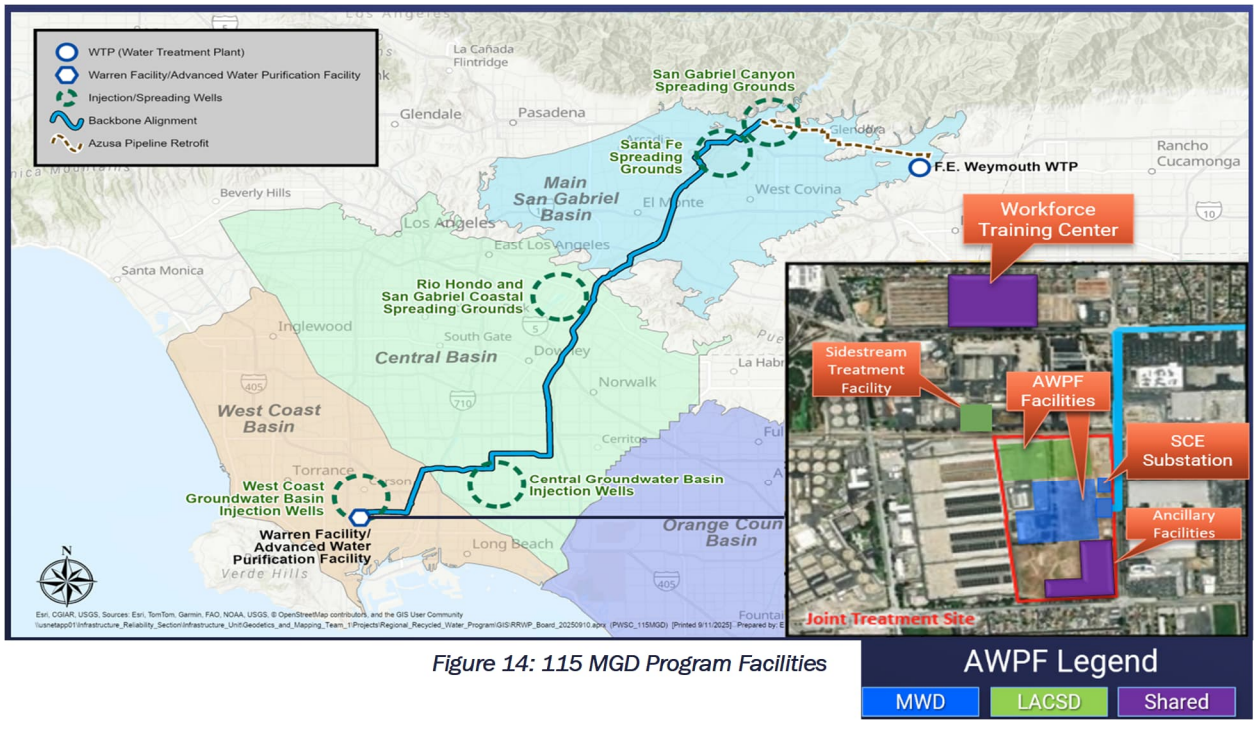


Figure 14: 115 MGD Program Facilities

2.4.4.1 Program Capital Costs—115 MGD

Table 11 summarizes the estimated capital costs for Phase 1 program facilities, expressed in May 2025 dollars. The costs are categorized by major program components, including AWT, conveyance infrastructure, recharge facilities, program management and indirect costs, contingency allowances, regulatory compliance (BABAA and tariff allowances), and shared program costs.

Table 11 also shows the Metropolitan and Sanitation Districts cost shares, as well as the total program cost for the Phase 1 program.

Table 11: Phase 1 Program Facility Costs

Assets	Cost ($M)
Advanced Water Treatment (AWT): 115 MGD, Site Preparation, Process Facilities, Ancillary Facilities, Workforce Training Center, Power Station, and Direct Potable Reuse (DPR) Satellite Facilities at Weymouth	1,098
Conveyance Facilities: Backbone Pipeline (Reaches 1 through 8b), Whittier Narrows and Santa Fe Pump Stations, Azusa Pipeline, and Two Pump Stations (for Phase 1 DPR)	3,419
Recharge Facilities (purchase, spreading facilities improvements, and groundwater monitoring)	494
Program Management, Engineering and Indirect Costs: PM (5%), Engineering and Indirect Cost Allowance (25%)	1,503
Program Contingency: AWT (30%), Conveyance (30% R1 & R2; Remaining 35%) and Local/Recharge Facilities (35%)	1,648
Other Allowances: BABAA (1%), Non-Allocatable Tariff Allowance (3.5% for AWT and 3% for Conveyance and Recharge)	91
Other Shared Program Costs: Environmental Mitigation Measures, Community Benefits, and AWPF Permits	58
Metropolitan Grand Total	**8,311**
Sanitation Districts Grand Total	**1,085**
PWSC Phase 1 Grand Total	**9,396**

Note:
* Property value of Sanitation Districts' joint treatment site and Workforce Training Facility site (valued at $164M) is not included.

2.4.4.2 Cashflow—115 MGD

Figure 15 shows the cash flow projections for the Phase 1 program facilities.

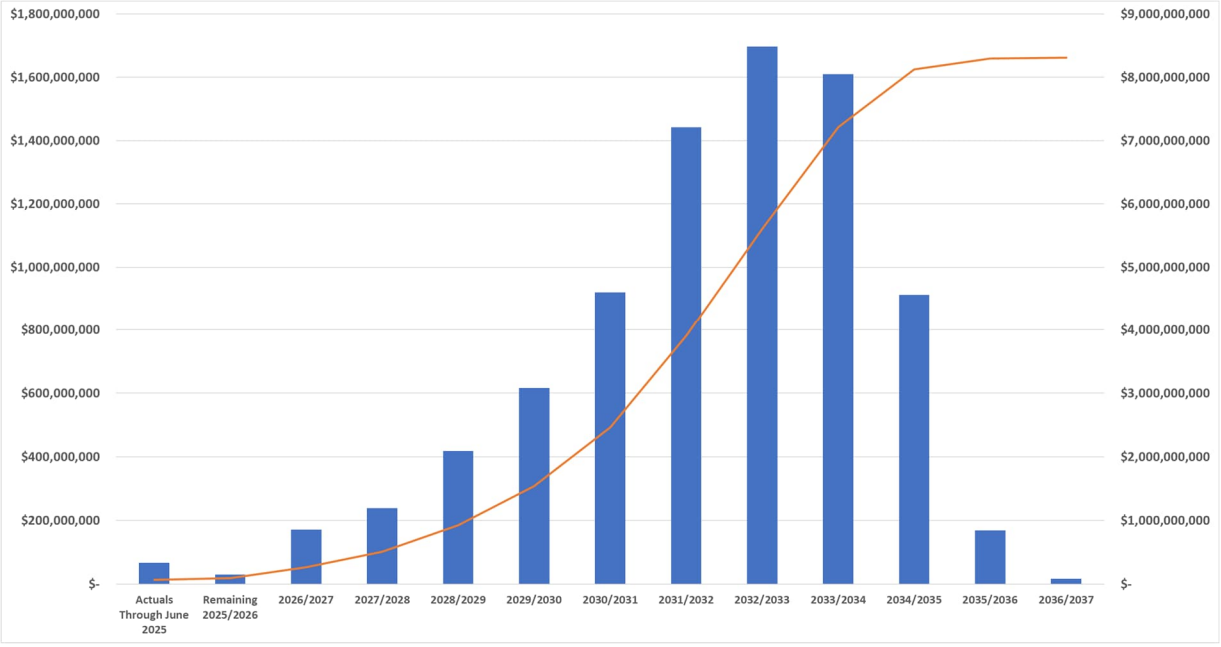


Figure 15: Cash Flow Projections—115 MGD

2.4.4.3 Schedule—115 MGD

Figure 16 shows the major milestones and sequencing for the Phase 1 program (115 MGD), which would culminate in full operational capacity by November 2036.

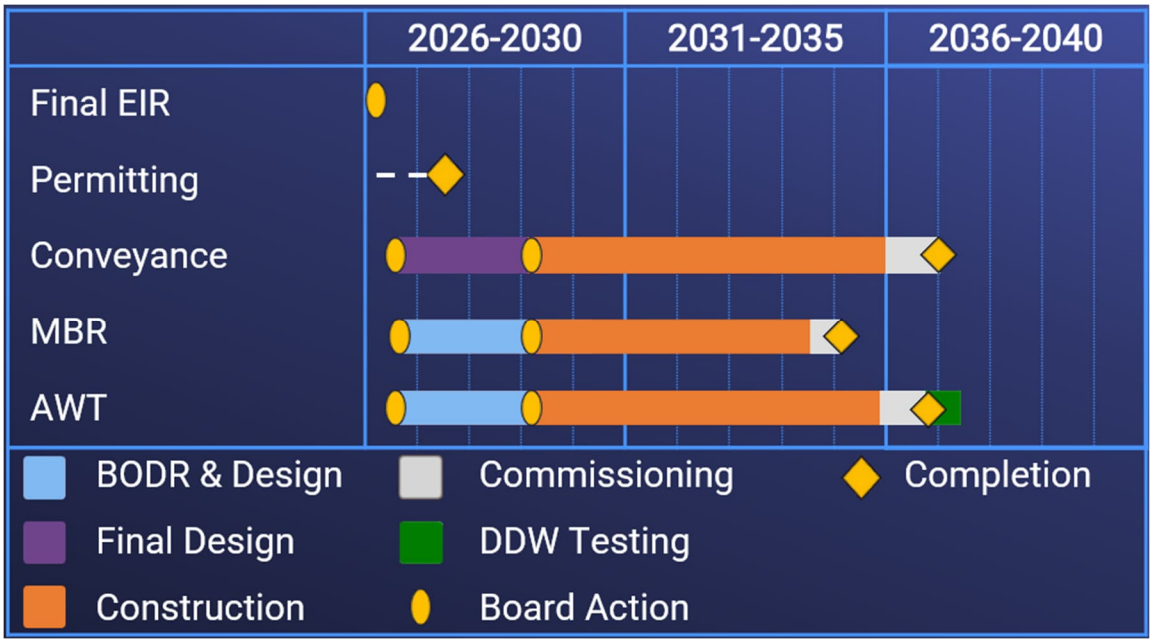


Figure 16: Implementation Schedule—115 MGD

2.4.4.4 O&M Costs—115 MGD

Table 12 shows the estimated annual O&M cost breakdown for the Phase 1 program facilities in May 2025 dollars.

Table 12: Annual O&M Cost Breakdown, Phase 1 (115 MGD)

Assets	Costs ($ M)
Treatment Facilities*	115
Conveyance Facilities	30
Recharge Facilities	1
Contingency	22
Metropolitan Grand Total	167
Sanitation Districts Grand Total	27

Note:
*Includes costs for the Program Management Information System (PMIS) and Building Information Modeling (BIM).

2.4.5 150 MGD Full-Buildout Program Facilities

Figure 17 shows the 150 MGD full build-out program facilities.

Planned Completion Year: 2041

Facilities Included:

- AWPF
- Backbone conveyance pipeline: reaches 1 through 8B (approximately 39 miles)
- Nine service connections
- Two backbone pump stations
- New DPR pipeline and pump station
- Satellite DPR facility at Weymouth

Delivery Locations:

- LADWP
- West Basin Municipal Water District
- Long Beach Utilities
- Central Basin Municipal Water District
- Upper San Gabriel Valley Municipal Water District
- Three Valleys Municipal Water District
- SGVMWD
- Weymouth Water Treatment Plant



Figure 17: 150 MGD Full-Buildout Program Facilities

2.4.5.1 Program Capital Costs—150 MGD

Table 13 summarizes the estimated capital costs for the full program (150 MGD), expressed in May 2025 dollars. The costs are categorized by major program components, including AWT, conveyance infrastructure, recharge facilities, program management and indirect costs, contingency allowances, regulatory compliance (BABAA and tariff allowances), and shared program costs.

Table 13 also shows Metropolitan and Sanitation Districts cost shares, as well as the total program cost.

Table 13: 150 MGD Full Program Facility Costs

Assets	Cost ($M)
Advanced Water Treatment (AWT): 150 MGD, Site Preparation, Process Facilities, Ancillary Facilities, Workforce Training Center, Power Station, and Direct Potable Reuse (DPR) Satellite Facilities at Weymouth	1,532
Conveyance Facilities: Backbone Pipeline (Reaches 1 through 8b), Whittier Narrows and Santa Fe Pump Stations, Azusa Pipeline and Two Pump Stations (for Phase 1 DPR), DPR Pipeline and Pump Station (Phase 2)	4,142
Recharge Facilities Improvements (purchase, spreading facilities improvements and groundwater monitoring)	265
Program Management, Engineering and Indirect Costs:– PM (5%), Engineering and Indirect Cost Allowance (25%)	1,782
Program Contingency: AWT (30%), Conveyance (30% R1 & R2; Remaining 35%) and Local/Recharge Facilities (35%)	1,951
Other Allowances: BABAA (1%), Non-Allocatable Tariff Allowance (3.5% for AWT and 3% for Conveyance and Recharge)	108
Other Shared Program Costs: Environmental Mitigation Measures, Community Benefits, and AWPF Permits	62
Metropolitan Grand Total	**9,841**
Sanitation Districts Grand Total	**1,474**
PWSC Full Program Grand Total	**11,315**

Note:
* Property value of the Sanitation Districts' joint treatment site and Workforce Training Facility site (valued at $164M) is not included.

2.4.5.2 Cashflow—150 MGD

Figure 18 shows the cash flow projections for the full 150 MGD program.

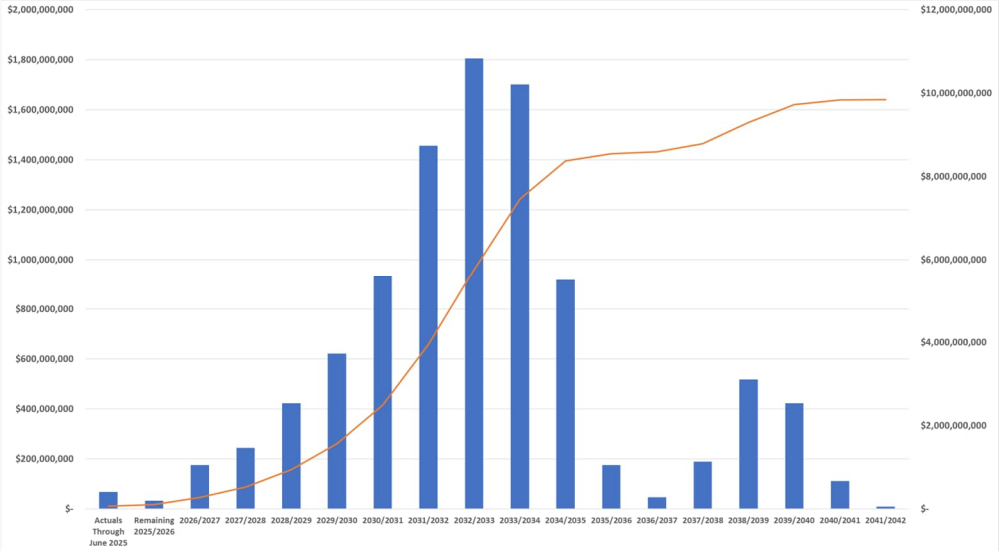


Figure 18: Cash Flow Projections—150 MGD

2.4.5.3 Schedule—150 MGD

Figure 19 shows the implementation schedule for the full 150 MGD program, extending beyond the Phase 1 timeline and incorporating additional conveyance, treatment, and DPR infrastructure to achieve full capacity by 2041.

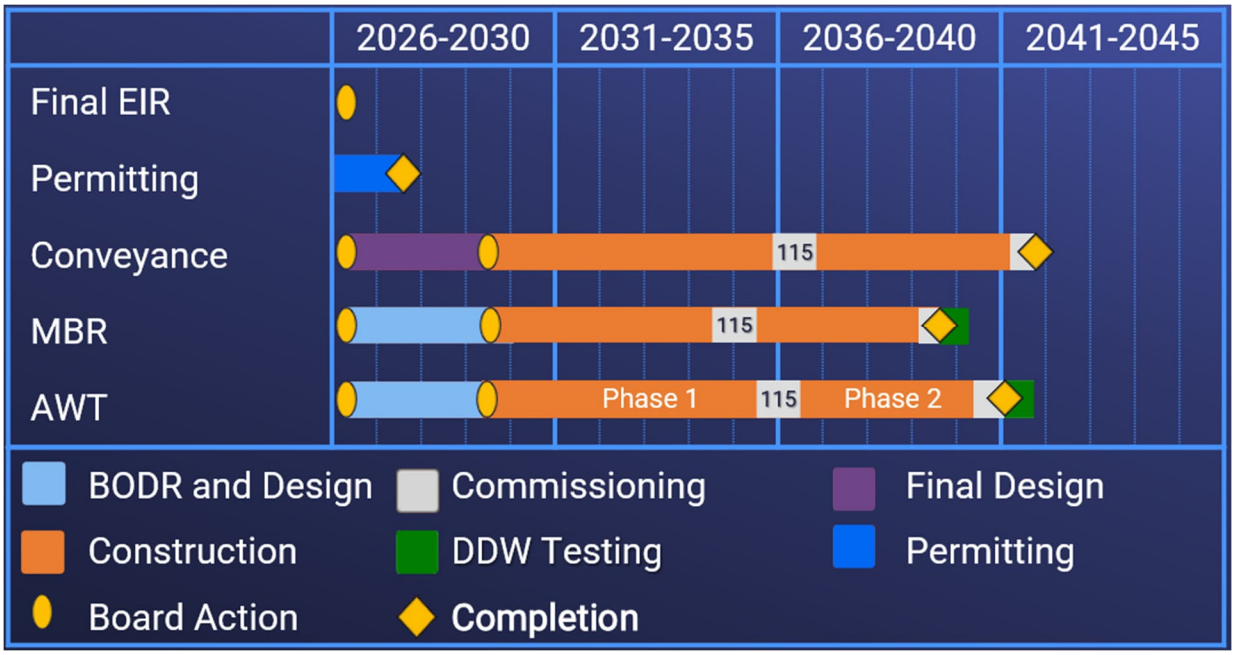


Figure 19: Implementation Schedule—150 MGD

2.4.5.4 O&M Costs—150 MGD

Table 14 shows the estimated annual O&M cost breakdown for the full program in May 2025 dollars.

Table 14: Annual O&M Cost Breakdown, Full Program (150 MGD)

Assets	Costs ($ M)
Treatment Facilities*	170
Conveyance Facilities	42
Recharge Facilities	1
Contingency	**32**
Metropolitan Grand Total	**245**
Sanitation Districts Grand Total	**40**

Note:
*Includes costs for the Program Management Information System (PMIS) and Building Information Modeling (BIM).

Appendix A Detailed Capital Cost Estimate - by Agency

	Phase 1 Staging					Full Program		
	Original 115MGD (2022/2023)	115MGD (May 2025)	75MGD (May 2025)	45/75MGD (May 2025)	45MGD (May 2025)	Original 150MGD (2022/2023)	150MGD (May 2025)	Notes
Metropolitan Cost Estimate	$ 4,851	$ 8,311	$ 7,139	$ 7,455	$ 2,881	$ 5,834	$ 9,841	
Advanced Water Treatment (AWT)	$ 850	$ 1,098	$ 826	$ 826	$ 654	$ 1,212	$ 1,532	The AWT cost were presented to PWSC Committee in March 2024 . In April 2025, updated AWT cost estimates (Stantec updated AWT costs were provided in December 2023) were provided to PMC based on the latest AWPF Conceptual Facilities Plan.
Site Preparation	$ 15	$ 28	$ 19	$ 19	$ 13	$ 41	$ 60	
Storm Drain Relocation		$ -	$ -	$ -	$ -		$ 21	- Escalated from December 2023 to May 2025 using AWT Escalation 8.4% based on actual ENR-CCI LA inflation factors. - Required only for Phase 2 - 150MGD - Shared Costs 50%
Utility Relocation	$ 2	$ 2	$ 2	$ 2	$ 2	$ 22	$ 2	- Escalated from December 2023 to May 2025 using AWT Escalation 8.4% based on actual ENR-CCI LA inflation factors. - Shared Costs 50% - The estimate was escalated from 2022 and it hase been determined that an extra zero was mistakenly inputted. The actual estimated cost should be 3.33 million.
Site Grading	$ 11	$ 23	$ 14	$ 14	$ 9	$ 17	$ 35	- Site Prep & Site Restoration Included here - Site grading includes site restoration costs. A factor was analyzed and applied per MGD of the scenario in question. - Shared Costs 50%
Soil/Concrete Pile Removal	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	$ 2	- Escalated from December 2023 to May 2025 using AWT Escalation 8.4% based on actual ENR-CCI LA inflation factors. - Shared Costs 50%
Abandoned Structure Removal	$ 1	$ 1	$ 1	$ 1	$ 1	$ 1	$ 1	- Escalated from December 2023 to May 2025 using AWT Escalation 8.4% based on actual ENR-CCI LA inflation factors. - Shared Costs 50%
AWT Process Facilities	$ 521	$ 695	$ 477	$ 477	$ 310	$ 667	$ 960	
MBR Filtrate/RO Equalization Tank/PS	$ 60	$ -	$ -	$ -	$ -	$ 65	$ -	
MBR Filtrate		$ 3	$ 1	$ 1	$ 1		$ 4	- MBR Filtrate Tank Only - The costs were applied differently since there was no information on how the original estimate applied costs. Some of the RO work is not included in the tank, such as the pumps. The total facility cost should be compared, not a specific line item. Due to different assumptions made throughout the estimate process
RO	$ 211	$ 284	$ 187	$ 187	$ 116	$ 286	$ 368	- Includes EQ Tank & Pumps
UV-AOP	$ 44	$ 80	$ 46	$ 46	$ 30	$ 57	$ 98	- Stantec estimate in 2023$ 115MGD is $73M and 150MGD - $94M. The updated cost estimate is in May 2025$ for115MGD - $80M and 150MGD is $97M. The variance is primary due to escalation. - A budgetary quote was obtained for the equipment. Additionally the facility size was modified to accommodate the quoted gear. The parameters between the two estimates are different.
Chemicals Systems	$ 33	$ 33	$ 23	$ 23	$ 14	$ 42	$ 43	
Lime & Post Treatment Systems		$ 35	$ 33	$ 33	$ 24		$ 39	- 115MGD Quicklime usage 34,600 lb./day (CaO) - Hydrated Lime Usage 43,300 lb./day (Ca(OH)2)
Electrical and I&C	$ 58	$ 78	$ 43	$ 43	$ 25	$ 76	$ 161	-Includes Electrical Buildings, Duct Banks, and E&I - The internal estimate provided was for both phases. Phase 1 would be 68% of the cost and Phase 2 would be the balance. Design was also modified by AECOM/BC so the estimate provided was based on revised parameters.
Backup Generators	$ -	$ 28	$ 28	$ 28	$ 28	$ -	$ 28	
Yard Piping	$ 18	$ 32	$ 27	$ 27	$ 17	$ 23	$ 66	
Finished Water Clearwell/PS/Surge tanks	$ 92	$ 121	$ 86	$ 86	$ 56	$ 112	$ 154	- 115 MGD Design Criteria is noted to be 10 MG for 115 MGD option (Pathway B 115 MGD DPR) - The designs are independent of each other, so the Clearwell tanks are sized to the scenario. There is no adjustment for future upsizing in any of the scenarios. The design criteria was not presented this way.
BABAA Allowance (1%)	$ 6					$ 7		Included below at the program level for the updated estimates
Ancillary Facilities	$ 110	$ 188	$ 188	$ 188	$ 188	$ 120	$ 188	
Operations/Administration/Electrical Buildings	$ 24	$ 26	$ 26	$ 26	$ 26	$ 30	$ 26	- Escalated from December 2023 using 8.4% factor.
Laboratory	$ 31	$ 34	$ 34	$ 34	$ 34	$ 31	$ 34	
MWD Warehouse	$ 13	$ 21	$ 21	$ 21	$ 21	$ 16	$ 21	
MWD Maintenance Building	$ -	$ 21	$ 21	$ 21	$ 21	$ -	$ 21	
Fueling Facility	$ -	$ 2	$ 2	$ 2	$ 2	$ -	$ 2	
Parking	$ 4	$ 33	$ 33	$ 33	$ 33	$ 4	$ 33	
EV facilities	$ 8	$ 9	$ 9	$ 9	$ 9	$ 8	$ 9	
Demonstration Garden	$ 0	$ 8	$ 8	$ 8	$ 8	$ 0	$ 8	- Shared costs 50%
Amphitheater/Visitor Center	$ 2	$ 7	$ 7	$ 7	$ 7	$ 2	$ 7	- Shared costs 50% - Design Criteria has not been established for a deeper analysis. PWSC AWPF Facilities Plan Draft from 2023 is the only document that is known to be available and the design criteria is not stated within.
Tour Galleries	$ 0.13	$ 0.14	$ 0.14	$ 0.14	$ 0.14	$ 0.13	$ 0.14	- Escalated from December 2023 to May 2025 using AWT Escalation 8.4% based on actual ENR-CCI LA inflation factors. - Shared costs 50%
Public Outreach Facilities	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	$ 5	- Escalated from December 2023 to May 2025 using AWT Escalation 8.4% based on actual ENR-CCI LA inflation factors. - Shared costs 50% - AECOM/BC reversed engineered the cost details by taking the square footage from the site plan and developing quantities for foundations, site work, structure and finishes.
Battery Storage	$ 12	$ 7	$ 7	$ 7	$ 7	$ 12	$ 7	
Solar Panels	$ 5	$ 8	$ 8	$ 8	$ 8	$ 5	$ 8	
Street Beautification	$ 6	$ 6	$ 6	$ 6	$ 6	$ 6	$ 6	- Escalated from December 2023 to May 2025 using MBR Escalation 8.4% based on actual ENR-CCI LA inflation factors. - The other 50% of the cost is included below in LACSD Cost estimate
Workforce Training Center	$ 5	$ 15	$ 15	$ 15	$ 15	$ 5	$ 15	- 50% shared costs - The other 50% of the cost is included below in LACSD Cost estimate - PMC reversed engineered the cost details by taking the square footage from the site plan and developing quantities for foundations, site work, structure and finishes.
Power Substation	$ 155	$ 129	$ 129	$ 129	$ 129	$ 155	$ 129	- Based on Figure 4-12 in the 2023 Facility Design Draft , in the scope doc the Distribution Switchyard has 4 each SF6 Breakers and 3 each Transformers. AECOM used the provided load calc sheet which shows 102,540KW of connected loads and we added 20% for miscellaneous loads to get to 123,048kw and to get to MVA you add 25% which puts us at 153,810kva or 3 each 55MVA Transformers. AECOM used recent projects for costing out substations similar to this one.
On-site Substation/Switchgear Facilities	$ 25	$ 69	$ 69	$ 69	$ 69	$ 25	$ 69	- Based on 2023 Draft Facilities Design using Figure 4-12 in the scope doc the Distribution Switchyard has 4 each SF6 Breakers and 3 each Transformers. AECOM used the provided load calc sheet which shows 102,540KW of connected loads and we added 20% for miscellaneous loads to get to 123,048kw and to get to MVA you add 25% which puts us at 153,810kva or 3 each 55MVA Transformers. AECOM used recent projects for costing out substations similar to this one.
SCE Off-site Transmission Facilities Off-site Electric Substation	$ 130	$ 60	$ 60	$ 60	$ 60	$ 130	$ 60	- Based on MOS - Option 1 "MWD owned and operated 112 MVA transformation provided with single substation.
DPR Satellite Facilities at Weymouth (from Azusa)	$ 45	$ 45	$ -	$ -	$ -	$ 225	$ 180	- Excludes the connection to Azuza - Design was based on providing UV and ClO2 Systems, the scope needs to be defined in order to understand what else should be included. This does not include pipeline upgrades or connectors to connect to Azuza. Scope was limited to the process systems at the facility only.
Conveyance Facilities	$ 1,805	$ 3,419	$ 3,085	$ 3,085	$ 889	$ 2,002	$ 3,854	
Backbone Pipeline	$ 1,625	$ 2,924	$ 2,881	$ 2,881	$ 889	$ 1,662	$ 2,924	
Reach 1	$ 125	$ 590	$ 590	$ 590	$ 590	$ 125	$ 590	
Reach 2	$ 151	$ 434	$ 434	$ 434	$ 108	$ 151	$ 434	
Reach 3	$ 53	$ 119	$ 119	$ 119	$ -	$ 53	$ 119	
Reach 4	$ 183	$ 254	$ 254	$ 254	$ -	$ 183	$ 254	
Reach 5	$ 79	$ 365	$ 365	$ 365	$ -	$ 79	$ 365	
Reach 6	$ 65	$ 282	$ 282	$ 282	$ -	$ 65	$ 282	
Reach 7	$ 93	$ 336	$ 336	$ 336	$ -	$ 93	$ 336	
Reach 8a	$ 92	$ 310	$ 310	$ 310	$ -	$ 92	$ 310	
Reach 8b		$ 43	$ -	$ -	$ -		$ 43	
From Santa Fe Lateral to United Rock Pit 3	$ 13	$ -	$ -	$ -	$ -	$ 13	$ -	
From Backbone to San Gabriel Coastal Spreading Grounds	$ 3	$ -	$ -	$ -	$ -	$ 3	$ -	
Backbone Valves and Service Connections	$ 62	$ -	$ -	$ -	$ -	$ 62	$ -	
Utility Relocation Allowance	$ 20	$ -	$ -	$ -	$ -	$ 23	$ -	
Separation Requirements Allowance	$ 46	$ -	$ -	$ -	$ -	$ 52	$ -	
Hazardous Soils and Groundwater Allowance	$ 66	$ -	$ -	$ -	$ -	$ 72	$ -	
Conveyance System Business Impacts	$ 6	$ -	$ -	$ -	$ -	$ 8	$ -	
Fiber Optic	$ 9	$ -	$ -	$ -	$ -	$ 11	$ -	
Right-of-Way/Easement Permit Costs	$ 173	$ 191	$ 191	$ 191	$ 191	$ 191	$ 191	
Upsized Backbone Pipeline (388.0)	$ 388	$ -	$ -	$ -	$ -	$ 388	$ -	
Backbone Pump Stations	$ 118	$ 328	$ 204	$ 204	$ -	$ 118	$ 328	
Whittier Narrows Pump Station	$ 118	$ 147	$ 147	$ 147	$ -	$ 118	$ 147	
Sante Fe Pump Station		$ 124	$ -	$ -	$ -		$ 124	
SCE Substation for Whitter Narrows Pump Station	$ -	$ 58	$ 58	$ 58	$ -	$ -	$ 58	
DPR Conveyance Facilities (25MGD) - Phase 1	$ 62	$ 167	$ -	$ -	$ -	$ 62	$ 167	
New 30" Pipelines (Azuza to Weymouth)			$ -	$ -	$ -			
Canyon Pump Station	$ 62	$ 148	$ -	$ -	$ -	$ 62	$ 148	
Big Dalton Pump Station			$ -	$ -	$ -			
Rehabilitation of Existing Pipeline	$ -	$ 19	$ -	$ -	$ -	$ -	$ 19	
DPR Conveyance Facilities (60MGD) - Phase 2	$ -	$ -	$ -	$ -	$ -	$ 160	$ 435	
Santa Fe Pump Station - Set B Pumps	$ -	$ -	$ -	$ -	$ -		$ 13	
DPR Pump Station	$ -	$ -	$ -	$ -	$ -	$ 160	$ 85	
DPR Pipeline	$ -	$ -	$ -	$ -	$ -		$ 315	
Improvements at Weymouth WTP	$ -	$ -	$ -	$ -	$ -		$ 22	Connection to Weymouth

	Phase 1 Staging					Full Program		
	Original 115MGD (2022/2023)	115MGD (May 2025)	75MGD (May 2025)	45/75MGD (May 2025)	45MGD (May 2025)	Original 150MGD (2022/2023)	150MGD (May 2025)	Notes
Recharge Facilities and Laterals Improvements	$ 185	$ 494	$ 389	$ 389	$ 230	$ 185	$ 553	
West Basin - SC-2 Lateral	$ -	$ 143	$ 143	$ 143	$ 143	$ -	$ 143	
Long Beach - SC-3 Lateral	$ -	$ 86	$ 86	$ 86	$ 86	$ -	$ 86	
Upper District & Three Valleys - SC-5 Lateral	$ -	$ 46	$ 46	$ 46	$ -	$ -	$ 46	
Upper District & Three Valleys - SC-6 Lateral	$ -	$ 4	$ 4	$ 4	$ -	$ -	$ 4	
Upper District & Three Valleys - SC-7 Lateral	$ -	$ 7	$ 7	$ 7	$ -	$ -	$ 7	
Upper District & Three Valleys - SC-8 Lateral	$ -	$ 2	$ 2	$ 2	$ -	$ -	$ 2	
Injection Wells	$ 42	$ -	$ -	$ -	$ -	$ 42	$ -	- assumed to be paid by others
Purchase	$ 50	$ 50	$ 50	$ 50	$ -	$ 50	$ 50	
United Rock Pit No. 3	$ 50	$ 50	$ 50	$ 50	$ -	$ 50	$ 50	
Vulcan Durbin	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Vulcan Reliance No.1	$ -	$ -	$ -	$ -	$ -	$ -	$ -	
Spreading Facilities Improvements	$ 41	$ 126	$ 49	$ 49	$ -	$ 41	$ 185	- escalated to 2025 based on ENR CCI LA
United Rock Pit No. 3	$ 41	$ 49	$ 49	$ 49	$ -	$ 41	$ 49	- Assumed available for purchase now, included in 75, 115, and 150 mgd options
Vulcan Durbin	$ -	$ 77	$ -	$ -	$ -	$ -	$ 77	- Assumed to be available for purchase in 2035, included in 115 mgd and 150 mgd options
Vulcan Reliance No.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 59	- Assumed to be available for purchase in 2040, included in 150 mgd option only
Relocation of Wells at Canyon Spreading Grounds	$ 18	$ 28	$ -	$ -	$ -	$ 18	$ 28	- 4 wells @$7M each
Backbone Laterals by others	$ 34	$ -	$ -	$ -	$ -	$ 34	$ -	- Assumed to be paid by others, not included in cost update
1 Year Ground Water Monitoring	$ -	$ 2	$ 2	$ 2	$ 1	$ -	$ 2	- Includes monitoring costs for 1 year
Subtotal	$ 2,840	$ 5,011	$ 4,300	$ 4,300	$ 1,773	$ 3,399	$ 5,939	
Program Management, Engineering and Indirect Costs	$ 785	$ 1,503	$ 1,290	$ 1,290	$ 532	$ 948	$ 1,782	
PM Allowance (5%)	$ 131	$ 251	$ 215	$ 215	$ 89	$ 158	$ 297	- Applied to Construction costs
Engineering and Indirect Cost Allowance (25%) - AWT	$ 213	$ 275	$ 207	$ 207	$ 164	$ 303	$ 383	- Applied to Construction costs
Engineering and Indirect Cost Allowance (25%) - Conveyance & Recharge	$ 442	$ 978	$ 869	$ 869	$ 280	$ 487	$ 1,102	- Applied to Construction costs
Other Allowances	$ -	$ 89	$ 76	$ 76	$ 32	$ -	$ 106	
BABAA Allowance (1%)	$ -	$ 50	$ 43	$ 43	$ 18	$ -	$ 59	- Applied to Construction costs
Non-Allocatable Tarriff Allowance (Assume 3.5%) - AWT	$ -	$ 10	$ 7	$ 7	$ 6	$ -	$ 13	- Used 25% value of AWT as basis for 3.5%, This equates to approx. a 5% tariff on permanent materials and process equipment on AWT and MBR - Applied to Construction costs
Non-Allocatable Tarriff Allowance (Assume 3.0%) - Conveyance & Recharge	$ -	$ 29	$ 26	$ 26	$ 8	$ -	$ 33	- Used 25% value of Conveyance as basis for 3.0% - Applied to Construction costs
Subtotal	$ 3,625	$ 6,604	$ 5,667	$ 5,667	$ 2,337	$ 4,347	$ 7,826	
Program Contingency	$ 1,191	$ 1,648	$ 1,413	$ 1,413	$ 486	$ 1,437	$ 1,951	
AWT Contingency (30%)	$ -	$ 329	$ 248	$ 248	$ 196	$ -	$ 459	
Conveyance Contingency - Reaches 1&2 (30%)	$ -	$ 307	$ 307	$ 307	$ 209	$ -	$ 307	
Conveyance Contingency - remaining scope (35%)	$ -	$ 838	$ 722	$ 722	$ -	$ -	$ 991	
Recharge Facilities & Pure Water Local Facilities (35%)	$ -	$ 173	$ 136	$ 136	$ 81	$ -	$ 194	
Contingency (35%)	$ 1,191	$ -	$ -	$ -	$ -	$ 1,437	$ -	- Applied to total including all allowances
Subtotal	$ 4,816	$ 8,251	$ 7,079	$ 7,079	$ 2,823	$ 5,784	$ 9,777	
PMIS & BIM	$ -	$ 2	$ 2	$ 2	$ 2	$ -	$ 2	
PMIS Design and Implementation	$ -	$ 1	$ 1	$ 1	$ 1	$ -	$ 1	- Includes implementation, roll-out and training. - Excludes 10K/Month Licensing cost
BIM Design and Implementation	$ -	$ 1	$ 1	$ 1	$ 1	$ -	$ 1	- Initial estimate that will be reviewed and revised.
Other Shared Program Costs	$ 35	$ 58	$ 58	$ 58	$ 56	$ 50	$ 62	
Environmental Mitigation Measures	$ 15	$ 20	$ 20	$ 20	$ 20	$ 20	$ 20	- 50% shared c costs
Community Benefits	$ 20	$ 30	$ 30	$ 30	$ 30	$ 30	$ 30	- 50% shared c costs
AWPF Permits	$ -	$ 8	$ 8	$ 8	$ 6		$ 12	-50% shared costs - 1% of the contruction cost
AWT 45/75 MGD Phasing Additional Costs				$ 316				
45 to 75 MGD Equipment Escalation				$ 123				17% Equipment Escalation based on Mid-Pt Construction of 45 MGD Facility and for the 40% remaining equipment to get to 75 MGD purchased
45 MGD PDB Mobilization/Demobilization				$ 26				2.5% of 75 MGD Baseline for AWT – Cost Estimator Provided
45/75 Double Commissioning				$ 42				4% of 75 MGD Baseline for 45/75 MGD Commissioning Staff
45 to 75 MGD PDB Negative Productivity, added Safety Needs, & Additional General Site/Construction Conditions				$ 126				12% of 75 MGD Baseline for AWT – Based on PDB Projects reviewed by Cost Estimators

Appendix B Detailed O&M Cost Estimate - by Agency

Annual O&M Cost ($Million/yr)	Original 115MGD (2022/2023)	115MGD (May 2025)	75MGD (May 2025)	45/75MGD (May 2025)	45MGD (May 2025)	Original 150MGD (May 2025)	150MGD (May 2025)
PWSC WATER PURIFICATION PLANT FACILITIES	$ 131.64	$ 135.23	$ 100.07	$ 100.07	$ 70.32	$ 186.88	$ 202.57
Power, Chemicals, Maintenance and Consumables	$ 73.18	$ 79.33	$ 58.70	$ 58.70	$ 41.25	$ 107.68	$ 116.73
AWT Pretreatment Process Facilities	$ 12.80	$ 13.88	$ 10.27	$ 10.27	$ 7.22	$ 27.30	$ 29.59
HPOLE	$ 1.80	$ 1.95	$ 1.44	$ 1.44	$ 1.01	$ 1.80	$ 1.95
Sidestream Centrate	$ 1.10	$ 1.19	$ 0.88	$ 0.88	$ 0.62	$ 1.10	$ 1.19
IPS/Screen	$ 1.50	$ 1.63	$ 1.20	$ 1.20	$ 0.85	$ 2.80	$ 3.04
MBR	$ 8.40	$ 9.11	$ 6.74	$ 6.74	$ 4.73	$ 21.60	$ 23.41
AWT Process Facilities	$ 58.28	$ 63.18	$ 46.75	$ 46.75	$ 32.85	$ 75.88	$ 82.26
Reverse Osmosis	$ 43.00	$ 46.61	$ 34.49	$ 34.49	$ 24.24	$ 56.10	$ 60.81
UV-AOP	$ 5.70	$ 6.18	$ 4.57	$ 4.57	$ 3.21	$ 7.20	$ 7.80
Stabilization	$ 4.20	$ 4.55	$ 3.37	$ 3.37	$ 2.37	$ 5.60	$ 6.07
Effluent Chlorination	$ 2.39	$ 2.59	$ 1.92	$ 1.92	$ 1.35	$ 3.09	$ 3.35
Balance of Chemicals, Buildings, Electrical	$ 2.99	$ 3.24	$ 2.40	$ 2.40	$ 1.69	$ 3.89	$ 4.22
DPR Process Facilities	$ 2.10	$ 2.28	$ 1.68	$ 1.68	$ 1.18	$ 4.50	$ 4.88
DPR (at Weymouth)	$ 2.10	$ 2.28	$ 1.68	$ 1.68	$ 1.18	$ 4.50	$ 4.88
Equipment Replacement	$ 9.93	$ 8.89	$ 6.58	$ 6.58	$ 4.62	$ 17.04	$ 18.47
Warren Facility Modifications (HPOLE/Centrate)	$ 0.09	$ 0.09	$ 0.07	$ 0.07	$ 0.05	$ 2.19	$ 2.37
IPS/Screen	$ 0.44	$ 0.47	$ 0.35	$ 0.35	$ 0.25	$ 0.49	$ 0.54
MBR	$ 4.91	$ 2.74	$ 2.03	$ 2.03	$ 1.43	$ 6.24	$ 6.77
AWT	$ 4.05	$ 5.14	$ 3.80	$ 3.80	$ 2.67	$ 5.87	$ 6.36
DPR	$ 0.45	$ 0.45	$ 0.33	$ 0.33	$ 0.23	$ 2.25	$ 2.44
Labor	$ 43.83	$ 41.91	$ 31.01	$ 31.01	$ 21.79	$ 55.68	$ 60.36
AWT Pretreatment Process Facilities	$ 13.42	$ 13.42	$ 9.93	$ 9.93	$ 6.98	$ 16.54	$ 17.93
Warren Facility Modifications (HPOLE/Centrate)	$ 0.94	$ 0.94	$ 0.69	$ 0.69	$ 0.49	$ 0.94	$ 1.01
IPS/Screen	$ 3.12	$ 3.12	$ 2.31	$ 2.31	$ 1.62	$ 4.68	$ 5.07
MBR	$ 9.36	$ 9.36	$ 6.93	$ 6.93	$ 4.87	$ 10.92	$ 11.84
AWT Process Facilities	$ 11.23	$ 11.23	$ 8.31	$ 8.31	$ 5.84	$ 14.66	$ 15.90
AWT	$ 11.23	$ 11.23	$ 8.31	$ 8.31	$ 5.84	$ 14.66	$ 15.90
DPR Process Facilities	$ 3.74	$ 3.74	$ 2.77	$ 2.77	$ 1.95	$ 9.05	$ 9.81
DPR	$ 3.74	$ 3.74	$ 2.77	$ 2.77	$ 1.95	$ 9.05	$ 9.81
Additional Ancillary Facilities	$ 15.43	$ 13.52	$ 10.00	$ 10.00	$ 7.03	$ 15.43	$ 16.73
Public Outreach	$ 1.08	$ 1.08	$ 0.80	$ 0.80	$ 0.56	$ 1.08	$ 1.17
Laboratory	$ 12.48	$ 10.82	$ 8.00	$ 8.00	$ 5.62	$ 12.48	$ 13.53
Workforce Facilities (off-site)	$ 1.87	$ 1.62	$ 1.20	$ 1.20	$ 0.84	$ 1.87	$ 2.03
Other	$ 4.70	$ 5.09	$ 3.77	$ 3.77	$ 2.65	$ 6.47	$ 7.01
Warren Facility Secondary Treatment and Biosolids	$ 4.80	$ 5.20	$ 3.85	$ 3.85	$ 2.71	$ 6.57	$ 7.12
Renewable Energy Credits	$ (0.10)	$ (0.11)	$ (0.08)	$ (0.08)	$ (0.06)	$ (0.10)	$ (0.11)
CONVEYANCE AND RECHARGE FACILITIES	$ 39.39	$ 30.56	$ 22.67	$ 22.67	$ 16.17	$ 54.78	$ 43.45
Conveyance Facilities	$ 28.05	$ 29.58	$ 22.32	$ 22.32	$ 16.17	$ 43.59	$ 42.10
Labor	$ -	$ 2.53	$ 1.87	$ 1.87	$ 1.32	$ -	$ 3.01
Pump Station at AWTF		$ 0.59	$ 0.44	$ 0.44	$ 0.31		$ 0.59
Pump Station at Whittier Narrows		$ 0.59	$ 0.44	$ 0.44	$ 0.31		$ 0.59
-- WNPS Disinfection Booster PS		$ 0.08	$ 0.06	$ 0.06	$ 0.04		$ 0.08
Pump Station at Santa Fe Spreading Grounds		$ 0.47	$ 0.35	$ 0.35	$ 0.24		$ 0.47
Pump Station - Azusa 1		$ 0.36	$ 0.27	$ 0.27	$ 0.19		$ 0.36
-- Canyon PS Disinfection Booster PS		$ 0.08	$ 0.06	$ 0.06	$ 0.04		$ -
Pump Station - Azusa 2		$ 0.36	$ 0.27	$ 0.27	$ 0.19		$ 0.36
Pump Station at Santa Fe Spreading Grounds - Set B		$ -	$ -	$ -	$ -		$ 0.12
--SFPS Set B Disinfection Booster PS		$ -	$ -	$ -	$ -		$ 0.08
Pump Station - DPR		$ -	$ -	$ -	$ -		$ 0.36
Maintenance and Repar Costs - Spare Parts/Consumables/Misc.	$ -	$ 1.28	$ 0.95	$ 0.95	$ 0.67	$ -	$ 1.64
Pump Station at AWTF		$ 0.28	$ 0.21	$ 0.21	$ 0.15		$ 0.28
Pump Station at Whittier Narrows		$ 0.28	$ 0.21	$ 0.21	$ 0.15		$ 0.28
-- WNPS Disinfection Booster PS		$ 0.08	$ 0.06	$ 0.06	$ 0.04		$ 0.08
Pump Station at Santa Fe Spreading Grounds		$ 0.24	$ 0.18	$ 0.18	$ 0.12		$ 0.24
Pump Station - Azusa 1		$ 0.18	$ 0.13	$ 0.13	$ 0.09		$ 0.18
-- Canyon PS Disinfection Booster PS		$ 0.04	$ 0.03	$ 0.03	$ 0.02		$ -
Pump Station - Azusa 2		$ 0.18	$ 0.13	$ 0.13	$ 0.09		$ 0.18
Pump Station at Santa Fe Spreading Grounds - Set B		$ -	$ -	$ -	$ -		$ 0.18
--SFPS Set B Disinfection Booster PS		$ -	$ -	$ -	$ -		$ 0.04
Pump Station - DPR		$ -	$ -	$ -	$ -		$ 0.18
Energy ($0.15/K-hr)	$ -	$ 25.77	$ 19.49	$ 19.49	$ 14.19	$ -	$ 37.45
Pump Station at AWTF		$ 6.97	$ 5.16	$ 5.16	$ 3.62		$ 10.02
Pump Station at Whittier Narrows		$ 10.99	$ 8.13	$ 8.13	$ 5.72		$ 13.80
-- WNPS Disinfection Booster PS		$ 0.03	$ 0.02	$ 0.02	$ 0.01		$ 0.03
Pump Station at Santa Fe Spreading Grounds		$ 1.55	$ 1.15	$ 1.15	$ 0.81		$ 1.55
Pump Station - Azusa 1		$ 2.31	$ 1.71	$ 1.71	$ 1.20		$ 2.31
- Canyon PS Disinfection Booster PS		$ 0.03	$ 0.02	$ 0.02	$ 0.01		$ -
Pump Station - Azusa 2		$ 2.25	$ 1.66	$ 1.66	$ 1.17		$ 2.25
Pump Station at Santa Fe Spreading Grounds - Set B		$ -	$ -	$ -	$ -		$ 3.09
--SFPS Set B Disinfection Booster PS		$ -	$ -	$ -	$ -		$ 0.03
Pump Station - DPR		$ -	$ -	$ -	$ -		$ 2.72
SCE Substation Without replacement coverage (0.39% monthly billing factor)		$ 1.64	$ 1.64	$ 1.64	$ 1.64		$ 1.64
Recharge Facilities	$ 11.34	$ 0.98	$ 0.35	$ 0.35	$ -	$ 11.19	$ 1.36
West Coast Basin Injection Wells	$ 2.52	$ -	$ -	$ -	$ -	$ 2.52	$ -
Long Beach Injection Wells	$ 2.52	$ -	$ -	$ -	$ -	$ 2.52	$ -
Coastal Spreading Basins	$ 1.26	$ -	$ -	$ -	$ -	$ 1.23	$ -
Rio Hondo Spreading Basins	$ 1.26	$ -	$ -	$ -	$ -	$ 1.23	$ -
Santa Fe Dam Spreading Basins	$ 1.26	$ -	$ -	$ -	$ -	$ 1.23	$ -
Rock Pit #3 Spreading Basin	$ 1.26	$ -	$ -	$ -	$ -	$ 1.23	$ -
Canyon Spreading Basins	$ 1.26	$ -	$ -	$ -	$ -	$ 1.23	$ -
United Rock Pit No. 3	$ -	$ 0.35	$ 0.35	$ 0.35	$ -	$ -	$ 0.35
Vulcan Durbin	$ -	$ 0.63	$ -	$ -	$ -	$ -	$ 0.63
Vulcan Quarry No.1	$ -	$ -	$ -	$ -	$ -	$ -	$ 0.38
Subtotal - Conveyance + AWPF	$ 171.03	$ 165.78	$ 122.73	$ 122.73	$ 86.49	$ 241.66	$ 246.03
BIM Maintenance Costs	$ -	$ 2.50	$ 2.50	$ 2.50	$ 2.50	$ -	$ 2.50
PMIS Maintenance Costs	$ -	$ 0.18	$ 0.18	$ 0.18	$ 0.18	$ -	$ 0.18
Subtotal	$ 171.03	$ 168.46	$ 125.41	$ 125.41	$ 89.17	$ 241.66	$ 248.71
Contingency (15%)	$ 25.65	$ 25.27	$ 18.81	$ 18.81	$ 13.38	$ 36.25	$ 37.31
TOTAL	$ 196.69	$ 193.73	$ 144.23	$ 144.23	$ 102.54	$ 277.90	$ 286.01
Metropolitan Share	$ 166.63	$ 167.26	$ 124.64	$ 124.64	$ 88.78	$ 240.32	$ 245.27
LACSD Share	$ 30.05	$ 26.47	$ 19.58	$ 19.58	$ 13.76	$ 37.58	$ 40.74

Appendix C Detailed Cost Estimate Report for AWPF, 2025

MWD Pure Waters Southern California
AWPF Design Info to Support Cost Estimate - Pure Waters Southern California Conveyance and Advanced Water Treatment Facility Options 25 MGD to 150 MGD
Opinion of Probable Cost - Preliminary Internal Estimate

Project name	23-021 MWD PWSC Program Management PO Box 54153 Los Angeles CA 90054-0153 USA
Client	Metropolitan Water District of Southern California PO Box 54153 Los Angeles CA 90054-0153
Architect	AECOM B&C
Estimator	Josh Jeffrey, PE
Labor rate table	1 AECOM RATES 25
Equipment rate table	Equip - ACM 2Sld wrk
Job size	115 MGD
Duration	60 Mo
Project	Water Conveyance
Bus Line	Water
Section	Southwest
Office	Los Angeles, CA
Principal Party	Donal Barron
Estimating Office	North Hampton, NH
Contract 1	Josh Jeffrey
Contact 2	Alexx Williams, Andrew Detwiler, William Melton
Estimate Class Lvl	4/5
Estimate Purpose	Conceptual
FY Estimate	2025
Estimate Number	23-021
Start Date	2025
LD's	NA
Notes	*Opinion of Probable Construction Cost - AWPF Design Info to Support Cost EstimateBid-Build Contract Format Client: Metropolitan Water District of Southern California Program: Pure Waters Southern California Conveyance and Advanced Water Treatment Facility Options 25 MGD to 150 MGD - AACEI Estimate Classification: Class 4/5 Contract Format: Design-Bid-Build PMC/Engineering Consultant: Program Managment Consultant, Joint Venture AECOM Brown & Caldwell Basis of Estimate: Date: June 24, 2025* *The enclosed Opinion of Probable Cost is only an EOPCC of possible construction costs for budgeting purposes. This EOPCC is limited to the conditions existing at issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as but not limited to; local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events and developing bidding conditions, imposed trade tariffs, etc. may affect the accuracy of this EOPCC. AECOM is not responsible for any variance from this Opinion of Probable Cost or actual prices and conditions obtained.* *Basis of Estimate Assumptions:* *·Placement of Buildings on Site based on site plan developed by Stantec* *·Building Square Footages Taken from Basis of Design Document (PWSC AWPF Conceptual Facilities Plan – Stantec 12/29/2023) and adjusted by original plant capacity of 115 MGD to approximate the size of buildings based on the new capacity factor.* *·Stantec Site Plan Scaled to Obtain other Building Square Footages that were not itemized in tables within Appendix H.* *·AWPF Design Info to Support Cost Estimate Spreadsheets provided by project design teams for each estimated scenario. Utilized for quantity of equipment trains, components, itemized pump size / horsepower, tanks sizes, etc.* *·Holding / Storage Tank Sizes Based on Volumes Provided in PWSC TWA Draft Basis of Design v0.1.xlsx Spreadsheet.* *·Quotes obtained and shared by project team during estimating process prior to the date of this BOE.* *·Historic Costs Located in previous estimates for Similar equipment itemized in the AWPF Design Info to Support Cost Estimate Spreadsheets.* *·Facilities with two floors carried Division 05-23 Costs as double hsf quantity in accordance with parameters used in Appendix H "Conceptual Facilities Plan to the Joint Plant."* *·The Exported Grand Total Direct Cost Format for this Estimate as requested by design team does not include escalation costs or contingency costs and therefore does not meet the parameters established by AACEI for the Current Class 4/5 Estimate provided by AECOM. The Design Team should verify and include in some fashion within their own reporting sheet all indirect cost types shown on the Totals Page included with this estimate export.* *·Process Piping Materials taken as 20% of Total Process Equipment Costs in accordance with parameters used in Appendix H "Conceptual Facilities Plan to the Joint Plant" until details are further defined.* *·Process Piping Installation taken as approximately 17.5% Labor and 7.5% Equipment of Total Process Equipment Costs in accordance with parameters used in Appendix H "Conceptual Facilities Plan to the Joint Plant" until details are further defined.* *·If the notes within a description of an item differ from the quantity of an item, the quantity is the controlling factor.* *·Electrical Buildings called out within the estimate for Major Systems Power.* *·Electrical Gear unit price per square foot carried within estimate.* *·Excavation Work for Major Buildings Associated with the Process Systems Defined in the Estimate.* *·Modifications to offsite Facilities / Systems for Discharge of Flush Waters, Brine, etc.* *·Yard Piping* *·Site Prep* *·Site Improvements / Site Restoration Costs* *·"Yard Piping" Itemized and Listed in Section 08 Appendix H "Conceptual Facilities Plan to the Joint Plant* *·"Civil" Site Prep, Site Improvements / Site Restoration Costs Itemized and Listed in Section 09 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Additional Site Prep" Itemized and Listed in Section 10 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Wastewater Processes" Itemized and Listed in Section 11 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Power Infrastructure" Itemized and Listed in Section 12 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·* *Estimated Grand Total Price Inclusions:* *·Mobe / Demobe* *·Labor Premium Costs for Overtime based on Actual Labor Hours Estimated.* *·Bond on Subcontractors (0.75% of Total Estimated Direct Costs)* *·Startup, Testing & Commissioning Costs (2% of total Estimated Direct Costs)* *·Labor Force Consumables (Small Tolls, Supplies, Safety Equipment) Directly Related to Scopes of Work.* *· GC OH&P on Self-Performed Work (L,M,E,O)* *·GC OH&P on Subcontractors* *·General Liability Insurance* *·Permits and Fees, by Contractor* *·Pollution Ltd Liability Insurance* *·Professional Liability Insurance* *·Builder's Risk (all Risk) Insurance* *·Performance & Payment Bond (%)* *Estimated Grand Total Price Exclusions:* *·Modifications to offsite Facilities / Systems for Discharge of Flush Waters, Brine, etc.* *·Site Demo* *·Auxiliary Buildings / Structure for Needed Infrastructure* *·Substations / Power Feeds / Duct Banks* *·Electrical Buildings not Specifically called out within the estimate.* *·"Other Facilities" Itemized and Listed in Section 07 Appendix H "Conceptual Facilities Plan to the Joint Plant Site for PWSC"* *·design team should review electrical costs carried in Appendix H as a quick check of these costs are pointing to the conclusion that actual current costs could be substantially higher that shown in Appendix H* *·Original estimate from Stantec missed the 8th generator on a future phase. refer to previous note above.* *·"Additional Site Prep" Itemized and Listed in Section 10 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Wastewater Processes" Itemized and Listed in Section 11 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·Phasing or Partial Construction is Excluded.* *Estimate Indirect Cost Exclusions:* *·"Soft Costs" Itemized and Listed in Section 13 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"O & M Costs" Itemized and Listed below Section 13 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Power Costs" Itemized and Listed below Section 13 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Chemicals Costs" Itemized and Listed below Section 13 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Equipment Maintenance Costs" Itemized and Listed below Section 13 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·"Equipment Replacement Costs" Itemized and Listed below Section 13 Appendix H "Conceptual Facilities Plan to the Joint Plant"* *·Escalation Costs* *·Allowances* *·Construction Contingencies* *·CM Fees* *·Owner Allowances* *·Owner Contingency* *·Owner Management Costs* *·Owner Soft Costs – Land, Legal, etc.* *Estimate Total Cost Shown of Totals Page:* *·Costs Shown on Totals Page were Developed by Mark McClenahan for the MWD PWSC Program as part of the programmatic standards recommended for all prepared estimates.* *Cost Estimate Legal Disclaimer:* *The enclosed Opinion of Probable Cost is only an EOPCC of possible construction costs for budgeting purposes. This EOPCC is limited to the conditions existing at issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as but not limited to; local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events and developing bidding conditions, imposed trade tariffs, etc. may affect the accuracy of this EOPCC. AECOM is not responsible for any variance from this Opinion of Probable Cost or actual prices and conditions obtained.*
Report format	Sorted by 'Pathway / Scenario/Location-1/Process System/Scope of Work -/CSI Division #' 'Detail' summary Allocate addons
Alternates	01.02.01

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
01.02.01					**Phase 2 (150 MGD) - 90 mgd IPR to Canyon SG + up to 60 mgd to Weymouth**													
	001. - Ozone				Ozone													
		010.-032			Filtrate Pump to Bubble Diffuser Pump Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					010.-032 Filtrate Pump to Bubble Diffuser Pump Piping								/lf			/lf		
		030.			LOX Tanks													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	1851.534 sf	370	33,434	2,819				19.58 /sf	36,253	26,427	34 /sf	62,681	0.00%
					Keyway 4"	617.213 lf	31	2,786	305				5.01 /lf	3,091	2,239	9 /lf	5,330	0.00%
					Waterstop 6" Bulb	617.213 lf	62	5,529	3,577				14.75 /lf	9,106	6,004	24 /lf	15,110	0.00%
					Strip & Oil Footing Forms	1851.534 sf	9	829	130				0.52 /sf	959	687	1 /sf	1,646	0.00%
					Footing Rebar	3.813 tn	76	7,818	7,207				3,940.41 /tn	15,025	9,498	6,431 /tn	24,522	0.00%
					Pump Place Wall Footings	103.058 cy	57	6,075			495		63.75 /cy	6,570	4,689	109 /cy	11,259	0.00%
					4500 psi Concrete	103.058 cy			21,642				210.00 /cy	21,642	11,326	320 /cy	32,968	0.00%
					Div. 03 Concrete	1,851.530 hsf	606	56,471	35,680		495		50.04 /hsf	92,646	60,870	82.91 /hsf	153,516	0.00%
					Footing Footing	**103.060 cy**	606	56,471	35,680		495		898.95 /cy	92,646	60,870	1,489.58 /cy	153,516	0.00%
			Foundation Wall		**Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	92.749 lf	5	419	46				5.01 /lf	464	336	9 /lf	801	0.00%
					Rented Form System 16'->	3709.959 sf	927	83,741	38,955				33.07 /sf	122,696	82,883	55 /sf	205,579	0.00%
					Wall Bulkhead Forms	185.499 sf	102	9,212	974				54.91 /sf	10,185	7,384	95 /sf	17,570	0.00%
					Waterstop 6" Bulb	185.499 lf	19	1,662	1,075				14.75 /lf	2,737	1,804	24 /lf	4,541	0.00%
					Strip & Oil Wall Forms	3709.959 sf	19	1,662	260				0.52 /sf	1,921	1,378	1 /sf	3,299	0.00%
					Hot Water Charge	137.406 cy			1,154				8.40 /cy	1,154	604	13 /cy	1,758	0.00%
					Wall Rebar	12.091 tn	278	28,508	22,853				4,247.84 /tn	51,361	32,840	6,964 /tn	84,201	0.00%
					Finish- Top of Wall & Curb	154.581 sf	9	761					4.93 /sf	761	569	9 /sf	1,330	0.00%
					Pump Place Walls	137.406 cy	192	20,432			989		155.89 /cy	21,421	15,415	268 /cy	36,835	0.00%
					4500 psi Concrete	137.406 cy			28,855				210.00 /cy	28,855	15,101	320 /cy	43,956	0.00%
					Grind/Patch Walls	3709.959 sf	297	26,582	130				7.20 /sf	26,712	19,931	13 /sf	46,643	0.00%
					Liquid Curing Compounds	3709.959 sf	11	997	2,922				1.06 /sf	3,919	2,274	2 /sf	6,193	0.00%
					Div. 03 Concrete	3,710.000 hsf	1,858	173,975	97,223		989		73.37 /hsf	272,187	180,519	122.02 /hsf	452,706	0.01%
					Foundation Wall Foundation Wall	**137.410 cy**	1,858	173,975	97,223		989		1,980.84 /cy	272,187	180,519	3,294.56 /cy	452,706	0.01%
			Ozone Generators		**Ozone Generators**													
				Div. 46	Water and Wastewater Equipment													
					Lox Tanks	188.64 MGD	4,527	471,950	603,648		37,619	16,506,000	93,401.28 /MGD	17,619,217	9,318,894	142,802 /MGD	26,938,111	0.61%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	4,527	471,950	603,648		37,619	16,506,000	117,461.45 /mgd	17,619,217	9,318,894	179,587.41 /mgd	26,938,111	0.61%
					Ozone Generators Ozone Generators	**150.000 MGD**	4,527	471,950	603,648		37,619	16,506,000	117,461.45 /MGD	17,619,217	9,318,894	179,587.41 /MGD	26,938,111	0.61%
			Slab		**Slab**													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	766.123 sf	260	23,518	1,166				32.22 /sf	24,685	18,162	56 /sf	42,847	0.00%
					S-O-G Const Joints > 1'	1430.523 sf	515	46,497	2,178				34.03 /sf	48,675	35,841	59 /sf	84,516	0.00%
					Strip & Oil SOG Form	2196.646 sf	11	984	154				0.52 /sf	1,138	816	1 /sf	1,953	0.00%
					SOG Rebar	68.877 tn	1,033	105,911	130,178				3,427.68 /tn	236,089	145,700	5,543 /tn	381,789	0.01%
					Mesh Support - bricks	1103 ea	2	226	567				0.72 /ea	794	463	1 /ea	1,256	0.00%
					Finish- Hard Trowel	9536.813 sf	219	19,644					2.06 /sf	19,644	14,679	4 /sf	34,324	0.00%
					Pump Place Slab on Grade	1059.646 cy	1,272	135,057			3,051		130.33 /cy	138,108	100,051	225 /cy	238,159	0.01%
					4500 psi Concrete	1059.646 cy			222,526				210.00 /cy	222,526	116,456	320 /cy	338,982	0.01%
					Liquid Curing Compounds	9536.813 sf	29	2,563	7,510				1.06 /sf	10,073	5,845	2 /sf	15,919	0.00%
					Seal Floors	9536.813 sf	48	4,271	2,003				0.66 /sf	6,274	4,240	1 /sf	10,514	0.00%
					Div. 03 Concrete	9,536.810 hsf	3,389	338,672	366,282		3,051		74.24 /hsf	708,005	442,253	120.61 /hsf	1,150,258	0.03%
					Slab Slab	**1,059.650 cy**	3,389	338,672	366,282		3,051		668.15 /cy	708,005	442,253	1,085.51 /cy	1,150,258	0.03%
					030. LOX Tanks	9,536.810 sf	10,380	1,041,068	1,102,833		42,154	16,506,000	1,959.99 /sf	18,692,055	10,002,537	3,008.82 /sf	28,694,592	0.65%
		030.-036			Lox Tanks to Ozone Generators Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder 1" Dia Pipe inside 6" Sch 80 pvc	***242.350 lf***							***/lf***			***/lf***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					030.-036 Lox Tanks to Ozone Generators Piping	150.000 MGD							/MGD			/MGD		
		032.			Bubble Diffuser Pump													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					032. Bubble Diffuser Pump	1.000 ls							/ls			/ls		

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
		032.-034			Bubble Diffuser Pump to Bubble Diffusers Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					032.-034 Bubble Diffuser Pump to Bubble Diffusers Piping								/lf			/lf		
		034.			Bubble Diffusers													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Bubler Diffuser		**Bubler Diffuser**													
				Div. 46	Water and Wastewater Equipment													
					Furnish & Install Distribution Systems & Diffusers (bubblers)	24486.52 sf	**3,061**	315,726	**306,082**		**46,970**	**244,865**	37.31 /sf	**913,643**	**544,197**	**60** /sf	**1,457,840**	0.03%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	**3,061**	**315,726**	**306,082**		**46,970**	**244,865**	**6,090.95** /mgd	**913,643**	**544,197**	**9,718.93** /mgd	**1,457,840**	**0.03%**
					Bubler Diffuser Bubler Diffuser		**3,061**	**315,726**	**306,082**		**46,970**	**244,865**	**/sf**	**913,643**	**544,197**	**/sf**	**1,457,840**	**0.03%**
					034. Bubble Diffusers	150.000 MGD	**3,061**	**315,726**	**306,082**		**46,970**	**244,865**	**6,090.95 /MGD**	**913,643**	**544,197**	**9,718.93 /MGD**	**1,457,840**	**0.03%**
		034.-040			Bubble Diffuser to Ozone Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					034.-040 Bubble Diffuser to Ozone Piping								/lf			/lf		
		036.			Ozone Generators Building													
			Building		**Building**													
				Div. 04	Masonry													
					Interior Staging over 10 '	12764.64 sf	**64**	6,590	**6,382**				1.02 /sf	**12,973**	**7,965**	**2** /sf	**20,937**	0.00%
					Staging to 30'	12764.64 sf	**64**	6,590	**9,573**				1.27 /sf	**16,164**	**9,635**	**2** /sf	**25,799**	0.00%
					Rub Block	12764.64 sf	**170**	17,570					1.38 /sf	**17,570**	**12,856**	**2** /sf	**30,426**	0.00%
					Mortar	919.054 cf			**7,170**				7.80 /cf	**7,170**	**3,752**	**12** /cf	**10,922**	0.00%
					Mortar	1531.757 cf			**11,950**				7.80 /cf	**11,950**	**6,254**	**12** /cf	**18,204**	0.00%
					Grout Fill 10" Block Cells	7901.312 cf	**2,370**	244,769	**50,193**				37.33 /cf	**294,962**	**205,364**	**63** /cf	**500,326**	0.01%
					Grout Fill 10"Lintel Block	63.823 cf	**19**	1,977	**405**				37.33 /cf	**2,383**	**1,659**	**63** /cf	**4,041**	0.00%
					Grout Fill 10 "Bond Beam	102.117 cf	**31**	3,163	**649**				37.33 /cf	**3,812**	**2,654**	**63** /cf	**6,466**	0.00%
					Dur-O-Wall 10"	10377.652 lf			**4,794**				0.46 /lf	**4,794**	**2,509**	**1** /lf	**7,304**	0.00%
					Wall Ties	14769 ea	**197**	20,329	**1,861**				1.50 /ea	**22,190**	**15,849**	**3** /ea	**38,038**	0.00%
					Extruded Control Joints 1/2"	1238.17 lf	**7**	730	**2,899**				2.93 /lf	**3,629**	**2,051**	**5** /lf	**5,681**	0.00%
					Masonry Rebar # 5	229.764 lbs	**3**	285	**162**				1.94 /lbs	**446**	**293**	**3** /lbs	**739**	0.00%
					Masonry Rebar # 5	60223.572 lbs	**723**	74,625	**42,397**				1.94 /lbs	**117,022**	**76,791**	**3** /lbs	**193,813**	0.00%
					Standard Brick	85409 ea	**3,416**	352,784	**89,679**				5.18 /ea	**442,463**	**305,062**	**9** /ea	**747,526**	0.02%
					10" Block Bond Beam	447 ea	**37**	3,855	**10,255**				31.57 /ea	**14,110**	**8,188**	**50** /ea	**22,298**	0.00%
					10" Block Lintels	166 ea	**14**	1,432	**3,808**				31.57 /ea	**5,240**	**3,041**	**50** /ea	**8,281**	0.00%
					10" Fire Rated 3 hr	13110 ea	**1,095**	113,065	**93,605**				15.76 /ea	**206,671**	**131,717**	**26** /ea	**338,387**	0.01%
					Div. 04 Masonry	**12,764.640 vsf**	**8,210**	**847,765**	**335,785**				**92.72 /vsf**	**1,183,551**	**795,638**	**155.05 /vsf**	**1,979,189**	**0.04%**
				Div. 05 -15	**Div 5/6/7/8/9/10/11/12/22/23**													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	17594.61 sf				**4,164,644**			236.70 /sf	**4,164,644**	**1,398,651**	**316** /sf	**5,563,295**	0.13%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	**17,594.610 hsf**				**4,164,644**			**236.70 /hsf**	**4,164,644**	**1,398,651**	**316.19 /hsf**	**5,563,295**	**0.13%**
					Building Building	**17,594.610 hsf**	**8,210**	**847,765**	**335,785**	**4,164,644**			**303.97 /hsf**	**5,348,195**	**2,194,289**	**428.68 /hsf**	**7,542,484**	**0.17%**
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2426.741 sf	**485**	43,821	**3,695**				19.58 /sf	**47,516**	**34,637**	**34** /sf	**82,153**	0.00%
					Keyway 4"	808.959 lf	**40**	3,652	**399**				5.01 /lf	**4,051**	**2,934**	**9** /lf	**6,986**	0.00%
					Waterstop 6" Bulb	808.959 lf	**81**	7,246	**4,689**				14.75 /lf	**11,935**	**7,869**	**24** /lf	**19,804**	0.00%
					Strip & Oil Footing Forms	2426.741 sf	**12**	1,087	**170**				0.52 /sf	**1,257**	**901**	**1** /sf	**2,158**	0.00%
					Footing Rebar	4.998 tn	**100**	10,247	**9,446**				3,940.28 /tn	**19,694**	**12,449**	**6,431** /tn	**32,143**	0.00%
					Pump Place Wall Footings	135.074 cy	**75**	7,962			**648**		63.75 /cy	**8,611**	**6,146**	**109** /cy	**14,757**	0.00%
					4500 psi Concrete	135.074 cy			**28,366**				210.00 /cy	**28,366**	**14,845**	**320** /cy	**43,210**	0.00%
					Div. 03 Concrete	**2,426.740 hsf**	**794**	**74,016**	**46,765**		**648**		**50.04 /hsf**	**121,429**	**79,781**	**82.91 /hsf**	**201,210**	**0.00%**
					Footing Footing	**135.070 cy**	**794**	**74,016**	**46,765**		**648**		**899.01 /cy**	**121,429**	**79,781**	**1,489.67 /cy**	**201,210**	**0.00%**
			Ozone Foundation Wall		**Ozone Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	121.567 lf	**6**	549	**60**				5.01 /lf	**609**	**441**	**9** /lf	**1,050**	0.00%
					Rented Form System 16'->	4862.668 sf	**1,216**	109,760	**51,058**				33.07 /sf	**160,818**	**108,635**	**55** /sf	**269,453**	0.01%
					Wall Bulkhead Forms	243.133 sf	**134**	12,074	**1,276**				54.91 /sf	**13,350**	**9,679**	**95** /sf	**23,029**	0.00%
					Waterstop 6" Bulb	243.133 lf	**24**	2,178	**1,409**				14.75 /lf	**3,587**	**2,365**	**24** /lf	**5,952**	0.00%
					Strip & Oil Wall Forms	4862.668 sf	**24**	2,178	**340**				0.52 /sf	**2,518**	**1,806**	**1** /sf	**4,324**	0.00%
					Hot Water Charge	180.099 cy			**1,513**				8.40 /cy	**1,513**	**792**	**13** /cy	**2,305**	0.00%
					Wall Rebar	15.848 tn	**365**	37,366	**29,952**				4,247.73 /tn	**67,318**	**43,043**	**6,964** /tn	**110,361**	0.00%
					Finish- Top of Wall & Curb	202.611 sf	**11**	998					4.93 /sf	**998**	**746**	**9** /sf	**1,744**	0.00%
					Pump Place Walls	180.099 cy	**252**	26,780			**1,296**		155.89 /cy	**28,076**	**20,204**	**268** /cy	**48,280**	0.00%
					4500 psi Concrete	180.099 cy			**37,821**				210.00 /cy	**37,821**	**19,793**	**320** /cy	**57,614**	0.00%
					Grind/Patch Walls	4862.668 sf	**389**	34,841	**170**				7.20 /sf	**35,011**	**26,124**	**13** /sf	**61,135**	0.00%
					Liquid Curing Compounds	4862.668 sf	**15**	1,307	**3,829**				1.06 /sf	**5,136**	**2,980**	**2** /sf	**8,117**	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 03 Concrete	4,862.670 hsf	2,435	228,031	127,429		1,296		73.37 /hsf	356,756	236,607	122.02 /hsf	593,363	0.01%
					Ozone Foundation Wall Ozone Foundation Wall	180.100 cy	2,435	228,031	127,429		1,296		1,980.88 /cy	356,756	236,607	3,294.63 /cy	593,363	0.01%
			Ozone Generators		Ozone Generators													
				Div. 46	Water and Wastewater Equipment													
					Ozone Generator, closed loop cooling sys. Destruct Units, PSU & controls	188.64 MGD	12,828	1,337,192	1,284,280		106,587	19,912,001	120,017.28 /MGD	22,640,060	12,126,290	184,300 /MGD	34,766,350	0.79%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	12,828	1,337,192	1,284,280		106,587	19,912,001	150,933.73 /mgd	22,640,060	12,126,290	231,775.66 /mgd	34,766,350	0.79%
					Ozone Generators Ozone Generators	150.000 MGD	12,828	1,337,192	1,284,280		106,587	19,912,001	150,933.73 /MGD	22,640,060	12,126,290	231,775.66 /MGD	34,766,350	0.79%
			Ozone Slab		Ozone Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	1412.276 sf	480	43,354	2,150				32.22 /sf	45,504	33,480	56 /sf	78,985	0.00%
					S-O-G Const Joints > 1'	2637.029 sf	949	85,713	4,015				34.03 /sf	89,728	66,069	59 /sf	155,797	0.00%
					Strip & Oil SOG Form	4049.303 sf	20	1,814	283				0.52 /sf	2,097	1,504	1 /sf	3,601	0.00%
					SOG Rebar	126.968 tn	1,905	195,236	239,969				3,427.67 /tn	435,205	268,583	5,543 /tn	703,788	0.02%
					Mesh Support - bricks	2032 ea	4	417	1,045				0.72 /ea	1,462	852	1 /ea	2,314	0.00%
					Finish- Hard Trowel	17580.187 sf	404	36,213					2.06 /sf	36,213	27,060	4 /sf	63,273	0.00%
					Pump Place Slab on Grade	1953.354 cy	2,344	248,964			5,625		130.33 /cy	254,589	184,434	225 /cy	439,022	0.01%
					4500 psi Concrete	1953.354 cy			410,204				210.00 /cy	410,204	214,676	320 /cy	624,880	0.01%
					Liquid Curing Compounds	17580.187 sf	53	4,724	13,844				1.06 /sf	18,569	10,776	2 /sf	29,344	0.00%
					Seal Floors	17580.187 sf	88	7,874	3,692				0.66 /sf	11,566	7,816	1 /sf	19,382	0.00%
					Div. 03 Concrete	17,580.190 hsf	6,247	624,308	675,203		5,625		74.24 /hsf	1,305,137	815,249	120.61 /hsf	2,120,386	0.05%
					Ozone Slab Ozone Slab	1,953.350 cy	6,247	624,308	675,203		5,625		668.15 /cy	1,305,137	815,249	1,085.51 /cy	2,120,386	0.05%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			7,204,253				7,204,253.17 /ls	7,204,253	3,770,268	10,974,521 /ls	10,974,521	0.25%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	36,663	3,666,287			1,246,537		4,912,824.04 /ls	4,912,824	3,243,360	8,156,184 /ls	8,156,184	0.18%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	36,663	3,666,287	7,204,253		1,246,537		80,780.51 /mgd	12,117,077	7,013,628	127,538.03 /mgd	19,130,705	0.43%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	36,663	3,666,287	7,204,253		1,246,537		80,780.51 /MGD	12,117,077	7,013,628	127,538.03 /MGD	19,130,705	0.43%
					036. Ozone Generators Building	150.000 MGD	67,177	6,777,599	9,673,716	4,164,644	1,360,694	19,912,001	279,257.69 /MGD	41,888,653	22,465,844	429,029.99 /MGD	64,354,498	1.46%
		036.-034			Ozone Generators to Bubble Diffusers Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					036.-034 Ozone Generators to Bubble Diffusers Piping								/lf			/lf		
		040.			Ozone Tank													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	15075.48 sf	75	7,784	7,538				1.02 /sf	15,321	9,406	2 /sf	24,728	0.00%
					Staging to 30'	15075.48 sf	75	7,784	11,307				1.27 /sf	19,090	11,379	2 /sf	30,469	0.00%
					Rub Block	15075.48 sf	201	20,751					1.38 /sf	20,751	15,183	2 /sf	35,934	0.00%
					Mortar	1085.435 cf			8,468				7.80 /cf	8,468	4,432	12 /cf	12,900	0.00%
					Mortar	1809.058 cf			14,113				7.80 /cf	14,113	7,386	12 /cf	21,499	0.00%
					Grout Fill 10" Block Cells	9331.722 cf	2,800	289,081	59,280				37.33 /cf	348,361	242,542	63 /cf	590,903	0.01%
					Grout Fill 10"Lintel Block	75.377 cf	23	2,335	479				37.33 /cf	2,814	1,959	63 /cf	4,773	0.00%
					Grout Fill 10 "Bond Beam	120.604 cf	36	3,736	766				37.33 /cf	4,502	3,135	63 /cf	7,637	0.00%
					Dur-O-Wall 10"	12256.365 lf			5,662				0.46 /lf	5,662	2,963	1 /lf	8,626	0.00%
					Wall Ties	17442.33 ea	233	24,009	2,198				1.50 /ea	26,207	18,717	3 /ea	44,924	0.00%
					Extruded Control Joints 1/2"	1462.322 lf	8	862	3,424				2.93 /lf	4,286	2,423	5 /lf	6,709	0.00%
					Masonry Rebar # 5	271.359 lbs	3	336	191				1.94 /lbs	527	346	3 /lbs	873	0.00%
					Masonry Rebar # 5	71126.115 lbs	854	88,135	50,073				1.94 /lbs	138,207	90,693	3 /lbs	228,900	0.01%
					Standard Brick	100870.037 ea	4,035	416,646	105,914				5.18 /ea	522,560	360,286	9 /ea	882,845	0.02%
					10" Block Bond Beam	528 ea	44	4,554	12,114				31.57 /ea	16,667	9,671	50 /ea	26,339	0.00%
					10" Block Lintels	196 ea	16	1,690	4,497				31.57 /ea	6,187	3,590	50 /ea	9,777	0.00%
					10" Fire Rated 3 hr	15483 ea	1,293	133,531	110,549				15.76 /ea	244,080	155,558	26 /ea	399,638	0.01%
					Div. 04 Masonry	15,075.480 vsf	9,696	1,001,233	396,571				92.72 /vsf	1,397,804	939,669	155.05 /vsf	2,337,473	0.05%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	49164.3 sf				11,637,190			236.70 /sf	11,637,190	3,908,224	316 /sf	15,545,414	0.35%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	49,164.300 hsf				11,637,190			236.70 /hsf	11,637,190	3,908,224	316.19 /hsf	15,545,414	0.35%
					Building Building	49,164.300 hsf	9,696	1,001,233	396,571	11,637,190			265.13 /hsf	13,034,994	4,847,893	363.74 /hsf	17,882,887	0.41%
			Elevated Slab		Elevated Slab													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	24582.15 sf	492	46,795	20,895				2.75 /sf	67,689	44,175	5 /sf	111,864	0.00%
					Form Suspended Slab 15-up	24582.15 sf	6,146	554,868	57,817				24.92 /sf	612,686	444,358	43 /sf	1,057,044	0.02%
					Slab Edge Form > 1'	1316.511 sf	329	29,716	3,950				25.57 /sf	33,666	24,244	44 /sf	57,910	0.00%
					Pour Strips	25898.661 lf	1,295	115,998	108,774				8.68 /lf	224,772	143,602	14 /lf	368,374	0.01%
					Strip & Oil Suspended Slab Frm	24582.15 sf	123	11,010	1,721				0.52 /sf	12,731	9,128	1 /sf	21,858	0.00%
					Suspended Slab Rebar	182.09 tn	5,463	559,992	344,151				4,965.37 /tn	904,143	590,266	8,207 /tn	1,494,410	0.03%
					Finish- Hard Trowel	24582.15 sf	565	50,636					2.06 /sf	50,636	37,838	4 /sf	88,473	0.00%
					Pump Place Suspended Slab	1820.9 cy	2,367	251,422			9,506		143.30 /cy	260,928	188,276	247 /cy	449,204	0.01%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					4500 psi Concrete	1820.9 cy			382,389				210.00 /cy	382,389	200,119	320 /cy	582,508	0.01%
					Liquid Curing Compounds	24582.15 sf	74	6,606	19,358				1.06 /sf	25,965	15,067	2 /sf	41,032	0.00%
					Div. 03 Concrete	24,582.150 hsf	16,853	1,627,043	939,055		9,506		104.78 /hsf	2,575,604	1,697,073	173.81 /hsf	4,272,677	0.10%
					Elevated Slab Elevated Slab	1,820.900 cy	16,853	1,627,043	939,055		9,506		1,414.47 /cy	2,575,604	1,697,073	2,346.46 /cy	4,272,677	0.10%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2866.148 sf	573	51,756	4,364				19.58 /sf	56,119	40,909	34 /sf	97,029	0.00%
					Keyway 4"	955.435 lf	48	4,313	472				5.01 /lf	4,785	3,466	9 /lf	8,250	0.00%
					Waterstop 6" Bulb	955.435 lf	96	8,559	5,538				14.75 /lf	14,096	9,293	24 /lf	23,390	0.00%
					Strip & Oil Footing Forms	2866.148 sf	14	1,284	201				0.52 /sf	1,484	1,064	1 /sf	2,549	0.00%
					Footing Rebar	5.903 tn	118	12,103	11,156				3,940.20 /tn	23,259	14,703	6,431 /tn	37,962	0.00%
					Pump Place Wall Footings	159.532 cy	89	9,404			766		63.75 /cy	10,170	7,259	109 /cy	17,429	0.00%
					4500 psi Concrete	159.532 cy			33,502				210.00 /cy	33,502	17,533	320 /cy	51,035	0.00%
					Div. 03 Concrete	2,866.150 hsf	937	87,418	55,232		766		50.04 /hsf	143,415	94,227	82.91 /hsf	237,642	0.01%
					Footing Footing	159.530 cy	937	87,418	55,232		766		898.99 /cy	143,415	94,227	1,489.64 /cy	237,642	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	825.562 lf	41	3,727	407				5.01 /lf	4,134	2,995	9 /lf	7,129	0.00%
					Rented Form System 16'->	33022.493 sf	8,256	745,384	346,736				33.07 /sf	1,092,120	737,743	55 /sf	1,829,863	0.04%
					Wall Bulkhead Forms	1651.125 sf	908	81,992	8,668				54.91 /sf	90,661	65,728	95 /sf	156,388	0.00%
					Waterstop 6" Bulb	1651.125 lf	165	14,790	9,570				14.75 /lf	24,360	16,060	24 /lf	40,421	0.00%
					Strip & Oil Wall Forms	33022.493 sf	165	14,790	2,312				0.52 /sf	17,102	12,262	1 /sf	29,364	0.00%
					Hot Water Charge	1223.055 cy			10,274				8.40 /cy	10,274	5,377	13 /cy	15,650	0.00%
					Wall Rebar	107.628 tn	2,475	253,763	203,416				4,247.77 /tn	457,179	292,321	6,964 /tn	749,500	0.02%
					Finish- Top of Wall & Curb	1375.938 sf	76	6,778					4.93 /sf	6,778	5,064	9 /sf	11,842	0.00%
					Pump Place Walls	1223.055 cy	1,712	181,864			8,803		155.89 /cy	190,667	137,206	268 /cy	327,873	0.01%
					4500 psi Concrete	1223.055 cy			256,842				210.00 /cy	256,842	134,415	320 /cy	391,257	0.01%
					Grind/Patch Walls	33022.493 sf	2,642	236,607	1,156				7.20 /sf	237,763	177,409	13 /sf	415,172	0.01%
					Liquid Curing Compounds	33022.493 sf	99	8,874	26,005				1.06 /sf	34,879	20,241	2 /sf	55,120	0.00%
					Div. 03 Concrete	33,022.490 hsf	16,540	1,548,570	865,386		8,803		73.37 /hsf	2,422,759	1,606,819	122.03 /hsf	4,029,578	0.09%
					Foundation Wall Foundation Wall	1,223.060 cy	16,540	1,548,570	865,386		8,803		1,980.90 /cy	2,422,759	1,606,819	3,294.67 /cy	4,029,578	0.09%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	1974.766 sf	671	60,621	3,007				32.22 /sf	63,628	46,815	56 /sf	110,443	0.00%
					S-O-G Const Joints > 1'	3687.323 sf	1,327	119,852	5,614				34.03 /sf	125,466	92,384	59 /sf	217,849	0.00%
					Strip & Oil SOG Form	5662.089 sf	28	2,536	396				0.52 /sf	2,932	2,102	1 /sf	5,035	0.00%
					SOG Rebar	177.538 tn	2,663	272,997	335,547				3,427.68 /tn	608,544	375,557	5,543 /tn	984,101	0.02%
					Mesh Support - bricks	2840.604 ea	6	582	1,461				0.72 /ea	2,044	1,191	1 /ea	3,235	0.00%
					Finish- Hard Trowel	24582.15 sf	565	50,636					2.06 /sf	50,636	37,838	4 /sf	88,473	0.00%
					Pump Place Slab on Grade	2731.35 cy	3,278	348,123			7,866		130.33 /cy	355,988	257,891	225 /cy	613,879	0.01%
					4500 psi Concrete	2731.35 cy			573,584				210.00 /cy	573,584	300,179	320 /cy	873,762	0.02%
					Liquid Curing Compounds	24582.15 sf	74	6,606	19,358				1.06 /sf	25,965	15,067	2 /sf	41,032	0.00%
					Seal Floors	24582.15 sf	123	11,010	5,162				0.66 /sf	16,172	10,929	1 /sf	27,101	0.00%
					Div. 03 Concrete	24,582.150 hsf	8,736	872,962	944,130		7,866		74.24 /hsf	1,824,957	1,139,954	120.61 /hsf	2,964,911	0.07%
					Slab Slab	2,731.350 cy	8,736	872,962	944,130		7,866		668.15 /cy	1,824,957	1,139,954	1,085.51 /cy	2,964,911	0.07%
					040. Ozone Tank	1.000 ls	52,762	5,137,226	3,200,374	11,637,190	26,940		20,001,729.26 /ls	20,001,729	9,385,966	29,387,695.32 /ls	29,387,695	0.67%
		040.-050			Ozone Tank to BAC Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - 84" Dia Piping	*309.160 lf*							/lf			/lf		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					040.-050 Ozone Tank to BAC Piping	150.000 MGD							/MGD			/MGD		
					001. - Ozone Ozone	150.000 MGD	133,380	13,271,619	14,283,003	15,801,834	1,476,758	36,662,866	543,307.20 /MGD	81,496,080	42,398,544	825,964.16 /MGD	123,894,625	2.81%
002. - BAC / BAF					Biologically Active Filtration (BAF) Systems													
		050.			BAC													
			BAC		BAC													
				Div. 46	Water and Wastewater Equipment													
					BAF Systems	21 ea	13,440	1,401,039	294,000		111,676	104,946,275	5,083,475.75 /ea	106,752,991	56,159,146	7,757,721 /ea	162,912,137	3.69%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	13,440	1,401,039	294,000		111,676	104,946,275	711,686.60 /mgd	106,752,991	56,159,146	1,086,080.91 /mgd	162,912,137	3.69%
					BAC BAC	150.000 MGD	13,440	1,401,039	294,000		111,676	104,946,275	711,686.60 /MGD	106,752,991	56,159,146	1,086,080.91 /MGD	162,912,137	3.69%
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	28445.34 sf	142	14,686	14,223				1.02 /sf	28,909	17,749	2 /sf	46,658	0.00%
					Staging to 30'	28445.34 sf	142	14,686	21,334				1.27 /sf	36,020	21,470	2 /sf	57,491	0.00%
					Rub Block	28445.34 sf	379	39,154					1.38 /sf	39,154	28,649	2 /sf	67,803	0.00%
					Mortar	2048.064 cf			15,978				7.80 /cf	15,978	8,362	12 /cf	24,340	0.00%
					Mortar	3413.441 cf			26,630				7.80 /cf	26,630	13,936	12 /cf	40,566	0.00%
					Grout Fill 10" Block Cells	17607.665 cf	5,282	545,456	111,853				37.33 /cf	657,308	457,643	63 /cf	1,114,951	0.03%
					Grout Fill 10"Lintel Block	142.227 cf	43	4,406	903				37.33 /cf	5,309	3,697	63 /cf	9,006	0.00%
					Grout Fill 10 "Bond Beam	227.563 cf	68	7,050	1,446				37.33 /cf	8,495	5,915	63 /cf	14,410	0.00%
					Dur-O-Wall 10"	23126.061 lf			10,684				0.46 /lf	10,684	5,591	1 /lf	16,276	0.00%
					Wall Ties	32912 ea	439	45,302	4,147				1.50 /ea	49,449	35,318	3 /ea	84,767	0.00%
					Extruded Control Joints 1/2"	2759.198 lf	16	1,627	6,461				2.93 /lf	8,088	4,572	5 /lf	12,659	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Masonry Rebar # 5	134205.114 lbs	1,610	166,298	94,480				1.94 /lbs	260,778	171,124	3 /lbs	431,903	0.01%
					Masonry Rebar # 5	512.016 lbs	6	634	360				1.94 /lbs	995	653	3 /lbs	1,648	0.00%
					Standard Brick	190328 ea	7,613	786,154	199,844				5.18 /ea	985,999	679,810	9 /ea	1,665,809	0.04%
					10" Block Bond Beam	996 ea	83	8,590	22,851				31.57 /ea	31,441	18,244	50 /ea	49,684	0.00%
					10" Block Lintels	370 ea	31	3,191	8,489				31.57 /ea	11,680	6,777	50 /ea	18,457	0.00%
					10" Fire Rated 3 hr	29214 ea	2,440	251,952	208,588				15.76 /ea	460,540	293,514	26 /ea	754,054	0.02%
					Div. 04 Masonry	**28,445.340 vsf**	**18,295**	**1,889,187**	**748,271**				**92.72 /vsf**	**2,637,457**	**1,773,023**	**155.05 /vsf**	**4,410,481**	**0.10%**
				Div. 05 -15	**Div 5/6/7/8/9/10/11/12/22/23**													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	70825.15 sf				16,764,313			236.70 /sf	16,764,313	5,630,113	316 /sf	22,394,426	0.51%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	**70,825.150 hsf**				**16,764,313**			**236.70 /hsf**	**16,764,313**	**5,630,113**	**316.19 /hsf**	**22,394,426**	**0.51%**
					Building Building	**70,825.150 hsf**	**18,295**	**1,889,187**	**748,271**	**16,764,313**			**273.94 /hsf**	**19,401,770**	**7,403,136**	**378.47 /hsf**	**26,804,906**	**0.61%**
			Elevated Slab		**Elevated Slab**													
				Div. 03	**Concrete**													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	71250.92 sf	1,425	135,633	60,563				2.75 /sf	196,197	128,039	5 /sf	324,236	0.01%
					Form Suspended Slab 15-up	71250.92 sf	17,813	1,608,276	167,582				24.92 /sf	1,775,858	1,287,964	43 /sf	3,063,822	0.07%
					Slab Edge Form > 1'	3815.882 sf	954	86,132	11,448				25.57 /sf	97,580	70,272	44 /sf	167,851	0.00%
					Pour Strips	75066.802 lf	3,753	336,217	315,281				8.68 /lf	651,497	416,228	14 /lf	1,067,726	0.02%
					Strip & Oil Suspended Slab Frm	71250.92 sf	356	31,913	4,988				0.52 /sf	36,900	26,456	1 /sf	63,356	0.00%
					Suspended Slab Rebar	527.785 tn	15,834	1,623,129	997,513				4,965.36 /tn	2,620,642	1,710,876	8,207 /tn	4,331,518	0.10%
					Finish- Hard Trowel	71250.92 sf	1,639	146,767					2.06 /sf	146,767	109,672	4 /sf	256,438	0.01%
					Pump Place Suspended Slab	5277.846 cy	6,861	728,742			27,554		143.30 /cy	756,296	545,714	247 /cy	1,302,010	0.03%
					4500 psi Concrete	5277.846 cy			1,108,348				210.00 /cy	1,108,348	580,042	320 /cy	1,688,389	0.04%
					Liquid Curing Compounds	71250.92 sf	214	19,148	56,110				1.06 /sf	75,258	43,672	2 /sf	118,930	0.00%
					Div. 03 Concrete	**71,250.920 hsf**	**48,849**	**4,715,955**	**2,721,832**		**27,554**		**104.78 /hsf**	**7,465,341**	**4,918,935**	**173.81 /hsf**	**12,384,276**	**0.28%**
					Elevated Slab Elevated Slab	**5,277.850 cy**	**48,849**	**4,715,955**	**2,721,832**		**27,554**		**1,414.47 /cy**	**7,465,341**	**4,918,935**	**2,346.46 /cy**	**12,384,276**	**0.28%**
			Footing		**Footing**													
				Div. 03	**Concrete**													
					Continuous Footing Forms > 12"	5407.977 sf	1,082	97,655	8,234				19.58 /sf	105,889	77,189	34 /sf	183,078	0.00%
					Keyway 4"	1802.759 lf	90	8,138	890				5.01 /lf	9,028	6,539	9 /lf	15,567	0.00%
					Waterstop 6" Bulb	1802.759 lf	180	16,149	10,449				14.75 /lf	26,598	17,535	24 /lf	44,133	0.00%
					Strip & Oil Footing Forms	5407.977 sf	27	2,422	379				0.52 /sf	2,801	2,008	1 /sf	4,809	0.00%
					Footing Rebar	11.138 tn	223	22,836	21,051				3,940.26 /tn	43,887	27,742	6,431 /tn	71,629	0.00%
					Pump Place Wall Footings	301.012 cy	167	17,744			1,445		63.75 /cy	19,189	13,696	109 /cy	32,885	0.00%
					4500 psi Concrete	301.012 cy			63,213				210.00 /cy	63,213	33,082	320 /cy	96,294	0.00%
					Div. 03 Concrete	**5,407.980 hsf**	**1,769**	**164,944**	**104,214**		**1,445**		**50.04 /hsf**	**270,603**	**177,792**	**82.91 /hsf**	**448,395**	**0.01%**
					Footing Footing	**301.010 cy**	**1,769**	**164,944**	**104,214**		**1,445**		**898.98 /cy**	**270,603**	**177,792**	**1,489.63 /cy**	**448,395**	**0.01%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	**Concrete**													
					Keyway 4"	880.448 lf	44	3,975	435				5.01 /lf	4,409	3,194	9 /lf	7,603	0.00%
					Rented Form System 16'->	35217.909 sf	8,804	794,939	369,788				33.07 /sf	1,164,727	786,790	55 /sf	1,951,517	0.04%
					Wall Bulkhead Forms	1760.895 sf	968	87,443	9,245				54.91 /sf	96,688	70,097	95 /sf	166,785	0.00%
					Waterstop 6" Bulb	1760.895 lf	176	15,774	10,206				14.75 /lf	25,980	17,128	24 /lf	43,108	0.00%
					Strip & Oil Wall Forms	35217.909 sf	176	15,774	2,465				0.52 /sf	18,239	13,077	1 /sf	31,316	0.00%
					Hot Water Charge	1304.367 cy			10,957				8.40 /cy	10,957	5,734	13 /cy	16,691	0.00%
					Wall Rebar	114.785 tn	2,640	270,637	216,943				4,247.77 /tn	487,581	311,759	6,964 /tn	799,340	0.02%
					Finish- Top of Wall & Curb	1467.414 sf	81	7,228					4.93 /sf	7,228	5,401	9 /sf	12,629	0.00%
					Pump Place Walls	1304.367 cy	1,826	193,955			9,388		155.89 /cy	203,343	146,328	268 /cy	349,671	0.01%
					4500 psi Concrete	1304.367 cy			273,917				210.00 /cy	273,917	143,351	320 /cy	417,268	0.01%
					Grind/Patch Walls	35217.909 sf	2,817	252,338	1,233				7.20 /sf	253,570	189,203	13 /sf	442,774	0.01%
					Liquid Curing Compounds	35217.909 sf	106	9,464	27,734				1.06 /sf	37,198	21,586	2 /sf	58,785	0.00%
					Div. 03 Concrete	**35,217.910 hsf**	**17,639**	**1,651,527**	**922,922**		**9,388**		**73.37 /hsf**	**2,583,837**	**1,713,649**	**122.03 /hsf**	**4,297,486**	**0.10%**
					Foundation Wall Foundation Wall	**1,304.370 cy**	**17,639**	**1,651,527**	**922,922**		**9,388**		**1,980.91 /cy**	**2,583,837**	**1,713,649**	**3,294.68 /cy**	**4,297,486**	**0.10%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	5723.82 sf	1,946	175,709	8,715				32.22 /sf	184,424	135,693	56 /sf	320,117	0.01%
					S-O-G Const Joints > 1'	10687.63 sf	3,848	347,387	16,272				34.03 /sf	363,659	267,772	59 /sf	631,431	0.01%
					Strip & Oil SOG Form	16411.448 sf	82	7,351	1,149				0.52 /sf	8,499	6,094	1 /sf	14,593	0.00%
					SOG Rebar	514.589 tn	7,719	791,273	972,572				3,427.68 /tn	1,763,846	1,088,542	5,543 /tn	2,852,388	0.06%
					Mesh Support - bricks	8234 ea	16	1,688	4,236				0.72 /ea	5,925	3,454	1 /ea	9,378	0.00%
					Finish- Hard Trowel	71250.861 sf	1,639	146,767					2.06 /sf	146,767	109,671	4 /sf	256,438	0.01%
					Pump Place Slab on Grade	7916.762 cy	9,500	1,009,026			22,798		130.33 /cy	1,031,824	747,492	225 /cy	1,779,316	0.04%
					4500 psi Concrete	7916.762 cy			1,662,520				210.00 /cy	1,662,520	870,062	320 /cy	2,532,582	0.06%
					Liquid Curing Compounds	71250.861 sf	214	19,148	56,110				1.06 /sf	75,258	43,672	2 /sf	118,930	0.00%
					Seal Floors	71250.861 sf	356	31,913	14,963				0.66 /sf	46,875	31,676	1 /sf	78,552	0.00%
					Div. 03 Concrete	**71,250.860 hsf**	**25,320**	**2,530,261**	**2,736,537**		**22,798**		**74.24 /hsf**	**5,289,596**	**3,304,129**	**120.61 /hsf**	**8,593,725**	**0.19%**
					Slab Slab	**7,916.760 cy**	**25,320**	**2,530,261**	**2,736,537**		**22,798**		**668.15 /cy**	**5,289,596**	**3,304,129**	**1,085.51 /cy**	**8,593,725**	**0.19%**
			Unidentified Process Pipe		**Unidentified Process Pipe**													
				Div. 40	**Process Integration (Process Piping)**													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			28,334,324				28,334,324.05 /ls	28,334,324	14,828,461	43,162,785 /ls	43,162,785	0.98%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	108,146	10,814,628			3,640,961		14,455,588.14 /ls	14,455,588	9,548,073	24,003,661 /ls	24,003,661	0.54%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**108,146**	**10,814,628**	**28,334,324**		**3,640,961**		**285,266.08 /mgd**	**42,789,912**	**24,376,534**	**447,776.31 /mgd**	**67,166,446**	**1.52%**
					Unidentified Process Pipe Unidentified Process Pipe	**150.000 MGD**	**108,146**	**10,814,628**	**28,334,324**		**3,640,961**		**285,266.08 /MGD**	**42,789,912**	**24,376,534**	**447,776.31 /MGD**	**67,166,446**	**1.52%**
					050. BAC	**1.000 ls**	**233,458**	**23,167,541**	**35,862,100**	**16,764,313**	**3,813,821**	**104,946,275**	**184,554,050.42 /ls**	**184,554,050**	**98,053,321**	**282,607,371.16 /ls**	**282,607,371**	**6.41%**

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
		050.-060			BAC to MF Feed Pump Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					050.-060 BAC to MF Feed Pump Piping	1.000 ls							/ls			/ls		
		050.B			BAC / Washwater Blower Room													
			Building		**Building**													
				Div. 04	Masonry													
					Interior Staging over 10 '	12159.42 sf	61	6,278	6,080				1.02 /sf	12,358	7,587	2 /sf	19,945	0.00%
					Staging to 30'	12159.42 sf	61	6,278	9,120				1.27 /sf	15,398	9,178	2 /sf	24,575	0.00%
					Rub Block	12159.42 sf	162	16,737					1.38 /sf	16,737	12,246	2 /sf	28,983	0.00%
					Mortar	875.478 cf			6,830				7.80 /cf	6,830	3,574	12 /cf	10,404	0.00%
					Mortar	1459.13 cf			11,383				7.80 /cf	11,383	5,957	12 /cf	17,341	0.00%
					Grout Fill 10" Block Cells	7526.681 cf	2,258	233,164	47,813				37.33 /cf	280,977	195,627	63 /cf	476,604	0.01%
					Grout Fill 10"Lintel Block	60.797 cf	18	1,883	386				37.33 /cf	2,270	1,580	63 /cf	3,850	0.00%
					Grout Fill 10 "Bond Beam	97.275 cf	29	3,013	618				37.33 /cf	3,631	2,528	63 /cf	6,160	0.00%
					Dur-O-Wall 10"	9885.608 lf			4,567				0.46 /lf	4,567	2,390	1 /lf	6,957	0.00%
					Wall Ties	14069 ea	188	19,366	1,773				1.50 /ea	21,138	15,097	3 /ea	36,236	0.00%
					Extruded Control Joints 1/2"	1179.464 lf	7	695	2,762				2.93 /lf	3,457	1,954	5 /lf	5,411	0.00%
					Masonry Rebar # 5	218.87 lbs	3	271	154				1.94 /lbs	425	279	3 /lbs	704	0.00%
					Masonry Rebar # 5	57368.144 lbs	688	71,087	40,387				1.94 /lbs	111,474	73,150	3 /lbs	184,624	0.00%
					Standard Brick	81359 ea	3,254	336,055	85,427				5.18 /ea	421,482	290,597	9 /ea	712,079	0.02%
					10" Block Bond Beam	426 ea	36	3,674	9,774				31.57 /ea	13,447	7,803	50 /ea	21,251	0.00%
					10" Block Lintels	159 ea	13	1,371	3,648				31.57 /ea	5,019	2,912	50 /ea	7,932	0.00%
					10" Fire Rated 3 hr	12488 ea	1,043	107,701	89,164				15.76 /ea	196,865	125,467	26 /ea	322,333	0.01%
					Div. 04 Masonry	12,159.420 vsf	7,821	807,574	319,886				92.72 /vsf	1,127,459	757,928	155.06 /vsf	1,885,388	0.04%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	12177.76 sf				2,882,476			236.70 /sf	2,882,476	968,048	316 /sf	3,850,524	0.09%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	12,177.760 hsf				2,882,476			236.70 /hsf	2,882,476	968,048	316.19 /hsf	3,850,524	0.09%
				Div. 25	Integrated Automation (I&C)													
					I&C	***24,491.760 sf***							***/sf***			***/sf***		
					Div. 25 Integrated Automation (I&C)	150.000 mgd							/mgd			/mgd		
					Building Building	**12,178.000 hsf**	7,821	807,574	319,886	2,882,476			**329.28 /hsf**	4,009,935	1,725,977	**471.01 /hsf**	5,735,912	**0.13%**
			Elevated Slab		**Elevated Slab**													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	12245.801 sf	245	23,311	10,409				2.75 /sf	33,720	22,006	5 /sf	55,726	0.00%
					Form Suspended Slab 15-up	12245.801 sf	3,061	276,412	28,802				24.92 /sf	305,214	221,361	43 /sf	526,575	0.01%
					Slab Edge Form > 1'	655.831 sf	164	14,803	1,967				25.57 /sf	16,771	12,077	44 /sf	28,848	0.00%
					Pour Strips	12901.632 lf	645	57,785	54,187				8.68 /lf	111,972	71,537	14 /lf	183,509	0.00%
					Strip & Oil Suspended Slab Frm	12245.801 sf	61	5,485	857				0.52 /sf	6,342	4,547	1 /sf	10,889	0.00%
					Suspended Slab Rebar	90.71 tn	2,721	278,966	171,443				4,965.37 /tn	450,409	294,047	8,207 /tn	744,456	0.02%
					Finish- Hard Trowel	12245.801 sf	282	25,225					2.06 /sf	25,225	18,849	4 /sf	44,074	0.00%
					Pump Place Suspended Slab	907.096 cy	1,179	125,248			4,736		143.30 /cy	129,983	93,791	247 /cy	223,775	0.01%
					4500 psi Concrete	907.096 cy			190,490				210.00 /cy	190,490	99,691	320 /cy	290,181	0.01%
					Liquid Curing Compounds	12245.801 sf	37	3,291	9,644				1.06 /sf	12,934	7,506	2 /sf	20,440	0.00%
					Div. 03 Concrete	12,245.800 hsf	8,396	810,526	467,799		4,736		104.78 /hsf	1,283,061	845,412	173.81 /hsf	2,128,473	0.05%
					Elevated Slab Elevated Slab	**907.100 cy**	8,396	810,526	467,799		4,736		**1,414.46 /cy**	1,283,061	845,412	**2,346.46 /cy**	2,128,473	**0.05%**
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2311.654 sf	462	41,743	3,519				19.58 /sf	45,262	32,995	34 /sf	78,257	0.00%
					Keyway 4"	770.594 lf	39	3,479	380				5.01 /lf	3,859	2,795	9 /lf	6,654	0.00%
					Waterstop 6" Bulb	770.594 lf	77	6,903	4,466				14.75 /lf	11,369	7,495	24 /lf	18,865	0.00%
					Strip & Oil Footing Forms	2311.654 sf	12	1,035	162				0.52 /sf	1,197	858	1 /sf	2,056	0.00%
					Footing Rebar	4.761 tn	95	9,761	8,998				3,940.22 /tn	18,759	11,859	6,431 /tn	30,618	0.00%
					Pump Place Wall Footings	128.668 cy	71	7,585			618		63.75 /cy	8,202	5,855	109 /cy	14,057	0.00%
					4500 psi Concrete	128.668 cy			27,020				210.00 /cy	27,020	14,141	320 /cy	41,161	0.00%
					Div. 03 Concrete	2,311.650 hsf	756	70,506	44,546		618		50.04 /hsf	115,670	75,998	82.91 /hsf	191,667	0.00%
					Footing Footing	**128.670 cy**	756	70,506	44,546		618		**898.96 /cy**	115,670	75,998	**1,489.60 /cy**	191,667	**0.00%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	636.926 lf	32	2,875	314				5.01 /lf	3,190	2,310	9 /lf	5,500	0.00%
					Rented Form System 16'->	25477.011 sf	6,369	575,067	267,509				33.07 /sf	842,576	569,172	55 /sf	1,411,748	0.03%
					Wall Bulkhead Forms	1273.851 sf	701	63,257	6,688				54.91 /sf	69,945	50,709	95 /sf	120,654	0.00%
					Waterstop 6" Bulb	1273.851 lf	127	11,411	7,383				14.75 /lf	18,794	12,390	24 /lf	31,185	0.00%
					Strip & Oil Wall Forms	25477.011 sf	127	11,411	1,783				0.52 /sf	13,194	9,460	1 /sf	22,654	0.00%
					Hot Water Charge	943.593 cy			7,926				8.40 /cy	7,926	4,148	13 /cy	12,074	0.00%
					Wall Rebar	83.036 tn	1,910	195,780	156,938				4,247.78 /tn	352,719	225,529	6,964 /tn	578,247	0.01%
					Finish- Top of Wall & Curb	1061.543 sf	58	5,229					4.93 /sf	5,229	3,907	9 /sf	9,136	0.00%
					Pump Place Walls	943.593 cy	1,321	140,309			6,791		155.89 /cy	147,100	105,855	268 /cy	252,955	0.01%
					4500 psi Concrete	943.593 cy			198,155				210.00 /cy	198,155	103,702	320 /cy	301,857	0.01%
					Grind/Patch Walls	25477.011 sf	2,038	182,544	892				7.20 /sf	183,436	136,872	13 /sf	320,307	0.01%
					Liquid Curing Compounds	25477.011 sf	76	6,847	20,063				1.06 /sf	26,910	15,616	2 /sf	42,525	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 03 Concrete	25,477.010 hsf	12,760	1,194,730	667,651		6,791		73.37 /hsf	1,869,173	1,239,671	122.03 /hsf	3,108,843	0.07%
					Foundation Wall Foundation Wall	943.590 cy	12,760	1,194,730	667,651		6,791		1,980.92 /cy	1,869,173	1,239,671	3,294.70 /cy	3,108,843	0.07%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	983.755 sf	334	30,199	1,498				32.22 /sf	31,697	23,322	56 /sf	55,019	0.00%
					S-O-G Const Joints > 1'	1836.889 sf	661	59,706	2,797				34.03 /sf	62,502	46,022	59 /sf	108,525	0.00%
					Strip & Oil SOG Form	2820.644 sf	14	1,263	197				0.52 /sf	1,461	1,047	1 /sf	2,508	0.00%
					SOG Rebar	88.443 tn	1,327	135,997	167,157				3,427.68 /tn	303,154	187,089	5,543 /tn	490,243	0.01%
					Mesh Support - bricks	1416 ea	3	290	729				0.72 /ea	1,019	594	1 /ea	1,613	0.00%
					Finish- Hard Trowel	12245.919 sf	282	25,225					2.06 /sf	25,225	18,849	4 /sf	44,074	0.00%
					Pump Place Slab on Grade	1360.658 cy	1,633	173,422			3,918		130.33 /cy	177,340	128,472	225 /cy	305,812	0.01%
					4500 psi Concrete	1360.658 cy			285,738				210.00 /cy	285,738	149,538	320 /cy	435,276	0.01%
					Liquid Curing Compounds	12245.919 sf	37	3,291	9,644				1.06 /sf	12,935	7,506	2 /sf	20,440	0.00%
					Seal Floors	12245.919 sf	61	5,485	2,572				0.66 /sf	8,056	5,444	1 /sf	13,501	0.00%
					Div. 03 Concrete	12,245.920 hsf	4,352	434,878	470,331		3,918		74.24 /hsf	909,127	567,883	120.61 /hsf	1,477,010	0.03%
					Slab Slab	1,360.660 cy	4,352	434,878	470,331		3,918		668.15 /cy	909,127	567,883	1,085.51 /cy	1,477,010	0.03%
					050.B BAC / Washwater Blower Room	12,178.000 SF	34,084	3,318,214	1,970,213	2,882,476	16,063		672.28 /SF	8,186,966	4,454,940	1,038.09 /SF	12,641,906	0.29%
		050.C			Process Components													
			Air Scour Blower		Air Scour Blower													
				Div. 46	Water and Wastewater Equipment													
					Blower 150 hp	4 ea	1,600	177,527	140,000		5,423		80,737.52 /ea	322,950	204,776	131,932 /ea	527,726	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,600	177,527	140,000		5,423		2,153.00 /mgd	322,950	204,776	3,518.18 /mgd	527,726	0.01%
					Air Scour Blower Air Scour Blower	4.000 ea	1,600	177,527	140,000		5,423		80,737.52 /ea	322,950	204,776	131,931.61 /ea	527,726	0.01%
					050.C Process Components	150.000 MGD	1,600	177,527	140,000		5,423		2,153.00 /MGD	322,950	204,776	3,518.18 /MGD	527,726	0.01%
		080.-050			RO Feed Tank to BAC Backwash Piping													
			Feed Pump		Feed Pump													
				Div. 46	Water and Wastewater Equipment													
					RO Feed Tank Backwash Pump	4 ea	960	100,074	24,000		7,977	2,400,000	633,012.78 /ea	2,532,051	1,345,916	969,492 /ea	3,877,967	0.09%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	960	100,074	24,000		7,977	2,400,000	16,880.34 /mgd	2,532,051	1,345,916	25,853.12 /mgd	3,877,967	0.09%
					Feed Pump Feed Pump	4.000 ea	960	100,074	24,000		7,977	2,400,000	633,012.78 /ea	2,532,051	1,345,916	969,491.85 /ea	3,877,967	0.09%
					080.-050 RO Feed Tank to BAC Backwash Piping	4.000 lf	960	100,074	24,000		7,977	2,400,000	633,012.78 /lf	2,532,051	1,345,916	969,491.85 /lf	3,877,967	0.09%
		085.			BAC Backwash													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Feed Pump		Feed Pump													
				Div. 46	Water and Wastewater Equipment													
					Backwash Discharge Pump to AK Warren	4 ea	960	100,074	24,000		7,977	800,000	233,012.78 /ea	932,051	508,574	360,156 /ea	1,440,625	0.03%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	960	100,074	24,000		7,977	800,000	6,213.67 /mgd	932,051	508,574	9,604.17 /mgd	1,440,625	0.03%
					Feed Pump Feed Pump	4.000 ea	960	100,074	24,000		7,977	800,000	233,012.78 /ea	932,051	508,574	360,156.19 /ea	1,440,625	0.03%
					085. BAC Backwash	1.000 ls	960	100,074	24,000		7,977	800,000	932,051.12 /ls	932,051	508,574	1,440,624.75 /ls	1,440,625	0.03%
		085.-050			BAC Backwash to BAC Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					085.-050 BAC Backwash to BAC Piping								/lf			/lf		
					002. - BAC / BAF Biologically Active Filtration (BAF) Systems	150.000 MGD	271,062	26,863,430	38,020,314	19,646,789	3,851,261	108,146,275	1,310,187.12 /MGD	196,528,068	104,567,527	2,007,303.97 /MGD	301,095,596	6.82%
	003. - MF				Membrane Filtration													
		059.			MF (Membrane Filtration) Building													
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	31570.214 sf	158	16,300	15,785				1.02 /sf	32,085	19,698	2 /sf	51,783	0.00%
					Staging to 30'	31570.214 sf	158	16,300	23,678				1.27 /sf	39,978	23,829	2 /sf	63,806	0.00%
					Rub Block	31570.214 sf	421	43,455					1.38 /sf	43,455	31,796	2 /sf	75,251	0.00%
					Mortar	2217.306 cf			17,298				7.80 /cf	17,298	9,053	12 /cf	26,351	0.00%
					Mortar	3801.096 cf			29,654				7.80 /cf	29,654	15,519	12 /cf	45,173	0.00%
					Grout Fill 10" Block Cells	19533.41 cf	5,860	605,112	124,086				37.33 /cf	729,198	507,695	63 /cf	1,236,893	0.03%
					Grout Fill 10"Lintel Block	105.586 cf	32	3,271	671				37.33 /cf	3,942	2,744	63 /cf	6,686	0.00%
					Grout Fill 10 "Bond Beam	211.172 cf	63	6,542	1,341				37.33 /cf	7,883	5,489	63 /cf	13,372	0.00%
					Dur-O-Wall 10"	25657.398 lf			11,854				0.46 /lf	11,854	6,203	1 /lf	18,057	0.00%
					Wall Ties	36428 ea	486	50,142	4,590				1.50 /ea	54,732	39,091	3 /ea	93,823	0.00%
					Extruded Control Joints 1/2"	3061.994 lf	17	1,805	7,170				2.93 /lf	8,975	5,073	5 /lf	14,048	0.00%
					Masonry Rebar # 5	148665.088 lbs	1,784	184,216	104,660				1.94 /lbs	288,876	189,562	3 /lbs	478,438	0.01%
					Masonry Rebar # 5	527.93 lbs	6	654	372				1.94 /lbs	1,026	673	3 /lbs	1,699	0.00%
					Standard Brick	210856 ea	8,434	870,945	221,399				5.18 /ea	1,092,344	753,132	9 /ea	1,845,476	0.04%
					10" Block Bond Beam	1056 ea	88	9,107	24,227				31.57 /ea	33,335	19,343	50 /ea	52,677	0.00%
					10" Block Lintels	423 ea	35	3,648	9,705				31.57 /ea	13,353	7,748	50 /ea	21,101	0.00%
					10" Fire Rated 3 hr	32415 ea	2,707	279,559	231,443				15.76 /ea	511,002	325,674	26 /ea	836,676	0.02%
					Div. 04 Masonry	31,570.210 vsf	20,250	2,091,056	827,933				92.46 /vsf	2,918,989	1,962,323	154.62 /vsf	4,881,312	0.11%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	211172 sf				49,984,412			236.70 /sf	49,984,412	16,786,722	316 /sf	66,771,135	1.51%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	211,172.000 hsf				49,984,412			236.70 /hsf	49,984,412	16,786,722	316.19 /hsf	66,771,135	1.51%
					Building Building	**211,172.000 hsf**	**20,250**	**2,091,056**	**827,933**	**49,984,412**			**250.52 /hsf**	**52,903,401**	**18,749,046**	**339.31 /hsf**	**71,652,447**	**1.62%**
			Elevated Slab		**Elevated Slab**													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	105586 sf	**2,112**	200,994	**89,748**				2.75 /sf	**290,742**	**189,740**	**5** /sf	**480,481**	0.01%
					Form Suspended Slab 15-up	105586 sf	**26,397**	2,383,287	**248,338**				24.92 /sf	**2,631,625**	**1,908,621**	**43** /sf	**4,540,247**	0.10%
					Slab Edge Form > 1'	5701.644 sf	**1,425**	128,698	**17,105**				25.57 /sf	**145,802**	**104,999**	**44** /sf	**250,802**	0.01%
					Pour Strips	111287.644 lf	**5,564**	498,446	**467,408**				8.68 /lf	**965,854**	**617,065**	**14** /lf	**1,582,919**	0.04%
					Strip & Oil Suspended Slab Frm	105586 sf	**528**	47,291	**7,391**				0.52 /sf	**54,682**	**39,205**	**1** /sf	**93,887**	0.00%
					Suspended Slab Rebar	739.102 tn	**22,173**	2,273,005	**1,396,903**				4,965.36 /tn	**3,669,907**	**2,395,885**	**8,207** /tn	**6,065,792**	0.14%
					Finish- Hard Trowel	105586 sf	**2,428**	217,492					2.06 /sf	**217,492**	**162,521**	**4** /sf	**380,013**	0.01%
					Pump Place Suspended Slab	7813.364 cy	**10,157**	1,078,835			**40,791**		143.30 /cy	**1,119,626**	**807,880**	**247** /cy	**1,927,506**	0.04%
					4500 psi Concrete	7813.364 cy			**1,640,806**				210.00 /cy	**1,640,806**	**858,698**	**320** /cy	**2,499,505**	0.06%
					Liquid Curing Compounds	105586 sf	**317**	28,375	**83,149**				1.06 /sf	**111,524**	**64,717**	**2** /sf	**176,241**	0.00%
				Div. 03	Div. 03 Concrete	105,586.000 hsf	71,102	6,856,422	3,950,848		40,791		102.74 /hsf	10,848,061	7,149,331	170.45 /hsf	17,997,392	0.41%
					Elevated Slab Elevated Slab	**7,813.360 cy**	71,102	**6,856,422**	3,950,848		40,791		**1,388.40 /cy**	10,848,061	7,149,331	**2,303.41 /cy**	17,997,392	**0.41%**
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	6018.402 sf	**1,204**	108,678	**9,163**				19.58 /sf	**117,841**	**85,902**	**34** /sf	**203,743**	0.00%
					Keyway 4"	2006.134 lf	**100**	9,056	**990**				5.01 /lf	**10,047**	**7,277**	**9** /lf	**17,324**	0.00%
					Waterstop 6" Bulb	2006.134 lf	**201**	17,971	**11,628**				14.75 /lf	**29,598**	**19,513**	**24** /lf	**49,111**	0.00%
					Strip & Oil Footing Forms	6018.402 sf	**30**	2,696	**421**				0.52 /sf	**3,117**	**2,235**	**1** /sf	**5,352**	0.00%
					Footing Rebar	11.721 tn	**234**	24,031	**22,153**				3,940.23 /tn	**46,183**	**29,194**	**6,431** /tn	**75,378**	0.00%
					Pump Place Wall Footings	316.758 cy	**176**	18,672			**1,520**		63.75 /cy	**20,192**	**14,413**	**109** /cy	**34,605**	0.00%
					4500 psi Concrete	316.758 cy			**66,519**				210.00 /cy	**66,519**	**34,812**	**320** /cy	**101,331**	0.00%
					Div. 03 Concrete	6,018.400 hsf	1,945	181,104	110,874		1,520		48.77 /hsf	293,497	193,346	80.89 /hsf	486,844	0.01%
					Footing Footing	**316.760 cy**	1,945	**181,104**	110,874		1,520		**926.56 /cy**	293,497	193,346	**1,536.95 /cy**	486,844	**0.01%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	1161.446 lf	**58**	5,243	**573**				5.01 /lf	**5,816**	**4,213**	**9** /lf	**10,029**	0.00%
					Rented Form System 16'->	44979.636 sf	**11,245**	1,015,280	**472,286**				33.07 /sf	**1,487,567**	**1,004,873**	**55** /sf	**2,492,440**	0.06%
					Wall Bulkhead Forms	2217.306 sf	**1,220**	110,108	**11,641**				54.91 /sf	**121,749**	**88,266**	**95** /sf	**210,015**	0.00%
					Waterstop 6" Bulb	2217.306 lf	**222**	19,862	**12,852**				14.75 /lf	**32,714**	**21,567**	**24** /lf	**54,281**	0.00%
					Strip & Oil Wall Forms	44979.636 sf	**225**	20,146	**3,149**				0.52 /sf	**23,295**	**16,701**	**1** /sf	**39,996**	0.00%
					Hot Water Charge	1689.376 cy			**14,191**				8.40 /cy	**14,191**	**7,427**	**13** /cy	**21,617**	0.00%
					Wall Rebar	105.586 tn	**2,428**	248,948	**199,557**				4,247.77 /tn	**448,505**	**286,775**	**6,964** /tn	**735,280**	0.02%
					Finish- Top of Wall & Curb	1900.548 sf	**105**	9,362					4.93 /sf	**9,362**	**6,995**	**9** /sf	**16,357**	0.00%
					Pump Place Walls	1689.376 cy	**2,365**	251,205			**12,159**		155.89 /cy	**263,363**	**189,519**	**268** /cy	**452,883**	0.01%
					4500 psi Concrete	1689.376 cy			**354,769**				210.00 /cy	**354,769**	**185,665**	**320** /cy	**540,434**	0.01%
					Grind/Patch Walls	44979.636 sf	**3,598**	322,281	**1,574**				7.20 /sf	**323,855**	**241,647**	**13** /sf	**565,502**	0.01%
					Liquid Curing Compounds	44979.636 sf	**135**	12,088	**35,421**				1.06 /sf	**47,509**	**27,570**	**2** /sf	**75,079**	0.00%
					Div. 03 Concrete	44,979.640 hsf	21,601	2,014,523	1,106,013		12,159		69.65 /hsf	3,132,694	2,081,217	115.92 /hsf	5,213,911	0.12%
					Foundation Wall Foundation Wall	**1,689.380 cy**	21,601	**2,014,523**	1,106,013		12,159		**1,854.35 /cy**	3,132,694	2,081,217	**3,086.29 /cy**	5,213,911	**0.12%**
			Slab		**Slab**													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	8446.88 sf	**2,872**	259,302	**12,860**				32.22 /sf	**272,162**	**200,248**	**56** /sf	**472,410**	0.01%
					S-O-G Const Joints > 1'	15837.9 sf	**5,702**	514,790	**24,113**				34.03 /sf	**538,903**	**396,809**	**59** /sf	**935,712**	0.02%
					Strip & Oil SOG Form	24284.78 sf	**121**	10,877	**1,700**				0.52 /sf	**12,577**	**9,017**	**1** /sf	**21,594**	0.00%
					SOG Rebar	739.102 tn	**11,087**	1,136,502	**1,396,903**				3,427.68 /tn	**2,533,405**	**1,563,469**	**5,543** /tn	**4,096,874**	0.09%
					Mesh Support - bricks	12143 ea	**24**	2,490	**6,248**				0.72 /ea	**8,737**	**5,093**	**1** /ea	**13,830**	0.00%
					Finish- Hard Trowel	105586 sf	**2,428**	217,492					2.06 /sf	**217,492**	**162,521**	**4** /sf	**380,013**	0.01%
					Pump Place Slab on Grade	11720.046 cy	**14,064**	1,493,771			**33,750**		130.33 /cy	**1,527,522**	**1,106,594**	**225** /cy	**2,634,116**	0.06%
					4500 psi Concrete	11720.046 cy			**2,461,210**				210.00 /cy	**2,461,210**	**1,288,047**	**320** /cy	**3,749,257**	0.08%
					Liquid Curing Compounds	105586 sf	**317**	28,375	**83,149**				1.06 /sf	**111,524**	**64,717**	**2** /sf	**176,241**	0.00%
					Seal Floors	105586 sf	**528**	47,291	**22,173**				0.66 /sf	**69,464**	**46,941**	**1** /sf	**116,405**	0.00%
					Div. 03 Concrete	105,586.000 hsf	37,143	3,710,890	4,008,355		33,750		73.43 /hsf	7,752,995	4,843,457	119.30 /hsf	12,596,452	0.29%
					Slab Slab	**11,720.050 cy**	37,143	**3,710,890**	4,008,355		33,750		**661.52 /cy**	7,752,995	4,843,457	**1,074.78 /cy**	12,596,452	**0.29%**
					059. MF (Membrane Filtration) Building	211,172.000 sf	152,040	14,853,994	10,004,023	49,984,412	88,220		354.83 /sf	74,930,649	33,016,397	511.18 /sf	107,947,046	2.45%
		060.			MF Feed Pump													
			Feed Pump		**Feed Pump**													
				Div. 46	Water and Wastewater Equipment													
					MF Feed Pumps 7 DUTY + 1 SB	8 ea	**1,920**	200,148	**48,000**		**15,954**	**9,600,000**	1,233,012.78 /ea	**9,864,102**	**5,203,860**	**1,883,495** /ea	**15,067,963**	0.34%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,920	200,148	48,000		15,954	9,600,000	65,760.68 /mgd	9,864,102	5,203,860	100,453.08 /mgd	15,067,963	0.34%
					Feed Pump Feed Pump	**8.000 ea**	1,920	**200,148**	48,000		15,954	9,600,000	**1,233,012.78 /ea**	9,864,102	5,203,860	**1,883,495.33 /ea**	15,067,963	**0.34%**
					060. MF Feed Pump	8.000 ea	1,920	200,148	48,000		15,954	9,600,000	1,233,012.78 /ea	9,864,102	5,203,860	1,883,495.33 /ea	15,067,963	0.34%
		062.			MF Strainer													
			Auto Strainers		**Auto Strainers**													
				Div. 46	Water and Wastewater Equipment													
					MF40000 Auto Strainers 7 duty + 1 SB	8 ea	**1,920**	200,148	**48,000**		**15,954**	**2,564,373**	353,559.45 /ea	**2,828,476**	**1,521,842**	**543,790** /ea	**4,350,317**	0.10%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,920	200,148	48,000		15,954	2,564,373	18,856.50 /mgd	2,828,476	1,521,842	29,002.11 /mgd	4,350,317	0.10%
					Auto Strainers Auto Strainers	**8.000 ea**	1,920	**200,148**	48,000		15,954	2,564,373	**353,559.45 /ea**	2,828,476	1,521,842	**543,789.65 /ea**	4,350,317	**0.10%**
					062. MF Strainer	8.000 ea	1,920	200,148	48,000		15,954	2,564,373	353,559.45 /ea	2,828,476	1,521,842	543,789.65 /ea	4,350,317	0.10%
		062./064-065			MF / MF Strainer to AK Warren HW Piping													

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - 558' + 2700'	*4,267.980 lf*							/lf			/lf		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					062./064-065 MF / MF Strainer to AK Warren HW Piping	4,267.980 lf							/lf			/lf		
		063.			Clean In Place / Enhanced Flux Maintenance Tanks													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					CIP / EFM Polyethylene Tanks, 15,000 Gal	8 ea	640	62,023			7,091	870,000	117,389.20 /ea	939,114	504,846	180,495 /ea	1,443,960	0.03%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	640	62,023			7,091	870,000	6,260.76 /mgd	939,114	504,846	9,626.40 /mgd	1,443,960	0.03%
					* unassigned *		640	62,023			7,091	870,000		939,114	504,846		1,443,960	0.03%
					063. Clean In Place / Enhanced Flux Maintenance Tanks	8.000 ea	640	62,023			7,091	870,000	117,389.20 /ea	939,114	504,846	180,495.00 /ea	1,443,960	0.03%
		064.			MF Membranes													
			Blower / Compressor System		Blower / Compressor System													
				Div. 46	Water and Wastewater Equipment													
					Blower Rotary 1,000 cfm	7 ea	335	36,592	5,250			700,000	105,977.47 /ea	741,842	395,659	162,500 /ea	1,137,501	0.03%
					Package Air Compressor 1000cfm	4 ea	160	17,753	24,000		2,712	110,000	38,616.04 /ea	154,464	84,424	59,722 /ea	238,889	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	495	54,345	29,250		2,712	810,000	5,975.38 /mgd	896,306	480,083	9,175.93 /mgd	1,376,390	0.03%
					Blower / Compressor System Blower / Compressor System	1.000 ls	495	54,345	29,250		2,712	810,000	896,306.45 /ls	896,306	480,083	1,376,389.89 /ls	1,376,390	0.03%
			CIP Pump		CIP Pump													
				Div. 46	Water and Wastewater Equipment													
					CIP Pumps	8 ea	1,920	200,148	48,000		15,954	1,000,000	158,012.78 /ea	1,264,102	703,144	245,906 /ea	1,967,246	0.04%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,920	200,148	48,000		15,954	1,000,000	8,427.35 /mgd	1,264,102	703,144	13,114.97 /mgd	1,967,246	0.04%
					CIP Pump CIP Pump	8.000 ea	1,920	200,148	48,000		15,954	1,000,000	158,012.78 /ea	1,264,102	703,144	245,905.75 /ea	1,967,246	0.04%
			Membrane System		Membrane System													
				Div. 46	Water and Wastewater Equipment													
					Toray HFUG-2020AN Membrane System	186.02 MGD	18,602	1,939,147	42,215		154,569	20,305,655	120,640.71 /MGD	22,441,585	12,147,503	185,943 /MGD	34,589,088	0.78%
					UF Modules	186.02 MGD	29,763	3,102,635	42,215		247,310	10,282,845	73,513.63 /MGD	13,675,005	7,801,373	115,452 /MGD	21,476,378	0.49%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	48,365	5,041,782	84,430		401,879	30,588,500	240,777.27 /mgd	36,116,590	19,948,876	373,769.77 /mgd	56,065,466	1.27%
					Membrane System Membrane System	150.000 MGD	48,365	5,041,782	84,430		401,879	30,588,500	240,777.27 /MGD	36,116,590	19,948,876	373,769.77 /MGD	56,065,466	1.27%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			12,270,213				12,270,212.73 /ls	12,270,213	6,421,483	18,691,695 /ls	18,691,695	0.42%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	65,168	6,516,794			3,153,445		9,670,238.95 /ls	9,670,239	6,260,488	15,930,727 /ls	15,930,727	0.36%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	65,168	6,516,794	12,270,213		3,153,445		146,269.68 /mgd	21,940,452	12,681,970	230,816.15 /mgd	34,622,422	0.78%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	65,168	6,516,794	12,270,213		3,153,445		146,269.68 /MGD	21,940,452	12,681,970	230,816.15 /MGD	34,622,422	0.78%
					064. MF Membranes	150.000 MGD	115,948	11,813,070	12,431,892		3,573,988	32,398,500	401,449.67 /MGD	60,217,450	33,814,074	626,876.83 /MGD	94,031,524	2.13%
		080.			MF Backwash Pump													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					MF Backwash Pumps	7 ea	1,680	175,130	42,000		13,960	1,400,000	233,012.78 /ea	1,631,089	890,004	360,156 /ea	2,521,093	0.06%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,680	175,130	42,000		13,960	1,400,000	10,873.93 /mgd	1,631,089	890,004	16,807.29 /mgd	2,521,093	0.06%
					* unassigned *		1,680	175,130	42,000		13,960	1,400,000		1,631,089	890,004		2,521,093	0.06%
					080. MF Backwash Pump	7.000 ea	1,680	175,130	42,000		13,960	1,400,000	233,012.78 /ea	1,631,089	890,004	360,156.19 /ea	2,521,093	0.06%
					003. - MF Membrane Filtration	150.000 MGD	274,149	27,304,513	22,573,915	49,984,412	3,715,167	46,832,873	1,002,739.20 /MGD	150,410,880	74,951,023	1,502,412.69 /MGD	225,361,903	5.11%
	004. - RO				Reverse Osmosis Related													
		089.			RO Feed Tank / RO Pump Building													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							/ls			/ls		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	16653.9 sf	83	8,598	8,327				1.02 /sf	16,925	10,391	2 /sf	27,317	0.00%
					Staging to 30'	16653.9 sf	83	8,598	12,490				1.27 /sf	21,089	12,570	2 /sf	33,659	0.00%
					Rub Block	16653.9 sf	222	22,924					1.38 /sf	22,924	16,773	2 /sf	39,697	0.00%
					Mortar	1199.1 cf			9,355				7.80 /cf	9,355	4,896	12 /cf	14,251	0.00%
					Mortar	1998.45 cf			15,591				7.80 /cf	15,591	8,159	12 /cf	23,750	0.00%
					Grout Fill 10" Block Cells	10308.75 cf	3,093	319,348	65,486				37.33 /cf	384,834	267,936	63 /cf	652,770	0.01%
					Grout Fill 10"Lintel Block	83.25 cf	25	2,579	529				37.33 /cf	3,108	2,164	63 /cf	5,272	0.00%
					Grout Fill 10 "Bond Beam	133.2 cf	40	4,126	846				37.33 /cf	4,972	3,462	63 /cf	8,434	0.00%
					Dur-O-Wall 10"	13539.75 lf			6,255				0.46 /lf	6,255	3,274	1 /lf	9,529	0.00%
					Wall Ties	19269 ea	257	26,523	2,428				1.50 /ea	28,951	20,677	3 /ea	49,629	0.00%
					Extruded Control Joints 1/2"	1615.35 lf	9	952	3,782				2.93 /lf	4,735	2,676	5 /lf	7,411	0.00%
					Masonry Rebar # 5	78573.15 lbs	943	97,363	55,316				1.94 /lbs	152,678	100,188	3 /lbs	252,866	0.01%
					Masonry Rebar # 5	299.85 lbs	4	372	211				1.94 /lbs	583	382	3 /lbs	965	0.00%
					Standard Brick	111432 ea	4,457	460,272	117,004				5.18 /ea	577,276	398,011	9 /ea	975,287	0.02%
					10" Block Bond Beam	583 ea	49	5,028	13,375				31.57 /ea	18,403	10,679	50 /ea	29,082	0.00%
					10" Block Lintels	217 ea	18	1,871	4,979				31.57 /ea	6,850	3,975	50 /ea	10,825	0.00%
					10" Fire Rated 3 hr	17104 ea	1,429	147,511	122,123				15.76 /ea	269,634	171,844	26 /ea	441,478	0.01%
					Div. 04 Masonry	16,653.900 vsf	10,711	1,106,066	438,097				92.72 /vsf	1,544,163	1,038,058	155.05 /vsf	2,582,221	0.06%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	57255.6 sf				3,242,957			56.64 /sf	3,242,957	1,089,112	76 /sf	4,332,069	0.10%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div 6 - $/SF	57255.6 sf				98,480			1.72 /sf	98,480	33,073	2 /sf	131,553	0.00%
					Div 7 - $/SF	57255.6 sf				2,343,472			40.93 /sf	2,343,472	787,030	55 /sf	3,130,501	0.07%
					Div 8 - $/SF	57255.6 sf				524,461			9.16 /sf	524,461	176,135	12 /sf	700,596	0.02%
					Div 9 - $/SF	57255.6 sf				2,061,202			36.00 /sf	2,061,202	692,232	48 /sf	2,753,434	0.06%
					Div 10 - $/SF	57255.6 sf				109,931			1.92 /sf	109,931	36,919	3 /sf	146,850	0.00%
					Div 11 - $/SF	57255.6 sf				54,393			0.95 /sf	54,393	18,267	1 /sf	72,660	0.00%
					Div 12 - $/SF	57255.6 sf				21,185			0.37 /sf	21,185	7,115	0 /sf	28,299	0.00%
					Div 22 - $/SF	57255.6 sf				349,832			6.11 /sf	349,832	117,487	8 /sf	467,319	0.01%
					Div 23 - $/SF	57255.6 sf				3,359,186			58.67 /sf	3,359,186	1,128,146	78 /sf	4,487,332	0.10%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	57,255.600 hsf				12,165,097			212.47 /hsf	12,165,097	4,085,516	283.83 /hsf	16,250,613	0.37%
					Building Building	**57,255.600 hsf**	**10,711**	**1,106,066**	**438,097**	**12,165,097**			**239.44 /hsf**	**13,709,260**	**5,123,574**	**328.93 /hsf**	**18,832,834**	**0.43%**
			Elevated Slab		**Elevated Slab**													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	28627.8 sf	573	54,496	24,334				2.75 /sf	78,830	51,445	5 /sf	130,274	0.00%
					Form Suspended Slab 15-up	28627.8 sf	7,157	646,187	67,333				24.92 /sf	713,519	517,489	43 /sf	1,231,009	0.03%
					Slab Edge Form > 1'	1545.9 sf	386	34,894	4,638				25.57 /sf	39,532	28,469	44 /sf	68,000	0.00%
					Pour Strips	30173.7 lf	1,509	135,145	126,730				8.68 /lf	261,875	167,306	14 /lf	429,181	0.01%
					Strip & Oil Suspended Slab Frm	28627.8 sf	143	12,822	2,004				0.52 /sf	14,826	10,630	1 /sf	25,456	0.00%
					Suspended Slab Rebar	200.4 tn	6,012	616,302	378,756				4,965.36 /tn	995,058	649,620	8,207 /tn	1,644,678	0.04%
					Finish- Hard Trowel	28627.8 sf	658	58,969					2.06 /sf	58,969	44,065	4 /sf	103,034	0.00%
					Pump Place Suspended Slab	2118.45 cy	2,754	292,506			11,060		143.30 /cy	303,566	219,042	247 /cy	522,608	0.01%
					4500 psi Concrete	2118.45 cy			444,875				210.00 /cy	444,875	232,820	320 /cy	677,695	0.02%
					Liquid Curing Compounds	28627.8 sf	86	7,693	22,544				1.06 /sf	30,238	17,547	2 /sf	47,785	0.00%
					Div. 03 Concrete	28,627.800 hsf	19,278	1,859,015	1,071,212		11,060		102.74 /hsf	2,941,287	1,938,432	170.45 /hsf	4,879,719	0.11%
					Elevated Slab Elevated Slab	**2,118.450 cy**	**19,278**	**1,859,015**	**1,071,212**		**11,060**		**1,388.41 /cy**	**2,941,287**	**1,938,432**	**2,303.44 /cy**	**4,879,719**	**0.11%**
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	3177.6 sf	636	57,380	4,838				19.58 /sf	62,218	45,355	34 /sf	107,572	0.00%
					Keyway 4"	1059.15 lf	53	4,781	523				5.01 /lf	5,304	3,842	9 /lf	9,146	0.00%
					Waterstop 6" Bulb	1059.15 lf	106	9,488	6,139				14.75 /lf	15,626	10,302	24 /lf	25,929	0.00%
					Strip & Oil Footing Forms	3177.6 sf	16	1,423	222				0.52 /sf	1,646	1,180	1 /sf	2,825	0.00%
					Footing Rebar	21.47 tn	429	44,019	40,579				3,940.28 /tn	84,598	53,478	6,431 /tn	138,075	0.00%
					Pump Place Wall Footings	171.75 cy	95	10,124			824		63.75 /cy	10,949	7,815	109 /cy	18,763	0.00%
					4500 psi Concrete	171.75 cy			36,068				210.00 /cy	36,068	18,876	320 /cy	54,943	0.00%
					Div. 03 Concrete	3,177.600 hsf	1,335	127,215	88,369		824		68.10 /hsf	216,408	140,846	112.43 /hsf	357,254	0.01%
					Footing Footing	**171.750 cy**	**1,335**	**127,215**	**88,369**		**824**		**1,260.02 /cy**	**216,408**	**140,846**	**2,080.08 /cy**	**357,254**	**0.01%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	356.85 lf	18	1,611	176				5.01 /lf	1,787	1,294	9 /lf	3,082	0.00%
					Rented Form System 16'->	14274.75 sf	3,569	322,210	149,885				33.07 /sf	472,095	318,907	55 /sf	791,001	0.02%
					Wall Bulkhead Forms	713.7 sf	393	35,441	3,747				54.91 /sf	39,188	28,411	95 /sf	67,599	0.00%
					Waterstop 6" Bulb	713.7 lf	71	6,393	4,137				14.75 /lf	10,530	6,942	24 /lf	17,472	0.00%
					Strip & Oil Wall Forms	14274.75 sf	71	6,394	999				0.52 /sf	7,393	5,300	1 /sf	12,693	0.00%
					Hot Water Charge	528.15 cy			4,436				8.40 /cy	4,436	2,322	13 /cy	6,758	0.00%
					Wall Rebar	42.9 tn	987	101,149	81,081				4,247.78 /tn	182,230	116,518	6,964 /tn	298,747	0.01%
					Finish- Top of Wall & Curb	599.55 sf	33	2,953					4.93 /sf	2,953	2,207	9 /sf	5,160	0.00%
					Pump Place Walls	528.15 cy	739	78,534			3,801		155.89 /cy	82,335	59,249	268 /cy	141,585	0.00%
					4500 psi Concrete	528.15 cy			110,912				210.00 /cy	110,912	58,044	320 /cy	168,956	0.00%
					Grind/Patch Walls	14274.75 sf	1,142	102,279	500				7.20 /sf	102,779	76,689	13 /sf	179,468	0.00%
					Liquid Curing Compounds	14274.75 sf	43	3,836	11,241				1.06 /sf	15,077	8,749	2 /sf	23,827	0.00%
					Div. 03 Concrete	14,274.750 hsf	7,066	660,800	367,114		3,801		72.28 /hsf	1,031,715	684,633	120.24 /hsf	1,716,348	0.04%
					Foundation Wall Foundation Wall	**528.150 cy**	**7,066**	**660,800**	**367,114**		**3,801**		**1,953.45 /cy**	**1,031,715**	**684,633**	**3,249.74 /cy**	**1,716,348**	**0.04%**
			Slab		**Slab**													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	2290.2 sf	779	70,304	3,487				32.22 /sf	73,791	54,293	56 /sf	128,084	0.00%
					S-O-G Const Joints > 1'	4294.2 sf	1,546	139,577	6,538				34.03 /sf	146,115	107,589	59 /sf	253,704	0.01%
					Strip & Oil SOG Form	6584.4 sf	33	2,949	461				0.52 /sf	3,410	2,445	1 /sf	5,855	0.00%
					SOG Rebar	200.4 tn	3,006	308,151	378,756				3,427.68 /tn	686,907	423,919	5,543 /tn	1,110,826	0.03%
					Mesh Support - bricks	3321 ea	7	681	1,709				0.72 /ea	2,390	1,393	1 /ea	3,782	0.00%
					Finish- Hard Trowel	28627.8 sf	658	58,969					2.06 /sf	58,969	44,065	4 /sf	103,034	0.00%
					Pump Place Slab on Grade	3177.6 cy	3,813	404,999			9,151		130.33 /cy	414,150	300,026	225 /cy	714,175	0.02%
					4500 psi Concrete	3177.6 cy			667,296				210.00 /cy	667,296	349,222	320 /cy	1,016,518	0.02%
					Liquid Curing Compounds	28627.8 sf	86	7,693	22,544				1.06 /sf	30,238	17,547	2 /sf	47,785	0.00%
					Seal Floors	28627.8 sf	143	12,822	6,012				0.66 /sf	18,834	12,727	1 /sf	31,561	0.00%
					Div. 03 Concrete	28,627.800 hsf	10,071	1,006,146	1,086,803		9,151		73.43 /hsf	2,102,100	1,313,225	119.30 /hsf	3,415,324	0.08%
					Slab Slab	**3,177.600 cy**	**10,071**	**1,006,146**	**1,086,803**		**9,151**		**661.54 /cy**	**2,102,100**	**1,313,225**	**1,074.81 /cy**	**3,415,324**	**0.08%**
					089. RO Feed Tank / RO Pump Building	57,255.600 sf	48,461	4,759,242	3,051,594	12,165,097	24,836		349.32 /sf	20,000,769	9,200,711	510.02 /sf	29,201,480	0.66%
		090.			RO Feed Tank													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					090. RO Feed Tank	1.000 ls							/ls			/ls		

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
		090.-080/085			RO Feed Tank to MF Backwash Pump/BAC Backwash Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					090.-080/085 RO Feed Tank to MF Backwash Pump/BAC Backwash Piping								/lf			/lf		
		090.-100			RO Feed Tank to RO Transfer Pump Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					090.-100 RO Feed Tank to RO Transfer Pump Piping								/lf			/lf		
		100.			RO Transfer Pump													
			RO Transfer Pumps		**RO Transfer Pumps**													
				Div. 46	Water and Wastewater Equipment													
					RO Transfer Pumps 8 DUTY + 1 SB	9 ea	**2,160**	225,167	**54,000**		**17,948**	**13,162,500**	1,495,512.78 /ea	**13,459,615**	**7,090,732**	**2,283,372 /ea**	**20,550,347**	0.47%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	**2,160**	**225,167**	**54,000**		**17,948**	**13,162,500**	**89,730.77 /mgd**	**13,459,615**	**7,090,732**	**137,002.31 /mgd**	**20,550,347**	**0.47%**
					RO Transfer Pumps RO Transfer Pumps	**9.000 ea**	**2,160**	**225,167**	**54,000**		**17,948**	**13,162,500**	**1,495,512.78 /ea**	**13,459,615**	**7,090,732**	**2,283,371.86 /ea**	**20,550,347**	**0.47%**
					100. RO Transfer Pump	9.000 ea	**2,160**	**225,167**	**54,000**		**17,948**	**13,162,500**	**1,495,512.78 /ea**	**13,459,615**	**7,090,732**	**2,283,371.86 /ea**	**20,550,347**	**0.47%**
		100.-110			RO Transfer Pump to Cartridge Filter Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					100.-110 RO Transfer Pump to Cartridge Filter Piping								/lf			/lf		
		110.			Cartridge Filter													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder - Cartridge Filter	20 ea			**1,900,000**				95,000.00 /ea	**1,900,000**	**994,344**	**144,717 /ea**	**2,894,344**	0.07%
					Div. 46 Water and Wastewater Equipment	150.000 mgd			**1,900,000**				**12,666.67 /mgd**	**1,900,000**	**994,344**	**19,295.63 /mgd**	**2,894,344**	**0.07%**
					*** unassigned ***				**1,900,000**					**1,900,000**	**994,344**		**2,894,344**	**0.07%**
					110. Cartridge Filter	20.000 ea			**1,900,000**				**95,000.00 /ea**	**1,900,000**	**994,344**	**144,717.22 /ea**	**2,894,344**	**0.07%**
		110.-130			Cartridge Filter to RO Feed Pump Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					110.-130 Cartridge Filter to RO Feed Pump Piping								/lf			/lf		
		130.			RO Feed Pump													
			CIP Pump		**CIP Pump**													
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder - Cartridge Filter	2 ea			**190,000**				95,000.00 /ea	**190,000**	**99,434**	**144,717 /ea**	**289,434**	0.01%
					CIP Feed Pump Skids 1 DUTY + 1 SB	2 ea	**480**	50,037	**12,000**		**3,988**	**1,125,000**	595,512.78 /ea	**1,191,026**	**633,708**	**912,367 /ea**	**1,824,733**	0.04%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	**480**	**50,037**	**202,000**		**3,988**	**1,125,000**	**9,206.84 /mgd**	**1,381,026**	**733,142**	**14,094.45 /mgd**	**2,114,168**	**0.05%**
					CIP Pump CIP Pump	**4.000 ea**	**480**	**50,037**	**202,000**		**3,988**	**1,125,000**	**345,256.39 /ea**	**1,381,026**	**733,142**	**528,541.92 /ea**	**2,114,168**	**0.05%**
			Feed Pump		**Feed Pump**													
				Div. 46	Water and Wastewater Equipment													
					RO Feed Pumps 19 DUTY + 1 SB	20 ea	**4,800**	500,371	**120,000**		**39,884**	**27,000,000**	1,383,012.78 /ea	**27,660,256**	**14,579,668**	**2,111,996 /ea**	**42,239,924**	0.96%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	**4,800**	**500,371**	**120,000**		**39,884**	**27,000,000**	**184,401.70 /mgd**	**27,660,256**	**14,579,668**	**281,599.49 /mgd**	**42,239,924**	**0.96%**
					Feed Pump Feed Pump	**20.000 ea**	**4,800**	**500,371**	**120,000**		**39,884**	**27,000,000**	**1,383,012.78 /ea**	**27,660,256**	**14,579,668**	**2,111,996.20 /ea**	**42,239,924**	**0.96%**
					130. RO Feed Pump	24.000 ea	**5,280**	**550,408**	**322,000**		**43,873**	**28,125,000**	**1,210,053.38 /ea**	**29,041,281**	**15,312,811**	**1,848,087.16 /ea**	**44,354,092**	**1.01%**
		130.-140			RO Feed Pump to RO (1st Stage) Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					130.-140 RO Feed Pump to RO (1st Stage) Piping								/lf			/lf		
		131.			RO Feed Panel Controls													
			RO Feed Panels / COntrols		**RO Feed Panels / COntrols**													
				Div. 46	Water and Wastewater Equipment													
					RO Feed Panel Controls	20 ea	**640**	66,716	**120,000**		**5,318**	**500,000**	34,601.70 /ea	**692,034**	**376,032**	**53,403 /ea**	**1,068,066**	0.02%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	**640**	**66,716**	**120,000**		**5,318**	**500,000**	**4,613.56 /mgd**	**692,034**	**376,032**	**7,120.44 /mgd**	**1,068,066**	**0.02%**
					RO Feed Panels / COntrols RO Feed Panels / COntrols	**20.000 ea**	**640**	**66,716**	**120,000**		**5,318**	**500,000**	**34,601.70 /ea**	**692,034**	**376,032**	**53,403.29 /ea**	**1,068,066**	**0.02%**
					131. RO Feed Panel Controls	20.000 EA	**640**	**66,716**	**120,000**		**5,318**	**500,000**	**34,601.70 /EA**	**692,034**	**376,032**	**53,403.29 /EA**	**1,068,066**	**0.02%**
		139.			RO Facility													
			Building		**Building**													
				Div. 04	Masonry													
					Interior Staging over 10 '	37142.55 sf	**186**	19,177	**18,571**				1.02 /sf	**37,748**	**23,175**	**2 /sf**	**60,923**	0.00%
					Staging to 30'	37142.55 sf	**186**	19,177	**27,857**				1.27 /sf	**47,034**	**28,035**	**2 /sf**	**75,069**	0.00%
					Rub Block	37142.55 sf	**495**	51,126					1.38 /sf	**51,126**	**37,408**	**2 /sf**	**88,534**	0.00%
					Mortar	2674.35 cf			**20,864**				7.80 /cf	**20,864**	**10,919**	**12 /cf**	**31,783**	0.00%
					Mortar	4457.1 cf			**34,772**				7.80 /cf	**34,772**	**18,198**	**12 /cf**	**52,970**	0.00%
					Grout Fill 10" Block Cells	22991.25 cf	**6,897**	712,230	**146,052**				37.33 /cf	**858,282**	**597,568**	**63 /cf**	**1,455,850**	0.03%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Grout Fill 10"Lintel Block	185.7 cf	56	5,753	1,180				37.33 /cf	6,932	4,827	63 /cf	11,759	0.00%
					Grout Fill 10 "Bond Beam	297.15 cf	89	9,205	1,888				37.33 /cf	11,093	7,723	63 /cf	18,816	0.00%
					Dur-O-Wall 10"	30196.95 lf			13,951				0.46 /lf	13,951	7,301	1 /lf	21,252	0.00%
					Wall Ties	42974 ea	573	59,152	5,415				1.50 /ea	64,567	46,115	3 /ea	110,682	0.00%
					Extruded Control Joints 1/2"	3602.85 lf	21	2,124	8,436				2.93 /lf	10,560	5,969	5 /lf	16,530	0.00%
					Masonry Rebar # 5	668.55 lbs	8	828	471				1.94 /lbs	1,299	852	3 /lbs	2,152	0.00%
					Masonry Rebar # 5	175238.85 lbs	2,103	217,144	123,368				1.94 /lbs	340,512	223,446	3 /lbs	563,958	0.01%
					Standard Brick	248522 ea	9,941	1,026,526	260,948				5.18 /ea	1,287,474	887,666	9 /ea	2,175,140	0.05%
					10" Block Bond Beam	1301 ea	109	11,220	29,848				31.57 /ea	41,068	23,831	50 /ea	64,899	0.00%
					10" Block Lintels	483 ea	40	4,166	11,081				31.57 /ea	15,247	8,847	50 /ea	24,094	0.00%
					10" Fire Rated 3 hr	38146 ea	3,186	328,985	272,362				15.76 /ea	601,347	383,254	26 /ea	984,601	0.02%
					Div. 04 Masonry	**37,142.550 vsf**	**23,889**	**2,466,813**	**977,064**				**92.72 /vsf**	**3,443,877**	**2,315,135**	**155.05 /vsf**	**5,759,012**	**0.13%**
				Div. 05 -15	**Div 5/6/7/8/9/10/11/12/22/23**													
					Div 5 - $/SF	137563.05 sf				7,791,571			56.64 /sf	7,791,571	2,616,715	76 /sf	10,408,286	0.24%
					Div 6 - $/SF	137563.05 sf				236,608			1.72 /sf	236,608	79,462	2 /sf	316,071	0.01%
					Div 7 - $/SF	137563.05 sf				5,630,456			40.93 /sf	5,630,456	1,890,927	55 /sf	7,521,383	0.17%
					Div 8 - $/SF	137563.05 sf				1,260,078			9.16 /sf	1,260,078	423,183	12 /sf	1,683,261	0.04%
					Div 9 - $/SF	137563.05 sf				4,952,270			36.00 /sf	4,952,270	1,663,166	48 /sf	6,615,436	0.15%
					Div 10 - $/SF	137563.05 sf				264,121			1.92 /sf	264,121	88,702	3 /sf	352,823	0.01%
					Div 11 - $/SF	137563.05 sf				130,685			0.95 /sf	130,685	43,889	1 /sf	174,574	0.00%
					Div 12 - $/SF	137563.05 sf				50,898			0.37 /sf	50,898	17,094	0 /sf	67,992	0.00%
					Div 22 - $/SF	137563.05 sf				840,510			6.11 /sf	840,510	282,276	8 /sf	1,122,786	0.03%
					Div 23 - $/SF	137563.05 sf				8,070,824			58.67 /sf	8,070,824	2,710,499	78 /sf	10,781,323	0.24%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	**137,563.050 hsf**				**29,228,021**			**212.47 /hsf**	**29,228,021**	**9,815,914**	**283.83 /hsf**	**39,043,935**	**0.88%**
					Building Building	**137,563.000 hsf**	**23,889**	**2,466,813**	**977,064**	**29,228,021**			**237.51 /hsf**	**32,671,898**	**12,131,049**	**325.69 /hsf**	**44,802,947**	**1.02%**
			Footing		**Footing**													
				Div. 03	**Concrete**													
					Continuous Footing Forms > 12"	7153.2 sf	1,431	129,170	10,891				19.58 /sf	140,060	102,099	34 /sf	242,160	0.01%
					Keyway 4"	2338.5 lf	117	10,557	1,154				5.01 /lf	11,711	8,483	9 /lf	20,194	0.00%
					Waterstop 6" Bulb	2338.5 lf	234	20,948	13,554				14.75 /lf	34,502	22,746	24 /lf	57,248	0.00%
					Strip & Oil Footing Forms	7153.2 sf	36	3,204	501				0.52 /sf	3,705	2,656	1 /sf	6,361	0.00%
					Footing Rebar	51.6 tn	1,032	105,792	97,524				3,940.24 /tn	203,316	128,524	6,431 /tn	331,841	0.01%
					Pump Place Wall Footings	412.8 cy	229	24,334			1,981		63.75 /cy	26,315	18,783	109 /cy	45,098	0.00%
					4500 psi Concrete	412.8 cy			86,688				210.00 /cy	86,688	45,367	320 /cy	132,055	0.00%
					Div. 03 Concrete	**7,153.200 hsf**	**3,078**	**294,004**	**210,311**		**1,981**		**70.78 /hsf**	**506,297**	**328,658**	**116.72 /hsf**	**834,955**	**0.02%**
					Footing Footing	**412.800 cy**	**3,078**	**294,004**	**210,311**		**1,981**		**1,226.49 /cy**	**506,297**	**328,658**	**2,022.66 /cy**	**834,955**	**0.02%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	**Concrete**													
					Keyway 4"	412.8 lf	21	1,864	204				5.01 /lf	2,067	1,497	9 /lf	3,565	0.00%
					Rented Form System 16'->	17883.15 sf	4,471	403,658	187,773				33.07 /sf	591,432	399,521	55 /sf	990,952	0.02%
					Wall Bulkhead Forms	825.45 sf	454	40,991	4,334				54.91 /sf	45,324	32,859	95 /sf	78,183	0.00%
					Waterstop 6" Bulb	825.45 lf	83	7,394	4,784				14.75 /lf	12,179	8,029	24 /lf	20,208	0.00%
					Strip & Oil Wall Forms	17883.15 sf	89	8,010	1,252				0.52 /sf	9,262	6,640	1 /sf	15,902	0.00%
					Hot Water Charge	687.75 cy			5,777				8.40 /cy	5,777	3,023	13 /cy	8,800	0.00%
					Wall Rebar	85.97 tn	1,977	202,698	162,484				4,247.79 /tn	365,182	233,498	6,964 /tn	598,680	0.01%
					Finish- Top of Wall & Curb	687.75 sf	38	3,388					4.93 /sf	3,388	2,531	9 /sf	5,919	0.00%
					Pump Place Walls	687.75 cy	963	102,266			4,950		155.89 /cy	107,216	77,154	268 /cy	184,370	0.00%
					4500 psi Concrete	687.75 cy			144,428				210.00 /cy	144,428	75,585	320 /cy	220,012	0.00%
					Grind/Patch Walls	17883.15 sf	1,431	128,133	626				7.20 /sf	128,759	96,075	13 /sf	224,834	0.01%
					Liquid Curing Compounds	17883.15 sf	54	4,806	14,083				1.06 /sf	18,889	10,961	2 /sf	29,850	0.00%
					Div. 03 Concrete	**17,883.150 hsf**	**9,580**	**903,208**	**525,744**		**4,950**		**80.18 /hsf**	**1,433,902**	**947,373**	**133.16 /hsf**	**2,381,275**	**0.05%**
					Foundation Wall Foundation Wall	**687.750 cy**	**9,580**	**903,208**	**525,744**		**4,950**		**2,084.92 /cy**	**1,433,902**	**947,373**	**3,462.41 /cy**	**2,381,275**	**0.05%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	11005.05 sf	3,742	337,832	16,755				32.22 /sf	354,587	260,894	56 /sf	615,481	0.01%
					S-O-G Const Joints > 1'	20634.45 sf	7,428	670,696	31,416				34.03 /sf	702,112	516,984	59 /sf	1,219,095	0.03%
					Strip & Oil SOG Form	31639.5 sf	158	14,171	2,215				0.52 /sf	16,386	11,748	1 /sf	28,134	0.00%
					SOG Rebar	963 tn	14,445	1,480,786	1,820,070				3,427.68 /tn	3,300,856	2,037,095	5,543 /tn	5,337,951	0.12%
					Mesh Support - bricks	15958 ea	32	3,272	8,210				0.72 /ea	11,482	6,693	1 /ea	18,175	0.00%
					Finish- Hard Trowel	137563.05 sf	3,164	283,360					2.06 /sf	283,360	211,741	4 /sf	495,101	0.01%
					Pump Place Slab on Grade	15269.55 cy	18,323	1,946,171			43,972		130.33 /cy	1,990,143	1,441,734	225 /cy	3,431,878	0.08%
					4500 psi Concrete	15269.55 cy			3,206,606				210.00 /cy	3,206,606	1,678,142	320 /cy	4,884,748	0.11%
					Liquid Curing Compounds	137563.05 sf	413	36,968	108,331				1.06 /sf	145,299	84,317	2 /sf	229,616	0.01%
					Seal Floors	137563.05 sf	688	61,613	28,888				0.66 /sf	90,501	61,157	1 /sf	151,659	0.00%
					Div. 03 Concrete	**137,563.050 hsf**	**48,393**	**4,834,869**	**5,222,491**		**43,972**		**73.43 /hsf**	**10,101,332**	**6,310,506**	**119.30 /hsf**	**16,411,838**	**0.37%**
					Slab Slab	**15,269.550 cy**	**48,393**	**4,834,869**	**5,222,491**		**43,972**		**661.53 /cy**	**10,101,332**	**6,310,506**	**1,074.81 /cy**	**16,411,838**	**0.37%**
					139. RO Facility	**137,563.000 sf**	**84,940**	**8,498,893**	**6,935,611**	**29,228,021**	**50,903**		**325.04 /sf**	**44,713,428**	**19,717,586**	**468.37 /sf**	**64,431,015**	**1.46%**
	140.				**RO (1st Stage)**													
			RO Cell		**RO Cell**													
				Div. 46	**Water and Wastewater Equipment**													
					RO BW Membrane Filter Elements and Assembly Components - ea - Stage 1	20736 ea						**11,185,620**	539.43 /ea	**11,185,620**	**5,853,873**	**822 /ea**	**17,039,494**	0.39%
					RO BW Membrane Filter Elements and Assembly Components - ea - Stage 1	20736 ea	**23,846**	2,310,978			**264,194**	**30,085,655**	1,575.08 /ea	**32,660,828**	**17,590,910**	**2,423 /ea**	**50,251,738**	1.14%
					Div. 46 Water and Wastewater Equipment	**150.000 mgd**	**23,846**	**2,310,978**			**264,194**	**41,271,276**	**292,309.66 /mgd**	**43,846,448**	**23,444,783**	**448,608.21 /mgd**	**67,291,231**	**1.53%**

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					RO Cell RO Cell	20,736.000 ea	23,846	2,310,978			264,194	41,271,276	2,114.51 /ea	43,846,448	23,444,783	3,245.14 /ea	67,291,231	1.53%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			31,110,199				31,110,198.93 /ls	31,110,199	16,281,185	47,391,384 /ls	47,391,384	1.07%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	115,223	11,522,296			10,946,181		22,468,477.01 /ls	22,468,477	13,906,620	36,375,097 /ls	36,375,097	0.82%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	115,223	11,522,296	31,110,199		10,946,181		357,191.17 /mgd	53,578,676	30,187,805	558,443.20 /mgd	83,766,481	1.90%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	115,223	11,522,296	31,110,199		10,946,181		357,191.17 /MGD	53,578,676	30,187,805	558,443.20 /MGD	83,766,481	1.90%
					140. RO (1st Stage)	150.000 MGD	139,069	13,833,274	31,110,199		11,210,375	41,271,276	649,500.83 /MGD	97,425,124	53,632,588	1,007,051.41 /MGD	151,057,712	3.42%
		140.-144			RO (1st Stage) to RO (2nd Stage) Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					140.-144 RO (1st Stage) to RO (2nd Stage) Piping								/lf			/lf		
		140.-190			RO (1st Stage) to UV/AOP Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					140.-190 RO (1st Stage) to UV/AOP Piping								/lf			/lf		
		144.			RO (2nd Stage)													
			RO Cell		RO Cell													
				Div. 46	Water and Wastewater Equipment													
					RO BW Membrane Filter Elements and Assembly Components - ea - Stage 2	9216 ea	10,598	1,027,102			117,420	13,371,402	1,575.08 /ea	14,515,923	7,818,182	2,423 /ea	22,334,106	0.51%
					RO BW Membrane Filter Elements and Assembly Components - ea - Stage 2	9216 ea						4,971,387	539.43 /ea	4,971,387	2,601,721	822 /ea	7,573,108	0.17%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	10,598	1,027,102			117,420	18,342,789	129,915.40 /mgd	19,487,310	10,419,903	199,381.43 /mgd	29,907,214	0.68%
					RO Cell RO Cell	18,432.000 ea	10,598	1,027,102			117,420	18,342,789	1,057.25 /ea	19,487,310	10,419,903	1,622.57 /ea	29,907,214	0.68%
					144. RO (2nd Stage)	1.000 ls	10,598	1,027,102			117,420	18,342,789	19,487,310.33 /ls	19,487,310	10,419,903	29,907,213.83 /ls	29,907,214	0.68%
		144.-160			RO (2nd Stage) to RO Booster Pump Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					144.-160 RO (2nd Stage) to RO Booster Pump Piping								/lf			/lf		
		144.-190			RO (2nd Stage) to UV/AOP Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					144.-190 RO (2nd Stage) to UV/AOP Piping								/lf			/lf		
		148.			RO (3rd Stage)													
			RO Cell		RO Cell													
				Div. 46	Water and Wastewater Equipment													
					RO BW Membrane Filter Elements and Assembly Components - ea - Stage 3	4608 ea	5,299	513,551			58,710	6,685,701	1,575.08 /ea	7,257,962	3,909,091	2,423 /ea	11,167,053	0.25%
					RO BW Membrane Filter Elements and Assembly Components - ea - Stage 3	4608 ea	5,299	513,551			58,710	2,485,693	663.62 /ea	3,057,954	1,711,063	1,035 /ea	4,769,017	0.11%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	10,598	1,027,102			117,420	9,171,395	68,772.77 /mgd	10,315,916	5,620,154	106,240.46 /mgd	15,936,070	0.36%
					RO Cell RO Cell	9,216.000 ea	10,598	1,027,102			117,420	9,171,395	1,119.35 /ea	10,315,916	5,620,154	1,729.17 /ea	15,936,070	0.36%
					148. RO (3rd Stage)	1.000 ls	10,598	1,027,102			117,420	9,171,395	10,315,915.78 /ls	10,315,916	5,620,154	15,936,069.50 /ls	15,936,070	0.36%
		148.-170			RO (3rd Stage) to Brine to Ocean Outfall Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					148.-170 RO (3rd Stage) to Brine to Ocean Outfall Piping								/lf			/lf		
		148.-190			RO (3rd Stage) to UV/AOP Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					148.-190 RO (3rd Stage) to UV/AOP Piping								/lf			/lf		
		160.			RO Booster Pump													
			Booster Pump Stage 3		Booster Pump Stage 3													
				Div. 46	Water and Wastewater Equipment													
					RO Booster Pumps 15 DUTY + 1 SB	16 ea	3,840	400,297	96,000		31,908	1,800,000	145,512.78 /ea	2,328,204	1,301,620	226,864 /ea	3,629,824	0.08%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	3,840	400,297	96,000		31,908	1,800,000	15,521.36 /mgd	2,328,204	1,301,620	24,198.83 /mgd	3,629,824	0.08%
					Booster Pump Stage 3 Booster Pump Stage 3	16.000 ea	3,840	400,297	96,000		31,908	1,800,000	145,512.78 /ea	2,328,204	1,301,620	226,864.01 /ea	3,629,824	0.08%
					160. RO Booster Pump	16.000 ea	3,840	400,297	96,000		31,908	1,800,000	145,512.78 /ea	2,328,204	1,301,620	226,864.01 /ea	3,629,824	0.08%
		170.			Brine to Ocean Outfall													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					170. Brine to Ocean Outfall	1.000 ls							/ls			/ls		

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
		179.			CIP Tank													
			Cip Tank		Cip Tank													
				Div. 46	Water and Wastewater Equipment													
					Polyethylene Tank, 17,000Gal	4 ea	320	31,012			3,545	1,740,000	443,639.20 /ea	1,774,557	935,381	677,484 /ea	2,709,938	0.06%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	320	31,012			3,545	1,740,000	11,830.38 /mgd	1,774,557	935,381	18,066.25 /mgd	2,709,938	0.06%
					Cip Tank Cip Tank	4.000 ea	320	31,012			3,545	1,740,000	443,639.20 /ea	1,774,557	935,381	677,484.40 /ea	2,709,938	0.06%
					179. CIP Tank	4.000 ea	320	31,012			3,545	1,740,000	443,639.20 /ea	1,774,557	935,381	677,484.40 /ea	2,709,938	0.06%
		180.			RO Flush Tank													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Polyethylene Tank, 60,000Gal	1 ea	80	7,753			886	435,000	443,639.20 /ea	443,639	233,845	677,484 /ea	677,484	0.02%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	80	7,753			886	435,000	2,957.60 /mgd	443,639	233,845	4,516.56 /mgd	677,484	0.02%
					* unassigned *		80	7,753			886	435,000		443,639	233,845		677,484	0.02%
					180. RO Flush Tank	1.000 ea	80	7,753			886	435,000	443,639.20 /ea	443,639	233,845	677,484.39 /ea	677,484	0.02%
		180.-190			RO Flush Tank to UV/AOP Piping													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					RO Flush Pump 1 DUTY + 1 SB	2 ea	480	50,037	12,000		3,988	675,000	370,512.78 /ea	741,026	398,205	569,615 /ea	1,139,231	0.03%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	480	50,037	12,000		3,988	675,000	4,940.17 /mgd	741,026	398,205	7,594.87 /mgd	1,139,231	0.03%
					* unassigned *		480	50,037	12,000		3,988	675,000		741,026	398,205		1,139,231	0.03%
					180.-190 RO Flush Tank to UV/AOP Piping	2.000 lf	480	50,037	12,000		3,988	675,000	370,512.78 /lf	741,026	398,205	569,615.31 /lf	1,139,231	0.03%
					004. - RO Reverse Osmosis Related	150.000 MGD	306,467	30,477,002	43,601,404	41,393,119	11,628,420	115,222,959	1,615,486.03 /MGD	242,322,904	125,233,911	2,450,378.77 /MGD	367,556,815	8.33%
	005. - UV AOP				UV AOP System													
		190.			UV/AOP													
			Building		Building													
				Div. 10	Specialties													
					Estimate Placeholder - Canopy	41478.15 sf				6,636,504			160.00 /sf	6,636,504	2,228,798	214 /sf	8,865,302	0.20%
					Div. 10 Specialties	41,478.150 hsf				6,636,504			160.00 /hsf	6,636,504	2,228,798	213.73 /hsf	8,865,302	0.20%
					Building Building	41,478.150 hsf				6,636,504			160.00 /hsf	6,636,504	2,228,798	213.73 /hsf	8,865,302	0.20%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	4009.8 sf	802	72,407	6,105				19.58 /sf	78,512	57,233	34 /sf	135,745	0.00%
					Keyway 4"	1336.65 lf	67	6,034	660				5.01 /lf	6,694	4,849	9 /lf	11,542	0.00%
					Waterstop 6" Bulb	1336.65 lf	134	11,973	7,747				14.75 /lf	19,721	13,001	24 /lf	32,722	0.00%
					Strip & Oil Footing Forms	4009.8 sf	20	1,796	281				0.52 /sf	2,077	1,489	1 /sf	3,565	0.00%
					Footing Rebar	8.25 tn	165	16,914	15,593				3,940.35 /tn	32,508	20,549	6,431 /tn	53,057	0.00%
					Pump Place Wall Footings	223.2 cy	124	13,157			1,071		63.75 /cy	14,228	10,156	109 /cy	24,384	0.00%
					4500 psi Concrete	223.2 cy			46,872				210.00 /cy	46,872	24,530	320 /cy	71,402	0.00%
					Div. 03 Concrete	4,009.800 hsf	1,311	122,283	77,258		1,071		50.03 /hsf	200,612	131,807	82.90 /hsf	332,418	0.01%
					Footing Footing	223.200 cy	1,311	122,283	77,258		1,071		898.80 /cy	200,612	131,807	1,489.33 /cy	332,418	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	200.85 lf	10	907	99				5.01 /lf	1,006	729	9 /lf	1,734	0.00%
					Rented Form System 16'->	8034.9 sf	2,009	181,364	84,366				33.07 /sf	265,730	179,505	55 /sf	445,235	0.01%
					Wall Bulkhead Forms	401.7 sf	221	19,948	2,109				54.91 /sf	22,057	15,991	95 /sf	38,048	0.00%
					Waterstop 6" Bulb	401.7 lf	40	3,598	2,328				14.75 /lf	5,927	3,907	24 /lf	9,834	0.00%
					Strip & Oil Wall Forms	8034.9 sf	40	3,599	562				0.52 /sf	4,161	2,983	1 /sf	7,145	0.00%
					Hot Water Charge	297.6 cy			2,500				8.40 /cy	2,500	1,308	13 /cy	3,808	0.00%
					Wall Rebar	26.25 tn	604	61,892	49,613				4,247.81 /tn	111,505	71,296	6,964 /tn	182,801	0.00%
					Finish- Top of Wall & Curb	334.8 sf	18	1,649					4.93 /sf	1,649	1,232	9 /sf	2,881	0.00%
					Pump Place Walls	297.6 cy	417	44,252			2,142		155.89 /cy	46,394	33,386	268 /cy	79,780	0.00%
					4500 psi Concrete	297.6 cy			62,496				210.00 /cy	62,496	32,707	320 /cy	95,203	0.00%
					Grind/Patch Walls	8034.9 sf	643	57,570	281				7.20 /sf	57,852	43,166	13 /sf	101,018	0.00%
					Liquid Curing Compounds	8034.9 sf	24	2,159	6,327				1.06 /sf	8,487	4,925	2 /sf	13,412	0.00%
					Div. 03 Concrete	8,034.900 hsf	4,026	376,938	210,683		2,142		73.40 /hsf	589,763	391,135	122.08 /hsf	980,898	0.02%
					Foundation Wall Foundation Wall	297.600 cy	4,026	376,938	210,683		2,142		1,981.73 /cy	589,763	391,135	3,296.03 /cy	980,898	0.02%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	3362.1 sf	1,143	103,209	5,119				32.22 /sf	108,328	79,704	56 /sf	188,033	0.00%
					S-O-G Const Joints > 1'	6277.8 sf	2,260	204,052	9,558				34.03 /sf	213,610	157,286	59 /sf	370,896	0.01%
					Strip & Oil SOG Form	9639.75 sf	48	4,318	675				0.52 /sf	4,992	3,579	1 /sf	8,572	0.00%
					SOG Rebar	302.25 tn	4,534	464,764	571,253				3,427.68 /tn	1,036,017	639,369	5,543 /tn	1,675,386	0.04%
					Mesh Support - bricks	4837 ea	10	992	2,489				0.72 /ea	3,480	2,029	1 /ea	5,509	0.00%
					Finish- Hard Trowel	41851.35 sf	963	86,208					2.06 /sf	86,208	64,419	4 /sf	150,627	0.00%
					Pump Place Slab on Grade	4650.15 cy	5,580	592,682			13,391		130.33 /cy	606,073	439,062	225 /cy	1,045,135	0.02%
					4500 psi Concrete	4650.15 cy			976,532				210.00 /cy	976,532	511,057	320 /cy	1,487,589	0.03%
					Liquid Curing Compounds	41851.35 sf	126	11,247	32,958				1.06 /sf	44,205	25,652	2 /sf	69,857	0.00%
					Seal Floors	41851.35 sf	209	18,745	8,789				0.66 /sf	27,534	18,606	1 /sf	46,140	0.00%
					Div. 03 Concrete	41,851.350 hsf	14,872	1,486,216	1,607,372		13,391		74.24 /hsf	3,106,979	1,940,764	120.61 /hsf	5,047,743	0.11%
					Slab Slab	4,650.150 cy	14,872	1,486,216	1,607,372		13,391		668.15 /cy	3,106,979	1,940,764	1,085.50 /cy	5,047,743	0.11%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			8,990,880				8,990,880.39 /ls	8,990,880	4,705,280	13,696,160 /ls	13,696,160	0.31%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	61,624	6,162,445			3,463,154		9,625,598.56 /ls	9,625,599	6,174,300	15,799,898 /ls	15,799,898	0.36%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	61,624	6,162,445	8,990,880		3,463,154		124,109.86 /mgd	18,616,479	10,879,579	196,640.39 /mgd	29,496,058	0.67%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	61,624	6,162,445	8,990,880		3,463,154		124,109.86 /MGD	18,616,479	10,879,579	196,640.39 /MGD	29,496,058	0.67%
			UV AOP		UV AOP													
				Div. 46	Water and Wastewater Equipment													
					Butterfly Valves MJ 48" Epoxy Coated w/ valve box & Elec Oper	20 ea	840	87,565	120,000			960,000	58,378.25 /ea	1,167,565	629,193	89,838 /ea	1,796,758	0.04%
					Magnetic Flow Meter, Inline - 48" w/ transmitter	10 ea	520	58,020	280,000			622,890	96,091.00 /ea	960,910	514,531	147,544 /ea	1,475,441	0.03%
					UV AOP Reactors (7 duty, 1 standby) 16.43 MGD per train, 1600 mj/cm	10 ea	6,400	667,162	160,000		53,179	31,716,667	3,259,700.75 /ea	32,597,007	17,197,922	4,979,493 /ea	49,794,929	1.13%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	7,760	812,747	560,000		53,179	33,299,557	231,503.22 /mgd	34,725,482	18,341,646	353,780.86 /mgd	53,067,128	1.20%
					UV AOP UV AOP	150.000 MGD	7,760	812,747	560,000		53,179	33,299,557	231,503.22 /MGD	34,725,482	18,341,646	353,780.86 /MGD	53,067,128	1.20%
					190. UV/AOP	150.000 MGD	89,594	8,960,627	11,446,193	6,636,504	3,532,937	33,299,557	425,838.79 /MGD	63,875,819	33,913,729	651,930.32 /MGD	97,789,548	2.22%
		190.-250			UV/AOP to Free Chlorine Piping													
			UV AOP		UV AOP													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					UV AOP UV AOP	150.000 MGD							/MGD			/MGD		
					190.-250 UV/AOP to Free Chlorine Piping								/lf			/lf		
					005. - UV AOP UV AOP System	150.000 MGD	89,594	8,960,627	11,446,193	6,636,504	3,532,937	33,299,557	425,838.79 /MGD	63,875,819	33,913,729	651,930.32 /MGD	97,789,548	2.22%
	006. - Chemical				Chemical Storage and Feed Systems													
		071.			Chemical Buildings Process E&I & Unidentified Piping													
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			999,574				999,573.75 /ls	999,574	523,116	1,522,690 /ls	1,522,690	0.03%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	4,998	499,788			129,574		629,361.98 /ls	629,362	420,814	1,050,176 /ls	1,050,176	0.02%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	4,998	499,788	999,574		129,574		10,859.57 /mgd	1,628,936	943,930	17,152.44 /mgd	2,572,866	0.06%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	4,998	499,788	999,574		129,574		10,859.57 /MGD	1,628,936	943,930	17,152.44 /MGD	2,572,866	0.06%
					071. Chemical Buildings Process E&I & Unidentified Piping	150.000 MGD	4,998	499,788	999,574		129,574		10,859.57 /MGD	1,628,936	943,930	17,152.44 /MGD	2,572,866	0.06%
		072.			Ammonium Sulfate													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Polyethylene Tank, 12,700Gal	6 ea	480	46,517			5,318	552,450	100,714.20 /ea	604,285	326,275	155,093 /ea	930,560	0.02%
					Chemical Feeding Units	2 ea	120	11,629			1,329	150,000	81,479.40 /ea	162,959	87,790	125,374 /ea	250,749	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	600	58,147			6,647	702,450	5,114.96 /mgd	767,244	414,065	7,875.39 /mgd	1,181,309	0.03%
					* unassigned *		600	58,147			6,647	702,450		767,244	414,065		1,181,309	0.03%
					072. Ammonium Sulfate	8.000 ea	600	58,147			6,647	702,450	95,905.50 /ea	767,244	414,065	147,663.57 /ea	1,181,309	0.03%
		072.-064			Ammonium Sulfate to MF Membranes Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					072.-064 Ammonium Sulfate to MF Membranes Piping								/lf			/lf		
		120.			Sulfuric Acid													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Polyethylene Tank, 14,000Gal	4 ea	320	31,012			3,545	406,000	110,139.20 /ea	440,557	237,246	169,451 /ea	677,803	0.02%
					Chemical Feeding Units	2 ea	120	11,629			1,329	150,000	81,479.40 /ea	162,959	87,790	125,374 /ea	250,749	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	440	42,641			4,875	556,000	4,023.44 /mgd	603,516	325,036	6,190.35 /mgd	928,552	0.02%
					* unassigned *		440	42,641			4,875	556,000		603,516	325,036		928,552	0.02%
					120. Sulfuric Acid	6.000 ea	440	42,641			4,875	556,000	100,585.93 /ea	603,516	325,036	154,758.63 /ea	928,552	0.02%
		120.-110			Sulfuric Acid to Cartridge Filter Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					120.-110 Sulfuric Acid to Cartridge Filter Piping								/lf			/lf		
		122.			Antiscalant													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Polyethylene Tank, 13,500Gal	2 ea	160	15,506			1,773	195,750	106,514.20 /ea	213,028	114,829	163,929 /ea	327,857	0.01%
					Chemical Feeding Units	2 ea	120	11,629			1,329	150,000	81,479.40 /ea	162,959	87,790	125,374 /ea	250,749	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	280	27,135			3,102	345,750	2,506.58 /mgd	375,987	202,619	3,857.37 /mgd	578,606	0.01%
					* unassigned *		280	27,135			3,102	345,750		375,987	202,619		578,606	0.01%
					122. Antiscalant	4.000 ea	280	27,135			3,102	345,750	93,996.80 /ea	375,987	202,619	144,651.51 /ea	578,606	0.01%
		122.-130			Antiscalant to RO Feed Pump Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					122.-130 Antiscalant to RO Feed Pump Piping								/lf			/lf		

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
		123.			Caustic (NaOH)													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Polyethylene Tank, 15,0000Gal	11 ea	880	85,282			9,750	1,196,250	117,389.20 /ea	1,291,281	694,164	180,495 /ea	1,985,445	0.05%
					Chemical Feeding Units	3 ea	180	17,444			1,994	225,000	81,479.40 /ea	244,438	131,685	125,374 /ea	376,123	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,060	102,726			11,744	1,421,250	10,238.13 /mgd	1,535,719	825,849	15,743.79 /mgd	2,361,568	0.05%
					* unassigned *		1,060	102,726			11,744	1,421,250		1,535,719	825,849		2,361,568	0.05%
					123. Caustic (NaOH)	14.000 ea	1,060	102,726			11,744	1,421,250	109,694.24 /ea	1,535,719	825,849	168,683.42 /ea	2,361,568	0.05%
		128.			Citric Acid													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Polyethylene Tank, 15,000Gal	3 ea	240	23,259			2,659	326,250	117,389.20 /ea	352,168	189,317	180,495 /ea	541,485	0.01%
					Chemical Feeding Units	3 ea	180	17,444			1,994	225,000	81,479.40 /ea	244,438	131,685	125,374 /ea	376,123	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	420	40,703			4,653	551,250	3,977.37 /mgd	596,606	321,002	6,117.39 /mgd	917,608	0.02%
					* unassigned *		420	40,703			4,653	551,250		596,606	321,002		917,608	0.02%
					128. Citric Acid	6.000 ea	420	40,703			4,653	551,250	99,434.30 /ea	596,606	321,002	152,934.67 /ea	917,608	0.02%
		199.			Chemical Building													
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	21036.45 sf	105	10,861	10,518				1.02 /sf	21,379	13,126	2 /sf	34,505	0.00%
					Staging to 30'	21036.45 sf	105	10,861	15,777				1.27 /sf	26,639	15,878	2 /sf	42,517	0.00%
					Rub Block	21036.45 sf	280	28,956					1.38 /sf	28,956	21,187	2 /sf	50,143	0.00%
					Mortar	1514.55 cf			11,816				7.80 /cf	11,816	6,184	12 /cf	17,999	0.00%
					Mortar	2524.35 cf			19,694				7.80 /cf	19,694	10,306	12 /cf	30,000	0.00%
					Grout Fill 10" Block Cells	13021.65 cf	3,906	403,389	82,720				37.33 /cf	486,109	338,447	63 /cf	824,556	0.02%
					Grout Fill 10"Lintel Block	105.15 cf	32	3,257	668				37.33 /cf	3,925	2,733	63 /cf	6,658	0.00%
					Grout Fill 10 "Bond Beam	168.3 cf	50	5,214	1,069				37.33 /cf	6,283	4,374	63 /cf	10,657	0.00%
					Dur-O-Wall 10"	17102.7 lf			7,901				0.46 /lf	7,901	4,135	1 /lf	12,037	0.00%
					Wall Ties	24340 ea	324	33,503	3,067				1.50 /ea	36,570	26,119	3 /ea	62,689	0.00%
					Extruded Control Joints 1/2"	2040.45 lf	12	1,203	4,778				2.93 /lf	5,981	3,381	5 /lf	9,361	0.00%
					Masonry Rebar # 5	99250.35 lbs	1,191	122,984	69,872				1.94 /lbs	192,857	126,554	3 /lbs	319,410	0.01%
					Masonry Rebar # 5	378.75 lbs	5	469	267				1.94 /lbs	736	483	3 /lbs	1,219	0.00%
					Standard Brick	140756 ea	5,630	581,396	147,794				5.18 /ea	729,190	502,750	9 /ea	1,231,939	0.03%
					10" Block Bond Beam	737 ea	62	6,356	16,909				31.57 /ea	23,265	13,500	50 /ea	36,764	0.00%
					10" Block Lintels	274 ea	23	2,363	6,286				31.57 /ea	8,649	5,019	50 /ea	13,668	0.00%
					10" Fire Rated 3 hr	21605 ea	1,804	186,329	154,260				15.76 /ea	340,589	217,066	26 /ea	557,655	0.01%
					Div. 04 Masonry	21,036.450 vsf	13,530	1,397,142	553,395				92.72 /vsf	1,950,538	1,311,241	155.05 /vsf	3,261,779	0.07%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	32869.5 sf				1,861,728			56.64 /sf	1,861,728	625,241	76 /sf	2,486,970	0.06%
					Div 6 - $/SF	32869.5 sf				56,536			1.72 /sf	56,536	18,987	2 /sf	75,522	0.00%
					Div 7 - $/SF	32869.5 sf				1,345,349			40.93 /sf	1,345,349	451,821	55 /sf	1,797,169	0.04%
					Div 8 - $/SF	32869.5 sf				301,085			9.16 /sf	301,085	101,116	12 /sf	402,201	0.01%
					Div 9 - $/SF	32869.5 sf				1,183,302			36.00 /sf	1,183,302	397,399	48 /sf	1,580,701	0.04%
					Div 10 - $/SF	32869.5 sf				63,109			1.92 /sf	63,109	21,195	3 /sf	84,304	0.00%
					Div 11 - $/SF	32869.5 sf				31,226			0.95 /sf	31,226	10,487	1 /sf	41,713	0.00%
					Div 12 - $/SF	32869.5 sf				12,162			0.37 /sf	12,162	4,084	0 /sf	16,246	0.00%
					Div 22 - $/SF	32869.5 sf				200,833			6.11 /sf	200,833	67,447	8 /sf	268,280	0.01%
					Div 23 - $/SF	32869.5 sf				1,928,454			58.67 /sf	1,928,454	647,650	78 /sf	2,576,104	0.06%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	32,869.500 hsf				6,983,783			212.47 /hsf	6,983,783	2,345,428	283.83 /hsf	9,329,210	0.21%
					Building Building	**32,869.500 hsf**	13,530	1,397,142	553,395	6,983,783			**271.81 /hsf**	8,934,320	3,656,669	**383.06 /hsf**	12,590,989	0.29%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	3999.45 sf	800	72,220	6,089				19.58 /sf	78,310	57,085	34 /sf	135,395	0.00%
					Keyway 4"	1333.2 lf	67	6,019	658				5.01 /lf	6,677	4,836	9 /lf	11,513	0.00%
					Waterstop 6" Bulb	1333.2 lf	133	11,943	7,727				14.75 /lf	19,670	12,968	24 /lf	32,637	0.00%
					Strip & Oil Footing Forms	3999.45 sf	20	1,791	280				0.52 /sf	2,071	1,485	1 /sf	3,556	0.00%
					Footing Rebar	8.25 tn	165	16,914	15,593				3,940.35 /tn	32,508	20,549	6,431 /tn	53,057	0.00%
					Pump Place Wall Footings	222.6 cy	124	13,122			1,068		63.75 /cy	14,190	10,128	109 /cy	24,319	0.00%
					4500 psi Concrete	222.6 cy			46,746				210.00 /cy	46,746	24,464	320 /cy	71,210	0.00%
					Div. 03 Concrete	3,999.450 hsf	1,308	122,009	77,094		1,068		50.05 /hsf	200,171	131,516	82.93 /hsf	331,687	0.01%
					Footing Footing	**222.600 cy**	1,308	122,009	77,094		1,068		**899.24 /cy**	200,171	131,516	**1,490.06 /cy**	331,687	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	200.4 lf	10	905	99				5.01 /lf	1,004	727	9 /lf	1,731	0.00%
					Rented Form System 16'->	8014.05 sf	2,004	180,893	84,148				33.07 /sf	265,041	179,039	55 /sf	444,080	0.01%
					Wall Bulkhead Forms	400.65 sf	220	19,896	2,103				54.91 /sf	21,999	15,949	95 /sf	37,948	0.00%
					Waterstop 6" Bulb	400.65 lf	40	3,589	2,322				14.75 /lf	5,911	3,897	24 /lf	9,808	0.00%
					Strip & Oil Wall Forms	8014.05 sf	40	3,589	561				0.52 /sf	4,150	2,976	1 /sf	7,126	0.00%
					Hot Water Charge	296.7 cy			2,492				8.40 /cy	2,492	1,304	13 /cy	3,797	0.00%
					Wall Rebar	26.25 tn	604	61,892	49,613				4,247.81 /tn	111,505	71,296	6,964 /tn	182,801	0.00%
					Finish- Top of Wall & Curb	334.05 sf	18	1,645					4.93 /sf	1,645	1,230	9 /sf	2,875	0.00%
					Pump Place Walls	296.7 cy	415	44,118			2,135		155.89 /cy	46,254	33,285	268 /cy	79,538	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					4500 psi Concrete	296.7 cy			62,307				210.00 /cy	62,307	32,608	320 /cy	94,915	0.00%
					Grind/Patch Walls	8014.05 sf	641	57,421	280				7.20 /sf	57,701	43,054	13 /sf	100,756	0.00%
					Liquid Curing Compounds	8014.05 sf	24	2,154	6,311				1.06 /sf	8,465	4,912	2 /sf	13,377	0.00%
					Div. 03 Concrete	8,014.050 hsf	4,017	376,102	210,237		2,135		73.43 /hsf	588,474	390,276	122.13 /hsf	978,751	0.02%
					Foundation Wall Foundation Wall	**296.700 cy**	**4,017**	**376,102**	**210,237**		**2,135**		**1,983.40 /cy**	**588,474**	**390,276**	**3,298.79 /cy**	**978,751**	**0.02%**
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	2640.45 sf	898	81,056	4,020				32.22 /sf	85,076	62,597	56 /sf	147,673	0.00%
					S-O-G Const Joints > 1'	4930.5 sf	1,775	160,259	7,507				34.03 /sf	167,766	123,531	59 /sf	291,297	0.01%
					Strip & Oil SOG Form	7570.95 sf	38	3,391	530				0.52 /sf	3,921	2,811	1 /sf	6,732	0.00%
					SOG Rebar	237.3 tn	3,560	364,891	448,497				3,427.68 /tn	813,388	501,976	5,543 /tn	1,315,364	0.03%
					Mesh Support - bricks	3798.3 ea	8	779	1,954				0.72 /ea	2,733	1,593	1 /ea	4,326	0.00%
					Finish- Hard Trowel	32869.5 sf	756	67,706					2.06 /sf	67,706	50,594	4 /sf	118,300	0.00%
					Pump Place Slab on Grade	3652.2 cy	4,383	465,489			10,517		130.33 /cy	476,006	344,837	225 /cy	820,843	0.02%
					4500 psi Concrete	3652.2 cy			766,962				210.00 /cy	766,962	401,381	320 /cy	1,168,343	0.03%
					Liquid Curing Compounds	32869.5 sf	99	8,833	25,885				1.06 /sf	34,718	20,147	2 /sf	54,865	0.00%
					Seal Floors	32869.5 sf	164	14,722	6,903				0.66 /sf	21,625	14,613	1 /sf	36,238	0.00%
					Div. 03 Concrete	32,869.500 hsf	11,679	1,167,127	1,262,257		10,517		74.23 /hsf	2,439,902	1,524,079	120.60 /hsf	3,963,981	0.09%
					Slab Slab	**3,652.200 cy**	**11,679**	**1,167,127**	**1,262,257**		**10,517**		**668.06 /cy**	**2,439,902**	**1,524,079**	**1,085.37 /cy**	**3,963,981**	**0.09%**
			Unidentified		Unidentified													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Estimate Placeholder - Additional Unidentified Process Piping	***1.000 ls***							***/ls***			***/ls***		
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					Unidentified Unidentified	**1.000 ls**							**/ls**			**/ls**		
					199. Chemical Building	32,870.000 sf	30,535	3,062,381	2,102,984	6,983,783	13,721		370.03 /sf	12,162,868	5,702,540	543.52 /sf	17,865,408	0.40%
		239.			Chlorine Building													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	***1.000 ls***							***/ls***			***/ls***		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	17311.35 sf	87	8,938	8,656				1.02 /sf	17,594	10,802	2 /sf	28,395	0.00%
					Staging to 30'	17311.35 sf	87	8,938	12,984				1.27 /sf	21,921	13,066	2 /sf	34,988	0.00%
					Rub Block	17311.35 sf	231	23,829					1.38 /sf	23,829	17,435	2 /sf	41,264	0.00%
					Mortar	1246.5 cf			9,725				7.80 /cf	9,725	5,089	12 /cf	14,814	0.00%
					Mortar	2077.35 cf			16,206				7.80 /cf	16,206	8,481	12 /cf	24,688	0.00%
					Grout Fill 10" Block Cells	10715.7 cf	3,215	331,954	68,071				37.33 /cf	400,026	278,513	63 /cf	678,539	0.02%
					Grout Fill 10"Lintel Block	86.55 cf	26	2,681	550				37.33 /cf	3,231	2,250	63 /cf	5,480	0.00%
					Grout Fill 10 "Bond Beam	138.45 cf	42	4,289	880				37.33 /cf	5,168	3,599	63 /cf	8,767	0.00%
					Dur-O-Wall 10"	14074.05 lf			6,502				0.46 /lf	6,502	3,403	1 /lf	9,905	0.00%
					Wall Ties	20030 ea	267	27,571	2,524				1.50 /ea	30,094	21,494	3 /ea	51,589	0.00%
					Extruded Control Joints 1/2"	1679.1 lf	10	990	3,932				2.93 /lf	4,922	2,782	5 /lf	7,704	0.00%
					Masonry Rebar # 5	311.55 lbs	4	386	219				1.94 /lbs	605	397	3 /lbs	1,003	0.00%
					Masonry Rebar # 5	81674.7 lbs	980	101,206	57,499				1.94 /lbs	158,705	104,143	3 /lbs	262,848	0.01%
					Standard Brick	115830 ea	4,633	478,438	121,622				5.18 /ea	600,060	413,719	9 /ea	1,013,779	0.02%
					10" Block Bond Beam	606 ea	51	5,226	13,903				31.57 /ea	19,130	11,100	50 /ea	30,230	0.00%
					10" Block Lintels	225 ea	19	1,940	5,162				31.57 /ea	7,103	4,121	50 /ea	11,224	0.00%
					10" Fire Rated 3 hr	17779 ea	1,485	153,332	126,942				15.76 /ea	280,275	178,626	26 /ea	458,901	0.01%
					Div. 04 Masonry	17,311.350 vsf	11,134	1,149,719	455,376				92.72 /vsf	1,605,095	1,079,021	155.05 /vsf	2,684,116	0.06%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	25132.2 sf				1,423,488			56.64 /sf	1,423,488	478,063	76 /sf	1,901,551	0.04%
					Div 6 - $/SF	25132.2 sf				43,227			1.72 /sf	43,227	14,517	2 /sf	57,745	0.00%
					Div 7 - $/SF	25132.2 sf				1,028,661			40.93 /sf	1,028,661	345,465	55 /sf	1,374,126	0.03%
					Div 8 - $/SF	25132.2 sf				230,211			9.16 /sf	230,211	77,314	12 /sf	307,525	0.01%
					Div 9 - $/SF	25132.2 sf				904,759			36.00 /sf	904,759	303,854	48 /sf	1,208,613	0.03%
					Div 10 - $/SF	25132.2 sf				48,254			1.92 /sf	48,254	16,206	3 /sf	64,459	0.00%
					Div 11 - $/SF	25132.2 sf				23,876			0.95 /sf	23,876	8,018	1 /sf	31,894	0.00%
					Div 12 - $/SF	25132.2 sf				9,299			0.37 /sf	9,299	3,123	0 /sf	12,422	0.00%
					Div 22 - $/SF	25132.2 sf				153,558			6.11 /sf	153,558	51,571	8 /sf	205,128	0.00%
					Div 23 - $/SF	25132.2 sf				1,474,506			58.67 /sf	1,474,506	495,197	78 /sf	1,969,703	0.04%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	25,132.200 hsf				5,339,839			212.47 /hsf	5,339,839	1,793,327	283.83 /hsf	7,133,165	0.16%
					Building Building	**25,132.000 hsf**	**11,134**	**1,149,719**	**455,376**	**5,339,839**			**276.34 /hsf**	**6,944,933**	**2,872,348**	**390.63 /hsf**	**9,817,281**	**0.22%**
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	3291 sf	658	59,428	5,011				19.58 /sf	64,438	46,973	34 /sf	111,411	0.00%
					Keyway 4"	1097.1 lf	55	4,953	541				5.01 /lf	5,494	3,980	9 /lf	9,474	0.00%
					Waterstop 6" Bulb	1097.1 lf	110	9,828	6,359				14.75 /lf	16,186	10,671	24 /lf	26,858	0.00%
					Strip & Oil Footing Forms	3291 sf	16	1,474	230				0.52 /sf	1,704	1,222	1 /sf	2,926	0.00%
					Footing Rebar	6.75 tn	135	13,839	12,758				3,940.37 /tn	26,598	16,813	6,431 /tn	43,411	0.00%
					Pump Place Wall Footings	183.15 cy	102	10,796			879		63.75 /cy	11,675	8,333	109 /cy	20,009	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					4500 psi Concrete	183.15 cy			38,462				210.00 /cy	38,462	20,128	320 /cy	58,590	0.00%
					Div. 03 Concrete	3,291.000 hsf	1,076	100,317	63,361		879		50.00 /hsf	164,557	108,121	82.86 /hsf	272,679	0.01%
					Footing Footing	183.150 cy	1,076	100,317	63,361		879		898.49 /cy	164,557	108,121	1,488.83 /cy	272,679	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	164.85 lf	8	744	81				5.01 /lf	826	598	9 /lf	1,424	0.00%
					Rented Form System 16'->	6594.75 sf	1,649	148,857	69,245				33.07 /sf	218,102	147,331	55 /sf	365,432	0.01%
					Wall Bulkhead Forms	329.7 sf	181	16,372	1,731				54.91 /sf	18,103	13,125	95 /sf	31,228	0.00%
					Waterstop 6" Bulb	329.7 lf	33	2,953	1,911				14.75 /lf	4,864	3,207	24 /lf	8,071	0.00%
					Strip & Oil Wall Forms	6594.75 sf	33	2,954	462				0.52 /sf	3,415	2,449	1 /sf	5,864	0.00%
					Hot Water Charge	244.35 cy			2,053				8.40 /cy	2,053	1,074	13 /cy	3,127	0.00%
					Wall Rebar	21.45 tn	493	50,574	40,541				4,247.82 /tn	91,116	58,259	6,964 /tn	149,375	0.00%
					Finish- Top of Wall & Curb	274.8 sf	15	1,354					4.93 /sf	1,354	1,011	9 /sf	2,365	0.00%
					Pump Place Walls	244.35 cy	342	36,334			1,759		155.89 /cy	38,093	27,412	268 /cy	65,505	0.00%
					4500 psi Concrete	244.35 cy			51,314				210.00 /cy	51,314	26,854	320 /cy	78,168	0.00%
					Grind/Patch Walls	6594.75 sf	528	47,252	231				7.20 /sf	47,482	35,429	13 /sf	82,912	0.00%
					Liquid Curing Compounds	6594.75 sf	20	1,772	5,193				1.06 /sf	6,966	4,042	2 /sf	11,008	0.00%
					Div. 03 Concrete	6,594.750 hsf	3,302	309,166	172,761		1,759		73.34 /hsf	483,686	320,792	121.99 /hsf	804,478	0.02%
					Foundation Wall Foundation Wall	244.350 cy	3,302	309,166	172,761		1,759		1,979.48 /cy	483,686	320,792	3,292.32 /cy	804,478	0.02%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	2041.95 sf	694	62,684	3,109				32.22 /sf	65,792	48,408	56 /sf	114,200	0.00%
					S-O-G Const Joints > 1'	3812.85 sf	1,373	123,932	5,805				34.03 /sf	129,737	95,529	59 /sf	225,265	0.01%
					Strip & Oil SOG Form	5854.95 sf	29	2,622	410				0.52 /sf	3,032	2,174	1 /sf	5,206	0.00%
					SOG Rebar	183.6 tn	2,754	282,318	347,004				3,427.68 /tn	629,322	388,381	5,543 /tn	1,017,703	0.02%
					Mesh Support - bricks	2938 ea	6	602	1,512				0.72 /ea	2,114	1,232	1 /ea	3,346	0.00%
					Finish- Hard Trowel	25419.15 sf	585	52,360					2.06 /sf	52,360	39,126	4 /sf	91,486	0.00%
					Pump Place Slab on Grade	2824.35 cy	3,389	359,976			8,133		130.33 /cy	368,109	266,672	225 /cy	634,781	0.01%
					4500 psi Concrete	2824.35 cy			593,114				210.00 /cy	593,114	310,400	320 /cy	903,513	0.02%
					Liquid Curing Compounds	25419.15 sf	76	6,831	20,018				1.06 /sf	26,849	15,580	2 /sf	42,429	0.00%
					Seal Floors	25419.15 sf	127	11,385	5,338				0.66 /sf	16,723	11,301	1 /sf	28,024	0.00%
					Div. 03 Concrete	25,419.150 hsf	9,033	902,710	976,309		8,133		74.24 /hsf	1,887,152	1,178,802	120.62 /hsf	3,065,954	0.07%
					Slab Slab	2,824.350 cy	9,033	902,710	976,309		8,133		668.17 /cy	1,887,152	1,178,802	1,085.54 /cy	3,065,954	0.07%
					239. Chlorine Building	25,132.000 sf	24,545	2,461,912	1,667,807	5,339,839	10,771		377.22 /sf	9,480,329	4,480,063	555.48 /sf	13,960,392	0.32%
		240.			Sodium Hypochlorite													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							/ls			/ls		
					Polyethylene Tank, 14,400Gal	11 ea	880	85,282			9,750	1,148,400	113,039.20 /ea	1,243,431	669,122	173,868 /ea	1,912,553	0.04%
					Chemical Feeding Units	7 ea	420	40,703			4,653	525,000	81,479.40 /ea	570,356	307,265	125,374 /ea	877,620	0.02%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,300	125,984			14,403	1,673,400	12,091.91 /mgd	1,813,787	976,386	18,601.16 /mgd	2,790,173	0.06%
					* unassigned *		1,300	125,984			14,403	1,673,400		1,813,787	976,386		2,790,173	0.06%
					240. Sodium Hypochlorite	18.000 ea	1,300	125,984			14,403	1,673,400	100,765.94 /ea	1,813,787	976,386	155,009.64 /ea	2,790,173	0.06%
		240.-064			Sodium Hypochlorite to MF Membranes Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							/ls			/ls		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					240.-064 Sodium Hypochlorite to MF Membranes Piping								/lf			/lf		
		240.-250			Sodium Hypochlorite to Free Chlorine Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							/ls			/ls		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					240.-250 Sodium Hypochlorite to Free Chlorine Piping								/lf			/lf		
		250.			Free Chlorine													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Estimate Placeholder	*1.000 ls*							/ls			/ls		
					Div. 46 Water and Wastewater Equipment	150.000 mgd							/mgd			/mgd		
					250. Free Chlorine								/ea			/ea		
					006. - Chemical Chemical Storage and Feed Systems	150.000 MGD	64,178	6,421,416	4,770,364	12,323,621	199,490	5,250,100	193,099.94 /MGD	28,964,991	14,191,490	287,709.88 /MGD	43,156,482	0.98%
	007. - El/Pd/DB				Electrical Buildings, Pads & Ductbanks													
		020.			MBR Filtrate Tank													
			Building		Building													
				Div. 26	Electrical													
					Electrical	2652 sf				129,179			48.71 /sf	129,179	43,383	65 /sf	172,562	0.00%
					Div. 26 Electrical	150.000 mgd				129,179			861.19 /mgd	129,179	43,383	1,150.42 /mgd	172,562	0.00%
					Building Building	2,652.000 hsf				129,179			48.71 /hsf	129,179	43,383	65.07 /hsf	172,562	0.00%
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					I&C	1 ls				234,000			234,000.00 /ls	234,000	78,586	312,586 /ls	312,586	0.01%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				234,000			1,560.00 /mgd	234,000	78,586	2,083.91 /mgd	312,586	0.01%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
				Div. 26	Electrical													
					Electrical	1 ls				936,000			936,000.00 /ls	936,000	314,345	1,250,345 /ls	1,250,345	0.03%
					Div. 26 Electrical	150.000 mgd				936,000			6,240.00 /mgd	936,000	314,345	8,335.64 /mgd	1,250,345	0.03%
					Process System E&I Process System E&I	1.000 al				1,170,000			1,170,000.00 /al	1,170,000	392,932	1,562,931.81 /al	1,562,932	0.04%
					020. MBR Filtrate Tank	150.000 MGD				1,299,179			8,661.19 /MGD	1,299,179	436,315	11,569.96 /MGD	1,735,494	0.04%
		020.E.			EB1 - MBR Electrical Building													
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	4109.472 sf	822	74,207	6,257				19.58 /sf	80,464	58,655	34 /sf	139,119	0.00%
					Keyway 4"	1370.736 lf	69	6,188	676				5.01 /lf	6,865	4,972	9 /lf	11,837	0.00%
					Waterstop 6" Bulb	1370.736 lf	137	12,279	7,945				14.75 /lf	20,224	13,333	24 /lf	33,556	0.00%
					Strip & Oil Footing Forms	4109.472 sf	21	1,841	288				0.52 /sf	2,128	1,526	1 /sf	3,654	0.00%
					Footing Rebar	8.208 tn	164	16,828	15,512				3,940.15 /tn	32,341	20,444	6,431 /tn	52,785	0.00%
					Pump Place Wall Footings	228.456 cy	127	13,467			1,096		63.75 /cy	14,563	10,395	109 /cy	24,958	0.00%
					4500 psi Concrete	228.456 cy			47,976				210.00 /cy	47,976	25,108	320 /cy	73,083	0.00%
					Div. 03 Concrete	4,109.470 hsf	1,339	124,810	78,654		1,096		49.78 /hsf	204,560	134,433	82.49 /hsf	338,993	0.01%
					Footing Footing	228.460 cy	1,339	124,810	78,654		1,096		895.39 /cy	204,560	134,433	1,483.82 /cy	338,993	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	164.16 lf	8	741	81				5.01 /lf	822	595	9 /lf	1,418	0.00%
					Rented Form System 16'->	17784 sf	4,446	401,420	186,732				33.07 /sf	588,152	397,306	55 /sf	985,458	0.02%
					Wall Bulkhead Forms	342 sf	188	16,983	1,796				54.91 /sf	18,779	13,614	95 /sf	32,393	0.00%
					Waterstop 6" Bulb	342 lf	34	3,064	1,982				14.75 /lf	5,046	3,327	24 /lf	8,372	0.00%
					Strip & Oil Wall Forms	17784 sf	89	7,965	1,245				0.52 /sf	9,210	6,603	1 /sf	15,813	0.00%
					Hot Water Charge	253.08 cy			2,126				8.40 /cy	2,126	1,113	13 /cy	3,238	0.00%
					Wall Rebar	20.52 tn	472	48,382	38,783				4,247.78 /tn	87,164	55,733	6,964 /tn	142,897	0.00%
					Finish- Top of Wall & Curb	287.28 sf	16	1,415					4.93 /sf	1,415	1,057	9 /sf	2,472	0.00%
					Pump Place Walls	253.08 cy	354	37,632			1,821		155.89 /cy	39,454	28,391	268 /cy	67,845	0.00%
					4500 psi Concrete	253.08 cy			53,147				210.00 /cy	53,147	27,814	320 /cy	80,961	0.00%
					Grind/Patch Walls	17784 sf	1,423	127,423	622				7.20 /sf	128,046	95,542	13 /sf	223,588	0.01%
					Liquid Curing Compounds	17784 sf	53	4,779	14,005				1.06 /sf	18,784	10,900	2 /sf	29,684	0.00%
					Div. 03 Concrete	17,784.000 hsf	7,084	649,805	300,518		1,821		53.54 /hsf	952,144	641,996	89.64 /hsf	1,594,140	0.04%
					Foundation Wall Foundation Wall	253.080 cy	7,084	649,805	300,518		1,821		3,762.23 /cy	952,144	641,996	6,298.96 /cy	1,594,140	0.04%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	2629.12 sf	894	80,709	4,003				32.22 /sf	84,711	62,328	56 /sf	147,039	0.00%
					S-O-G Const Joints > 1'	4929.6 sf	1,775	160,230	7,505				34.03 /sf	167,735	123,508	59 /sf	291,244	0.01%
					Strip & Oil SOG Form	7558.72 sf	38	3,385	529				0.52 /sf	3,915	2,807	1 /sf	6,721	0.00%
					SOG Rebar	230.048 tn	3,451	353,740	434,790				3,427.68 /tn	788,530	486,635	5,543 /tn	1,275,165	0.03%
					Mesh Support - bricks	3813 ea	8	782	1,962				0.72 /ea	2,744	1,599	1 /ea	4,343	0.00%
					Finish- Hard Trowel	32864 sf	756	67,695					2.06 /sf	67,695	50,585	4 /sf	118,280	0.00%
					Pump Place Slab on Grade	3647.904 cy	4,377	464,941			10,505		130.33 /cy	475,446	344,431	225 /cy	819,877	0.02%
					4500 psi Concrete	3647.904 cy			766,060				210.00 /cy	766,060	400,909	320 /cy	1,166,969	0.03%
					Liquid Curing Compounds	32864 sf	99	8,832	25,880				1.06 /sf	34,712	20,144	2 /sf	54,856	0.00%
					Seal Floors	32864 sf	164	14,719	6,901				0.66 /sf	21,621	14,611	1 /sf	36,231	0.00%
					Div. 03 Concrete	32,864.000 hsf	11,561	1,155,034	1,247,631		10,505		73.43 /hsf	2,413,169	1,507,556	119.30 /hsf	3,920,726	0.09%
					Slab Slab	3,647.900 cy	11,561	1,155,034	1,247,631		10,505		661.52 /cy	2,413,169	1,507,556	1,074.79 /cy	3,920,726	0.09%
					020.E. EB1 - MBR Electrical Building	32,864.000 sf	19,984	1,929,648	1,626,803		13,423		108.63 /sf	3,569,874	2,283,985	178.12 /sf	5,853,859	0.13%
		020-2.			Membrane Tanks for MBR													
			Building		Building													
				Div. 26	Electrical													
					Electrical	71974 sf				3,505,854			48.71 /sf	3,505,854	1,177,403	65 /sf	4,683,256	0.11%
					Div. 26 Electrical	150.000 mgd				3,505,854			23,372.36 /mgd	3,505,854	1,177,403	31,221.71 /mgd	4,683,256	0.11%
					Building Building	71,974.000 hsf				3,505,854			48.71 /hsf	3,505,854	1,177,403	65.07 /hsf	4,683,256	0.11%
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					Process I&C	*al*							*/al*			*/al*		
					Div. 25 Integrated Automation (I&C)	150.000 mgd							/mgd			/mgd		
				Div. 26	Electrical													
					Process Electrical	*al*							*/al*			*/al*		
					Div. 26 Electrical	150.000 mgd							/mgd			/mgd		
					Process System E&I Process System E&I	1.000 al							/al			/al		
					020-2. Membrane Tanks for MBR	71,974.000 hsf				3,505,854			48.71 /hsf	3,505,854	1,177,403	65.07 /hsf	4,683,256	0.11%
		020-3.			Bioreactor Tanks fro MBR													
			Building		Building													
				Div. 26	Electrical													
					Electrical	420000 sf				20,458,200			48.71 /sf	20,458,200	6,870,664	65 /sf	27,328,864	0.62%
					Div. 26 Electrical	150.000 mgd				20,458,200			136,388.00 /mgd	20,458,200	6,870,664	182,192.43 /mgd	27,328,864	0.62%
					Building Building	420,000.000 hsf				20,458,200			48.71 /hsf	20,458,200	6,870,664	65.07 /hsf	27,328,864	0.62%
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					Process I&C	*al*							*/al*			*/al*		
					Div. 25 Integrated Automation (I&C)	150.000 mgd							/mgd			/mgd		

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
				Div. 26	Electrical													
					Process Electrical	***al***							***/al***			***/al***		
					Div. 26 Electrical	150.000 mgd							/mgd			/mgd		
					Process System E&I Process System E&I	**1.000 al**							**/al**			**/al**		
					020-3. Bioreactor Tanks fro MBR	420,000.000 hsf				20,458,200			48.71 /hsf	20,458,200	6,870,664	65.07 /hsf	27,328,864	0.62%
		020-4.			MBR - Odor Control Facility													
			Building		Building													
				Div. 26	Electrical													
					Electrical	12060 sf				587,443			48.71 /sf	587,443	197,286	65 /sf	784,729	0.02%
					Div. 26 Electrical	150.000 mgd				587,443			3,916.28 /mgd	587,443	197,286	5,231.53 /mgd	784,729	0.02%
					Building Building	**12,060.000 hsf**				587,443			**48.71 /hsf**	587,443	197,286	**65.07 /hsf**	784,729	**0.02%**
			Process System E&I		**Process System E&I**													
				Div. 25	Integrated Automation (I&C)													
					Process I&C	1 al				285,280			285,279.95 /al	285,280	95,808	381,088 /al	381,088	0.01%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				285,280			1,901.87 /mgd	285,280	95,808	2,540.59 /mgd	381,088	0.01%
					Process System E&I Process System E&I	**1.000 al**				285,280			**285,279.95 /al**	285,280	95,808	**381,088.12 /al**	381,088	**0.01%**
					020-4. MBR - Odor Control Facility	12,060.000 hsf				872,723			72.37 /hsf	872,723	293,094	96.67 /hsf	1,165,817	0.03%
		030.			LOX Tanks													
			Building		Building													
				Div. 26	Electrical													
					Electrical	17580.2 sf				856,332			48.71 /sf	856,332	287,590	65 /sf	1,143,921	0.03%
					Div. 26 Electrical	150.000 mgd				856,332			5,708.88 /mgd	856,332	287,590	7,626.14 /mgd	1,143,921	0.03%
					Building Building	**17,580.200 hsf**				856,332			**48.71 /hsf**	856,332	287,590	**65.07 /hsf**	1,143,921	**0.03%**
					030. LOX Tanks	17,580.200 sf				856,332			48.71 /sf	856,332	287,590	65.07 /sf	1,143,921	0.03%
		036.			Ozone Generators Building													
			Building		Building													
				Div. 26	Electrical													
					Electrical	42081.13 sf				2,049,772			48.71 /sf	2,049,772	688,394	65 /sf	2,738,165	0.06%
					Div. 26 Electrical	150.000 mgd				2,049,772			13,665.15 /mgd	2,049,772	688,394	18,254.44 /mgd	2,738,165	0.06%
					Building Building	**42,081.130 hsf**				2,049,772			**48.71 /hsf**	2,049,772	688,394	**65.07 /hsf**	2,738,165	**0.06%**
					036. Ozone Generators Building	150.000 MGD				2,049,772			13,665.15 /MGD	2,049,772	688,394	18,254.44 /MGD	2,738,165	0.06%
		040.			Ozone Tank													
			Building		Building													
				Div. 26	Electrical													
					Electrical	49164.3 sf				2,394,793			48.71 /sf	2,394,793	804,265	65 /sf	3,199,058	0.07%
					Div. 26 Electrical	150.000 mgd				2,394,793			15,965.29 /mgd	2,394,793	804,265	21,327.06 /mgd	3,199,058	0.07%
					Building Building	**49,164.300 hsf**				2,394,793			**48.71 /hsf**	2,394,793	804,265	**65.07 /hsf**	3,199,058	**0.07%**
					040. Ozone Tank	1.000 ls				2,394,793			2,394,793.05 /ls	2,394,793	804,265	3,199,058.29 /ls	3,199,058	0.07%
		050.			BAC													
			Building		Building													
				Div. 26	Electrical													
					Electrical	24024.09 sf				234,043			9.74 /sf	234,043	78,601	13 /sf	312,643	0.01%
					Div. 26 Electrical	150.000 mgd				234,043			1,560.29 /mgd	234,043	78,601	2,084.29 /mgd	312,643	0.01%
					Building Building	**24,024.090 hsf**				234,043			**9.74 /hsf**	234,043	78,601	**13.01 /hsf**	312,643	**0.01%**
					050. BAC	1.000 ls				234,043			234,042.68 /ls	234,043	78,601	312,643.38 /ls	312,643	0.01%
		050.B			BAC / Washwater Blower Room													
			Building		Building													
				Div. 26	Electrical													
					Electrical	24491.76 sf				1,192,994			48.71 /sf	1,192,994	400,654	65 /sf	1,593,648	0.04%
					Div. 26 Electrical	150.000 mgd				1,192,994			7,953.29 /mgd	1,192,994	400,654	10,624.32 /mgd	1,593,648	0.04%
					Building Building	**24,491.760 hsf**				1,192,994			**48.71 /hsf**	1,192,994	400,654	**65.07 /hsf**	1,593,648	**0.04%**
					050.B BAC / Washwater Blower Room	24,491.760 SF				1,192,994			48.71 /SF	1,192,994	400,654	65.07 /SF	1,593,648	0.04%
		050.C			Process Components													
			Process System E&I		**Process System E&I**													
				Div. 25	Integrated Automation (I&C)													
					Process I&C	1 al				13,178,646			13,178,645.50 /al	13,178,646	4,425,905	17,604,551 /al	17,604,551	0.40%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				13,178,646			87,857.64 /mgd	13,178,646	4,425,905	117,363.67 /mgd	17,604,551	0.40%
				Div. 26	Electrical													
					Process Electrical	1 al				52,714,582			52,714,582.00 /al	52,714,582	17,703,620	70,418,202 /al	70,418,202	1.60%
					Div. 26 Electrical	150.000 mgd				52,714,582			351,430.55 /mgd	52,714,582	17,703,620	469,454.68 /mgd	70,418,202	1.60%
					Process System E&I Process System E&I	**1.000 al**				65,893,228			**65,893,227.50 /al**	65,893,228	22,129,525	**88,022,752.56 /al**	88,022,753	**2.00%**
					050.C Process Components	150.000 MGD				65,893,228			439,288.18 /MGD	65,893,228	22,129,525	586,818.35 /MGD	88,022,753	2.00%
		059.			MF (Membrane Filtration) Building													
			Building		Building													
				Div. 26	Electrical													
					Electrical	211172 sf				10,286,188			48.71 /sf	10,286,188	3,454,505	65 /sf	13,740,693	0.31%
					Div. 26 Electrical	150.000 mgd				10,286,188			68,574.59 /mgd	10,286,188	3,454,505	91,604.62 /mgd	13,740,693	0.31%
					Building Building	**211,172.000 hsf**				10,286,188			**48.71 /hsf**	10,286,188	3,454,505	**65.07 /hsf**	13,740,693	**0.31%**
					059. MF (Membrane Filtration) Building	211,172.000 sf				10,286,188			48.71 /sf	10,286,188	3,454,505	65.07 /sf	13,740,693	0.31%
		071.			Chemical Buildings Process E&I & Unidentified Piping													
			Process System E&I		**Process System E&I**													
				Div. 25	Integrated Automation (I&C)													
					I&C	1 ls				415,572			415,572.19 /ls	415,572	139,565	555,138 /ls	555,138	0.01%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 25 Integrated Automation (I&C)	150.000 mgd				415,572			2,770.48 /mgd	415,572	139,565	3,700.92 /mgd	555,138	0.01%
				Div. 26	Electrical													
					Electrical	1 ls				1,662,289			1,662,288.75 /ls	1,662,289	558,262	2,220,550 /ls	2,220,550	0.05%
					Div. 26 Electrical	150.000 mgd				1,662,289			11,081.93 /mgd	1,662,289	558,262	14,803.67 /mgd	2,220,550	0.05%
					Process System E&I Process System E&I	1.000 al				2,077,861			2,077,860.94 /al	2,077,861	697,827	2,775,687.98 /al	2,775,688	0.06%
					071. Chemical Buildings Process E&I & Unidentified Piping	150.000 MGD				2,077,861			13,852.41 /MGD	2,077,861	697,827	18,504.59 /MGD	2,775,688	0.06%
		089.			RO Feed Tank / RO Pump Building													
			Building		Building													
				Div. 26	Electrical													
					Electrical	57255.6 sf				2,788,920			48.71 /sf	2,788,920	936,629	65 /sf	3,725,549	0.08%
					Div. 26 Electrical	150.000 mgd				2,788,920			18,592.80 /mgd	2,788,920	936,629	24,836.99 /mgd	3,725,549	0.08%
					Building Building	57,255.600 hsf				2,788,920			48.71 /hsf	2,788,920	936,629	65.07 /hsf	3,725,549	0.08%
					089. RO Feed Tank / RO Pump Building	57,255.600 sf				2,788,920			48.71 /sf	2,788,920	936,629	65.07 /sf	3,725,549	0.08%
		139.			RO Facility													
			Building		Building													
				Div. 26	Electrical													
					Electrical	137563.05 sf				6,700,696			48.71 /sf	6,700,696	2,250,356	65 /sf	8,951,052	0.20%
					Div. 26 Electrical	150.000 mgd				6,700,696			44,671.31 /mgd	6,700,696	2,250,356	59,673.68 /mgd	8,951,052	0.20%
					Building Building	137,563.050 hsf				6,700,696			48.71 /hsf	6,700,696	2,250,356	65.07 /hsf	8,951,052	0.20%
					139. RO Facility	137,563.050 sf				6,700,696			48.71 /sf	6,700,696	2,250,356	65.07 /sf	8,951,052	0.20%
		140.			RO (1st Stage)													
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					Process I&C	1 al				5,084,424			5,084,424.07 /al	5,084,424	1,707,549	6,791,973 /al	6,791,973	0.15%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				5,084,424			33,896.16 /mgd	5,084,424	1,707,549	45,279.82 /mgd	6,791,973	0.15%
				Div. 26	Electrical													
					Process Electrical	1 al				20,337,696			20,337,696.27 /al	20,337,696	6,830,194	27,167,891 /al	27,167,891	0.62%
					Div. 26 Electrical	150.000 mgd				20,337,696			135,584.64 /mgd	20,337,696	6,830,194	181,119.27 /mgd	27,167,891	0.62%
					Process System E&I Process System E&I	1.000 al				25,422,120			25,422,120.34 /al	25,422,120	8,537,743	33,959,863.43 /al	33,959,863	0.77%
					140. RO (1st Stage)	150.000 MGD				25,422,120			169,480.80 /MGD	25,422,120	8,537,743	226,399.09 /MGD	33,959,863	0.77%
		190.			UV/AOP													
			Building		Building													
				Div. 26	Electrical													
					Electrical	41478.15 ls				2,020,401			48.71 /ls	2,020,401	678,530	65 /ls	2,698,930	0.06%
					Div. 26 Electrical	150.000 mgd				2,020,401			13,469.34 /mgd	2,020,401	678,530	17,992.87 /mgd	2,698,930	0.06%
					Building Building	41,478.150 hsf				2,020,401			48.71 /hsf	2,020,401	678,530	65.07 /hsf	2,698,930	0.06%
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					I&C	1 ls				1,348,632			1,348,632.05 /ls	1,348,632	452,923	1,801,555 /ls	1,801,555	0.04%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				1,348,632			8,990.88 /mgd	1,348,632	452,923	12,010.37 /mgd	1,801,555	0.04%
				Div. 26	Electrical													
					Electrical	1 ls				5,394,528			5,394,528.18 /ls	5,394,528	1,811,694	7,206,222 /ls	7,206,222	0.16%
					Div. 26 Electrical	150.000 mgd				5,394,528			35,963.52 /mgd	5,394,528	1,811,694	48,041.48 /mgd	7,206,222	0.16%
					Process System E&I Process System E&I	1.000 al				6,743,160			6,743,160.23 /al	6,743,160	2,264,617	9,007,777.37 /al	9,007,777	0.20%
					190. UV/AOP	150.000 MGD				8,763,561			58,423.74 /MGD	8,763,561	2,943,147	78,044.72 /MGD	11,706,708	0.27%
		199.			Chemical Building													
			Building		Building													
				Div. 25	Integrated Automation (I&C)													
					I&C	*32,869.500 sf*							*/sf*			*/sf*		
					Div. 25 Integrated Automation (I&C)	150.000 mgd							/mgd			/mgd		
				Div. 26	Electrical													
					Electrical	32869.5 sf				1,601,073			48.71 /sf	1,601,073	537,703	65 /sf	2,138,776	0.05%
					Div. 26 Electrical	150.000 mgd				1,601,073			10,673.82 /mgd	1,601,073	537,703	14,258.51 /mgd	2,138,776	0.05%
					Building Building	32,869.500 hsf				1,601,073			48.71 /hsf	1,601,073	537,703	65.07 /hsf	2,138,776	0.05%
					199. Chemical Building	32,869.500 sf				1,601,073			48.71 /sf	1,601,073	537,703	65.07 /sf	2,138,776	0.05%
		201.			Post Treatment Buildings Process E&I & Unidentified Piping													
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					I&C	1 ls				902,470			902,470.01 /ls	902,470	303,085	1,205,555 /ls	1,205,555	0.03%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				902,470			6,016.47 /mgd	902,470	303,085	8,037.03 /mgd	1,205,555	0.03%
				Div. 26	Electrical													
					Electrical	1 ls				3,609,880			3,609,880.02 /ls	3,609,880	1,212,339	4,822,219 /ls	4,822,219	0.11%
					Div. 26 Electrical	150.000 mgd				3,609,880			24,065.87 /mgd	3,609,880	1,212,339	32,148.13 /mgd	4,822,219	0.11%
					Process System E&I Process System E&I	1.000 al				4,512,350			4,512,350.03 /al	4,512,350	1,515,424	6,027,773.78 /al	6,027,774	0.14%
					201. Post Treatment Buildings Process E&I & Unidentified Piping	150.000 MGD				4,512,350			30,082.33 /MGD	4,512,350	1,515,424	40,185.16 /MGD	6,027,774	0.14%
		239.			Chlorine Building													
			Building		Building													
				Div. 25	Integrated Automation (I&C)													
					I&C	*25,419.150 sf*							*/sf*			*/sf*		
					Div. 25 Integrated Automation (I&C)	150.000 mgd							/mgd			/mgd		
				Div. 26	Electrical													
					Electrical	25132.2 sf				1,224,189			48.71 /sf	1,224,189	411,131	65 /sf	1,635,320	0.04%
					Div. 26 Electrical	150.000 mgd				1,224,189			8,161.26 /mgd	1,224,189	411,131	10,902.13 /mgd	1,635,320	0.04%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Building Building	25,419.150 hsf				1,224,189			48.16 /hsf	1,224,189	411,131	64.33 /hsf	1,635,320	0.04%
					239. Chlorine Building	25,419.150 sf				1,224,189			48.16 /sf	1,224,189	411,131	64.33 /sf	1,635,320	0.04%
		260.			Product Water Wet Well Tank (Clearwell/Chlor Contact Tank)/High Svc Pump Sta													
			Building		Building													
				Div. 25	Integrated Automation (I&C)													
					I&C	143478.3 sf				4,163,740			29.02 /sf	4,163,740	1,398,347	39 /sf	5,562,087	0.13%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				4,163,740			27,758.27 /mgd	4,163,740	1,398,347	37,080.58 /mgd	5,562,087	0.13%
				Div. 26	Electrical													
					Electrical	143478.3 sf				6,988,828			48.71 /sf	6,988,828	2,347,122	65 /sf	9,335,950	0.21%
					Div. 26 Electrical	150.000 mgd				6,988,828			46,592.19 /mgd	6,988,828	2,347,122	62,239.67 /mgd	9,335,950	0.21%
					Building Building	143,478.300 hsf				11,152,568			77.73 /hsf	11,152,568	3,745,469	103.83 /hsf	14,898,037	0.34%
			Process System E&I		Process System E&I													
				Div. 25	Integrated Automation (I&C)													
					I&C	1 ls				324,000			324,000.00 /ls	324,000	108,812	432,812 /ls	432,812	0.01%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				324,000			2,160.00 /mgd	324,000	108,812	2,885.41 /mgd	432,812	0.01%
				Div. 26	Electrical													
					Electrical	1 ls				1,296,000			1,296,000.00 /ls	1,296,000	435,248	1,731,248 /ls	1,731,248	0.04%
					Div. 26 Electrical	150.000 mgd				1,296,000			8,640.00 /mgd	1,296,000	435,248	11,541.65 /mgd	1,731,248	0.04%
					Process System E&I Process System E&I	1.000 al				1,620,000			1,620,000.00 /al	1,620,000	544,059	2,164,059.40 /al	2,164,059	0.05%
					260. Product Water Wet Well Tank (Clearwell/Chlor Contact Tank)/High Svc Pump Sta	1.000 ls				12,772,568			12,772,568.26 /ls	12,772,568	4,289,528	17,062,096.63 /ls	17,062,097	0.39%
		260.E			High Service PS Electrical Room													
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	9850.35 sf	49	5,086	4,925				1.02 /sf	10,011	6,146	2 /sf	16,157	0.00%
					Staging to 30'	9850.35 sf	49	5,086	7,388				1.27 /sf	12,474	7,435	2 /sf	19,908	0.00%
					Rub Block	9850.35 sf	131	13,559					1.38 /sf	13,559	9,921	2 /sf	23,480	0.00%
					Mortar	709.35 cf			5,534				7.80 /cf	5,534	2,896	12 /cf	8,430	0.00%
					Mortar	1182 cf			9,221				7.80 /cf	9,221	4,826	12 /cf	14,047	0.00%
					Grout Fill 10" Block Cells	6097.35 cf	1,829	188,886	38,733				37.33 /cf	227,619	158,477	63 /cf	386,096	0.01%
					Grout Fill 10"Lintel Block	49.35 cf	15	1,529	314				37.33 /cf	1,842	1,283	63 /cf	3,125	0.00%
					Grout Fill 10 "Bond Beam	78.75 cf	24	2,440	500				37.33 /cf	2,940	2,047	63 /cf	4,987	0.00%
					Dur-O-Wall 10"	8008.5 lf			3,700				0.46 /lf	3,700	1,936	1 /lf	5,636	0.00%
					Wall Ties	11397 ea	152	15,688	1,436				1.50 /ea	17,124	12,230	3 /ea	29,354	0.00%
					Extruded Control Joints 1/2"	955.5 lf	5	563	2,237				2.93 /lf	2,801	1,583	5 /lf	4,384	0.00%
					Masonry Rebar # 5	46474.35 lbs	558	57,588	32,718				1.94 /lbs	90,306	59,259	3 /lbs	149,565	0.00%
					Masonry Rebar # 5	177.3 lbs	2	220	125				1.94 /lbs	345	226	3 /lbs	571	0.00%
					Standard Brick	65909.25 ea	2,636	272,240	69,205				5.18 /ea	341,444	235,413	9 /ea	576,858	0.01%
					10" Block Bond Beam	345 ea	29	2,975	7,915				31.57 /ea	10,891	6,319	50 /ea	17,210	0.00%
					10" Block Lintels	129 ea	11	1,113	2,960				31.57 /ea	4,072	2,363	50 /ea	6,435	0.00%
					10" Fire Rated 3 hr	10117 ea	845	87,253	72,235				15.76 /ea	159,488	101,646	26 /ea	261,134	0.01%
					Div. 04 Masonry	9,850.350 vsf	6,336	654,223	259,146				92.73 /vsf	913,369	614,007	155.06 /vsf	1,527,376	0.03%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	13773.9 sf				780,154			56.64 /sf	780,154	262,006	76 /sf	1,042,160	0.02%
					Div 6 - $/SF	13773.9 sf				23,691			1.72 /sf	23,691	7,956	2 /sf	31,647	0.00%
					Div 7 - $/SF	13773.9 sf				563,766			40.93 /sf	563,766	189,335	55 /sf	753,100	0.02%
					Div 8 - $/SF	13773.9 sf				126,169			9.16 /sf	126,169	42,372	12 /sf	168,541	0.00%
					Div 9 - $/SF	13773.9 sf				495,860			36.00 /sf	495,860	166,529	48 /sf	662,390	0.02%
					Div 10 - $/SF	13773.9 sf				26,446			1.92 /sf	26,446	8,882	3 /sf	35,327	0.00%
					Div 11 - $/SF	13773.9 sf				13,085			0.95 /sf	13,085	4,395	1 /sf	17,480	0.00%
					Div 12 - $/SF	13773.9 sf				5,096			0.37 /sf	5,096	1,712	0 /sf	6,808	0.00%
					Div 22 - $/SF	13773.9 sf				84,159			6.11 /sf	84,159	28,264	8 /sf	112,422	0.00%
					Div 23 - $/SF	13773.9 sf				808,115			58.67 /sf	808,115	271,397	78 /sf	1,079,511	0.02%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	13,773.900 hsf				2,926,541			212.47 /hsf	2,926,541	982,847	283.83 /hsf	3,909,387	0.09%
				Div. 25	Integrated Automation (I&C)													
					I&C	13773.9 sf				399,719			29.02 /sf	399,719	134,241	39 /sf	533,960	0.01%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				399,719			2,664.79 /mgd	399,719	134,241	3,559.73 /mgd	533,960	0.01%
				Div. 26	Electrical													
					Electrical	13773.9 sf				1,070,645			77.73 /sf	1,070,645	359,565	104 /sf	1,430,210	0.03%
					Div. 26 Electrical	150.000 mgd				1,070,645			7,137.64 /mgd	1,070,645	359,565	9,534.73 /mgd	1,430,210	0.03%
					Building Building	13,773.900 hsf	6,336	654,223	259,146	4,396,904			385.53 /hsf	5,310,274	2,090,659	537.32 /hsf	7,400,933	0.17%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2457.9 sf	492	44,384	3,742				19.58 /sf	48,126	35,082	34 /sf	83,208	0.00%
					Keyway 4"	819.45 lf	41	3,699	404				5.01 /lf	4,104	2,972	9 /lf	7,076	0.00%
					Waterstop 6" Bulb	819.45 lf	82	7,340	4,750				14.75 /lf	12,090	7,971	24 /lf	20,061	0.00%
					Strip & Oil Footing Forms	2457.9 sf	12	1,101	172				0.52 /sf	1,273	913	1 /sf	2,186	0.00%
					Footing Rebar	5.1 tn	102	10,456	9,639				3,940.24 /tn	20,095	12,703	6,431 /tn	32,798	0.00%
					Pump Place Wall Footings	136.8 cy	76	8,064			657		63.75 /cy	8,721	6,225	109 /cy	14,945	0.00%
					4500 psi Concrete	136.8 cy			28,728				210.00 /cy	28,728	15,034	320 /cy	43,762	0.00%
					Div. 03 Concrete	2,457.900 hsf	805	75,045	47,435		657		50.10 /hsf	123,136	80,900	83.01 /hsf	204,036	0.00%
					Footing Footing	136.800 cy	805	75,045	47,435		657		900.12 /cy	123,136	80,900	1,491.49 /cy	204,036	0.00%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Keyway 4"	153.9 lf	8	695	76				5.01 /lf	771	558	9 /lf	1,329	0.00%
					Rented Form System 16'->	6156.3 sf	1,539	138,960	64,641				33.07 /sf	203,601	137,536	55 /sf	341,137	0.01%
					Wall Bulkhead Forms	307.8 sf	169	15,285	1,616				54.91 /sf	16,901	12,253	95 /sf	29,154	0.00%
					Waterstop 6" Bulb	307.8 lf	31	2,757	1,784				14.75 /lf	4,541	2,994	24 /lf	7,535	0.00%
					Strip & Oil Wall Forms	6156.3 sf	31	2,757	431				0.52 /sf	3,188	2,286	1 /sf	5,474	0.00%
					Hot Water Charge	228 cy			1,915				8.40 /cy	1,915	1,002	13 /cy	2,918	0.00%
					Wall Rebar	20.1 tn	462	47,391	37,989				4,247.78 /tn	85,380	54,592	6,964 /tn	139,973	0.00%
					Finish- Top of Wall & Curb	256.5 sf	14	1,263					4.93 /sf	1,263	944	9 /sf	2,208	0.00%
					Pump Place Walls	228 cy	319	33,903			1,641		155.89 /cy	35,544	25,578	268 /cy	61,122	0.00%
					4500 psi Concrete	228 cy			47,880				210.00 /cy	47,880	25,057	320 /cy	72,937	0.00%
					Grind/Patch Walls	6156.3 sf	493	44,110	215				7.20 /sf	44,326	33,074	13 /sf	77,399	0.00%
					Liquid Curing Compounds	6156.3 sf	18	1,654	4,848				1.06 /sf	6,503	3,773	2 /sf	10,276	0.00%
					Div. 03 Concrete	6,156.300 hsf	3,084	288,776	161,396		1,641		73.39 /hsf	451,813	299,648	122.06 /hsf	751,461	0.02%
					Foundation Wall Foundation Wall	**228.000 cy**	3,084	288,776	161,396		1,641		**1,981.64 /cy**	451,813	299,648	3,295.88 /cy	751,461	**0.02%**
			Slab		**Slab**													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	1106.55 sf	376	33,969	1,685				32.22 /sf	35,654	26,233	56 /sf	61,886	0.00%
					S-O-G Const Joints > 1'	2066.1 sf	744	67,156	3,146				34.03 /sf	70,301	51,765	59 /sf	122,066	0.00%
					Strip & Oil SOG Form	3172.65 sf	16	1,421	222				0.52 /sf	1,643	1,178	1 /sf	2,821	0.00%
					SOG Rebar	99.45 tn	1,492	152,922	187,961				3,427.69 /tn	340,884	210,373	5,543 /tn	551,257	0.01%
					Mesh Support - bricks	1592 ea	3	326	819				0.72 /ea	1,145	668	1 /ea	1,813	0.00%
					Finish- Hard Trowel	13773.9 sf	317	28,372					2.06 /sf	28,372	21,201	4 /sf	49,573	0.00%
					Pump Place Slab on Grade	1530.45 cy	1,837	195,063			4,407		130.33 /cy	199,470	144,503	225 /cy	343,973	0.01%
					4500 psi Concrete	1530.45 cy			321,395				210.00 /cy	321,395	168,198	320 /cy	489,593	0.01%
					Liquid Curing Compounds	13773.9 sf	41	3,702	10,847				1.06 /sf	14,548	8,442	2 /sf	22,991	0.00%
					Seal Floors	13773.9 sf	69	6,169	2,893				0.66 /sf	9,062	6,124	1 /sf	15,185	0.00%
					Div. 03 Concrete	13,773.900 hsf	4,894	489,100	528,967		4,407		74.23 /hsf	1,022,474	638,686	120.60 /hsf	1,661,160	0.04%
					Slab Slab	**1,530.450 cy**	4,894	489,100	528,967		4,407		**668.09 /cy**	1,022,474	638,686	1,085.41 /cy	1,661,160	**0.04%**
					260.E High Service PS Electrical Room	13,773.900 sf	15,119	1,507,144	996,944	4,396,904	6,705		501.51 /sf	6,907,697	3,109,893	727.29 /sf	10,017,590	0.23%
		600.			EB2 - RO Electrical Building													
			Building		**Building**													
				Div. 04	Masonry													
					Interior Staging over 10 '	8704.5 sf	44	4,494	4,352				1.02 /sf	8,846	5,431	2 /sf	14,278	0.00%
					Staging to 30'	8704.5 sf	44	4,494	6,528				1.27 /sf	11,023	6,570	2 /sf	17,593	0.00%
					Rub Block	8704.5 sf	116	11,981					1.38 /sf	11,981	8,767	2 /sf	20,748	0.00%
					Mortar	629.85 cf			4,914				7.80 /cf	4,914	2,572	12 /cf	7,485	0.00%
					Mortar	1045.2 cf			8,154				7.80 /cf	8,154	4,267	12 /cf	12,422	0.00%
					Grout Fill 10" Block Cells	5383.05 cf	1,615	166,758	34,196				37.33 /cf	200,954	139,912	63 /cf	340,865	0.01%
					Grout Fill 10"Lintel Block	42.9 cf	13	1,329	273				37.33 /cf	1,601	1,115	63 /cf	2,716	0.00%
					Grout Fill 10 "Bond Beam	71.55 cf	21	2,217	455				37.33 /cf	2,671	1,860	63 /cf	4,531	0.00%
					Dur-O-Wall 10"	7072.35 lf			3,267				0.46 /lf	3,267	1,710	1 /lf	4,977	0.00%
					Wall Ties	10065 ea	134	13,854	1,268				1.50 /ea	15,122	10,801	3 /ea	25,923	0.00%
					Extruded Control Joints 1/2"	844.65 lf	5	498	1,978				2.93 /lf	2,476	1,399	5 /lf	3,875	0.00%
					Masonry Rebar # 5	41045.55 lbs	493	50,861	28,896				1.94 /lbs	79,757	52,337	3 /lbs	132,094	0.00%
					Masonry Rebar # 5	157.5 lbs	2	195	111				1.94 /lbs	306	201	3 /lbs	507	0.00%
					Standard Brick	58211 ea	2,328	240,442	61,122				5.18 /ea	301,563	207,917	9 /ea	509,480	0.01%
					10" Block Bond Beam	301 ea	25	2,596	6,906				31.57 /ea	9,502	5,513	50 /ea	15,015	0.00%
					10" Block Lintels	115 ea	10	992	2,638				31.57 /ea	3,630	2,107	50 /ea	5,737	0.00%
					10" Fire Rated 3 hr	8934 ea	746	77,050	63,789				15.76 /ea	140,839	89,760	26 /ea	230,599	0.01%
					Div. 04 Masonry	8,704.500 vsf	5,595	577,761	228,846				92.67 /vsf	806,607	542,238	154.96 /vsf	1,348,845	0.03%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	14316.6 sf				810,892			56.64 /sf	810,892	272,329	76 /sf	1,083,222	0.02%
					Div 6 - $/SF	14316.6 sf				24,625			1.72 /sf	24,625	8,270	2 /sf	32,894	0.00%
					Div 7 - $/SF	14316.6 sf				585,978			40.93 /sf	585,978	196,794	55 /sf	782,773	0.02%
					Div 8 - $/SF	14316.6 sf				131,140			9.16 /sf	131,140	44,042	12 /sf	175,182	0.00%
					Div 9 - $/SF	14316.6 sf				515,398			36.00 /sf	515,398	173,091	48 /sf	688,488	0.02%
					Div 10 - $/SF	14316.6 sf				27,488			1.92 /sf	27,488	9,231	3 /sf	36,719	0.00%
					Div 11 - $/SF	14316.6 sf				13,601			0.95 /sf	13,601	4,568	1 /sf	18,168	0.00%
					Div 12 - $/SF	14316.6 sf				5,297			0.37 /sf	5,297	1,779	0 /sf	7,076	0.00%
					Div 22 - $/SF	14316.6 sf				87,474			6.11 /sf	87,474	29,377	8 /sf	116,852	0.00%
					Div 23 - $/SF	14316.6 sf				839,955			58.67 /sf	839,955	282,090	78 /sf	1,122,045	0.03%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	14,316.600 hsf				3,041,848			212.47 /hsf	3,041,848	1,021,572	283.83 /hsf	4,063,420	0.09%
				Div. 25	Integrated Automation (I&C)													
					I&C	14316.6 sf				415,468			29.02 /sf	415,468	139,530	39 /sf	554,998	0.01%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				415,468			2,769.79 /mgd	415,468	139,530	3,699.99 /mgd	554,998	0.01%
				Div. 26	Electrical													
					Electrical	14316.6 sf				1,112,829			77.73 /sf	1,112,829	373,732	104 /sf	1,486,561	0.03%
					Div. 26 Electrical	150.000 mgd				1,112,829			7,418.86 /mgd	1,112,829	373,732	9,910.41 /mgd	1,486,561	0.03%
					Building Building	**14,316.600 hsf**	5,595	577,761	228,846	4,570,145			**375.56 /hsf**	5,376,752	2,077,072	520.64 /hsf	7,453,824	**0.17%**
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2176.05 sf	435	39,294	3,313				19.58 /sf	42,607	31,059	34 /sf	73,667	0.00%
					Keyway 4"	730.2 lf	37	3,296	360				5.01 /lf	3,657	2,649	9 /lf	6,305	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Waterstop 6" Bulb	730.2 lf	73	6,541	4,232				14.75 /lf	10,773	7,103	24 /lf	17,876	0.00%
					Strip & Oil Footing Forms	2176.05 sf	11	975	152				0.52 /sf	1,127	808	1 /sf	1,935	0.00%
					Footing Rebar	14.33 tn	287	29,380	27,085				3,940.30 /tn	56,465	35,693	6,431 /tn	92,158	0.00%
					Pump Place Wall Footings	114.6 cy	64	6,755			550		63.75 /cy	7,305	5,214	109 /cy	12,520	0.00%
					4500 psi Concrete	114.6 cy			24,066				210.00 /cy	24,066	12,595	320 /cy	36,661	0.00%
					Div. 03 Concrete	2,176.050 hsf	906	86,242	59,209		550		67.09 /hsf	146,000	95,121	110.81 /hsf	241,121	0.01%
					Footing Footing	**114.600 cy**	906	86,242	59,209		550		**1,274.00 /cy**	146,000	95,121	2,104.02 /cy	241,121	0.01%
			Foundation Wall		**Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	128.85 lf	6	582	64				5.01 /lf	645	467	9 /lf	1,113	0.00%
					Rented Form System 16'->	5440.2 sf	1,360	122,796	57,122				33.07 /sf	179,918	121,537	55 /sf	301,456	0.01%
					Wall Bulkhead Forms	271.95 sf	150	13,505	1,428				54.91 /sf	14,932	10,826	95 /sf	25,758	0.00%
					Waterstop 6" Bulb	271.95 lf	27	2,436	1,576				14.75 /lf	4,012	2,645	24 /lf	6,657	0.00%
					Strip & Oil Wall Forms	5440.2 sf	27	2,437	381				0.52 /sf	2,817	2,020	1 /sf	4,837	0.00%
					Hot Water Charge	200.4 cy			1,683				8.40 /cy	1,683	881	13 /cy	2,564	0.00%
					Wall Rebar	14.25 tn	328	33,598	26,933				4,247.84 /tn	60,532	38,704	6,964 /tn	99,236	0.00%
					Finish- Top of Wall & Curb	229.05 sf	13	1,128					4.93 /sf	1,128	843	9 /sf	1,971	0.00%
					Pump Place Walls	200.4 cy	281	29,799			1,442		155.89 /cy	31,241	22,481	268 /cy	53,723	0.00%
					4500 psi Concrete	200.4 cy			42,084				210.00 /cy	42,084	22,024	320 /cy	64,108	0.00%
					Grind/Patch Walls	5440.2 sf	435	38,979	190				7.20 /sf	39,170	29,227	13 /sf	68,396	0.00%
					Liquid Curing Compounds	5440.2 sf	16	1,462	4,284				1.06 /sf	5,746	3,335	2 /sf	9,081	0.00%
					Div. 03 Concrete	5,440.200 hsf	2,643	246,722	135,746		1,442		70.57 /hsf	383,910	254,991	117.44 /hsf	638,900	0.01%
					Foundation Wall Foundation Wall	**200.400 cy**	2,643	246,722	135,746		1,442		**1,915.72 /cy**	383,910	254,991	3,188.13 /cy	638,900	0.01%
			Slab		**Slab**													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	1145.25 sf	389	35,157	1,744				32.22 /sf	36,900	27,150	56 /sf	64,051	0.00%
					S-O-G Const Joints > 1'	2147.4 sf	773	69,798	3,269				34.03 /sf	73,068	53,802	59 /sf	126,870	0.00%
					Strip & Oil SOG Form	3292.8 sf	16	1,475	231				0.52 /sf	1,705	1,223	1 /sf	2,928	0.00%
					SOG Rebar	100.2 tn	1,503	154,076	189,378				3,427.68 /tn	343,454	211,959	5,543 /tn	555,413	0.01%
					Mesh Support - bricks	1660.8 ea	3	341	854				0.72 /ea	1,195	697	1 /ea	1,892	0.00%
					Finish- Hard Trowel	14316.6 sf	329	29,490					2.06 /sf	29,490	22,037	4 /sf	51,527	0.00%
					Pump Place Slab on Grade	1589.1 cy	1,907	202,538			4,576		130.33 /cy	207,114	150,041	225 /cy	357,155	0.01%
					4500 psi Concrete	1589.1 cy			333,711				210.00 /cy	333,711	174,644	320 /cy	508,355	0.01%
					Liquid Curing Compounds	14316.6 sf	43	3,847	11,274				1.06 /sf	15,122	8,775	2 /sf	23,897	0.00%
					Seal Floors	14316.6 sf	72	6,412	3,006				0.66 /sf	9,419	6,365	1 /sf	15,784	0.00%
					Div. 03 Concrete	14,316.600 hsf	5,036	503,134	543,468		4,576		73.42 /hsf	1,051,178	656,692	119.29 /hsf	1,707,870	0.04%
					Slab Slab	**1,589.100 cy**	5,036	503,134	543,468		4,576		**661.49 /cy**	1,051,178	656,692	1,074.74 /cy	1,707,870	0.04%
					600. EB2 - RO Electrical Building	14,316.600 sf	14,180	1,413,858	967,268	4,570,145	6,569		486.00 /sf	6,957,840	3,083,876	701.40 /sf	10,041,715	0.23%
		610.			Battery Pad Generator													
			Building		**Building**													
				Div. 25	Integrated Automation (I&C)													
					I&C	***6,547.800 sf***							***/sf***			***/sf***		
					Div. 25 Integrated Automation (I&C)	150.000 mgd							/mgd			/mgd		
				Div. 26	Electrical													
					Electrical	***6,547.800 sf***							***/sf***			***/sf***		
					Div. 26 Electrical	150.000 mgd							/mgd			/mgd		
					Building Building	**6,547.800 hsf**							**/hsf**			**/hsf**		
			Footing		**Footing**													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	1937.25 sf	387	34,982	2,949				19.58 /sf	37,932	27,651	34 /sf	65,582	0.00%
					Keyway 4"	645.75 lf	32	2,915	319				5.01 /lf	3,234	2,342	9 /lf	5,576	0.00%
					Waterstop 6" Bulb	645.75 lf	65	5,785	3,743				14.75 /lf	9,527	6,281	24 /lf	15,808	0.00%
					Strip & Oil Footing Forms	1937.25 sf	10	868	136				0.52 /sf	1,003	719	1 /sf	1,723	0.00%
					Footing Rebar	4.05 tn	81	8,303	7,655				3,940.46 /tn	15,959	10,088	6,431 /tn	26,047	0.00%
					Pump Place Wall Footings	107.85 cy	60	6,358			518		63.75 /cy	6,875	4,907	109 /cy	11,782	0.00%
					4500 psi Concrete	107.85 cy			22,649				210.00 /cy	22,649	11,853	320 /cy	34,501	0.00%
					Div. 03 Concrete	1,937.250 hsf	635	59,210	37,451		518		50.16 /hsf	97,179	63,842	83.12 /hsf	161,020	0.00%
					Footing Footing	**107.850 cy**	635	59,210	37,451		518		**901.05 /cy**	97,179	63,842	1,493.00 /cy	161,020	0.00%
			Foundation Wall		**Foundation Wall**													
				Div. 03	Concrete													
					Keyway 4"	97.05 lf	5	438	48				5.01 /lf	486	352	9 /lf	838	0.00%
					Rented Form System 16'->	3881.7 sf	970	87,618	40,758				33.07 /sf	128,376	86,720	55 /sf	215,095	0.00%
					Wall Bulkhead Forms	194.1 sf	107	9,639	1,019				54.91 /sf	10,658	7,727	95 /sf	18,384	0.00%
					Waterstop 6" Bulb	194.1 lf	19	1,739	1,125				14.75 /lf	2,864	1,888	24 /lf	4,752	0.00%
					Strip & Oil Wall Forms	3881.7 sf	19	1,739	272				0.52 /sf	2,010	1,441	1 /sf	3,452	0.00%
					Hot Water Charge	143.85 cy			1,208				8.40 /cy	1,208	632	13 /cy	1,841	0.00%
					Wall Rebar	12.75 tn	293	30,062	24,098				4,247.85 /tn	54,160	34,630	6,964 /tn	88,790	0.00%
					Finish- Top of Wall & Curb	161.7 sf	9	796					4.93 /sf	796	595	9 /sf	1,392	0.00%
					Pump Place Walls	143.85 cy	201	21,390			1,035		155.89 /cy	22,425	16,138	268 /cy	38,563	0.00%
					4500 psi Concrete	143.85 cy			30,209				210.00 /cy	30,209	15,809	320 /cy	46,018	0.00%
					Grind/Patch Walls	3881.7 sf	311	27,813	136				7.20 /sf	27,948	20,854	13 /sf	48,802	0.00%
					Liquid Curing Compounds	3881.7 sf	12	1,043	3,057				1.06 /sf	4,100	2,379	2 /sf	6,479	0.00%
					Div. 03 Concrete	3,881.700 hsf	1,947	182,276	101,930		1,035		73.48 /hsf	285,241	189,165	122.22 /hsf	474,406	0.01%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Foundation Wall Foundation Wall	**143.850 cy**	**1,947**	**182,276**	**101,930**		**1,035**		**1,982.90 /cy**	**285,241**	**189,165**	**3,297.92 /cy**	**474,406**	**0.01%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	529.05 sf	**180**	16,241	**805**				32.22 /sf	**17,046**	**12,542**	**56 /sf**	**29,588**	0.00%
					S-O-G Const Joints > 1'	987.9 sf	**356**	32,110	**1,504**				34.03 /sf	**33,614**	**24,751**	**59 /sf**	**58,366**	0.00%
					Strip & Oil SOG Form	1516.95 sf	**8**	679	**106**				0.52 /sf	**786**	**563**	**1 /sf**	**1,349**	0.00%
					SOG Rebar	47.55 tn	**713**	73,117	**89,870**				3,427.70 /tn	**162,987**	**100,586**	**5,543 /tn**	**263,573**	0.01%
					Mesh Support - bricks	762 ea	**2**	156	**392**				0.72 /ea	**548**	**320**	**1 /ea**	**868**	0.00%
					Finish- Hard Trowel	6585.6 sf	**151**	13,565					2.06 /sf	**13,565**	**10,137**	**4 /sf**	**23,702**	0.00%
					Pump Place Slab on Grade	731.7 cy	**878**	93,258			**2,107**		130.33 /cy	**95,365**	**69,086**	**225 /cy**	**164,452**	0.00%
					4500 psi Concrete	731.7 cy			**153,657**				210.00 /cy	**153,657**	**80,415**	**320 /cy**	**234,072**	0.01%
					Liquid Curing Compounds	6585.6 sf	**20**	1,770	**5,186**				1.06 /sf	**6,956**	**4,037**	**2 /sf**	**10,992**	0.00%
					Seal Floors	6585.6 sf	**33**	2,950	**1,383**				0.66 /sf	**4,333**	**2,928**	**1 /sf**	**7,260**	0.00%
					Div. 03 Concrete	**6,585.600 hsf**	**2,340**	**233,847**	**252,904**		**2,107**		**74.23 /hsf**	**488,858**	**305,364**	**120.60 /hsf**	**794,222**	**0.02%**
					Slab Slab	**731.700 cy**	**2,340**	**233,847**	**252,904**		**2,107**		**668.11 /cy**	**488,858**	**305,364**	**1,085.45 /cy**	**794,222**	**0.02%**
					610. Battery Pad Generator	**1.000 ls**	**4,921**	**475,333**	**392,284**		**3,660**		**871,277.12 /ls**	**871,277**	**558,371**	**1,429,648.26 /ls**	**1,429,648**	**0.03%**
		620.			**Generator Pad**													
			Building		**Building**													
				Div. 25	**Integrated Automation (I&C)**													
					I&C	***46,545.600 sf***							***/sf***			***/sf***		
					Div. 25 Integrated Automation (I&C)	**150.000 mgd**							**/mgd**			**/mgd**		
				Div. 26	**Electrical**													
					Electrical	***46,545.600 sf***							***/sf***			***/sf***		
					Div. 26 Electrical	**150.000 mgd**							**/mgd**			**/mgd**		
					Building Building	**46,545.600 hsf**							**/hsf**			**/hsf**		
			Footing		**Footing**													
				Div. 03	**Concrete**													
					Continuous Footing Forms > 12"	3936.9 sf	**787**	71,091	**5,994**				19.58 /sf	**77,085**	**56,192**	**34 /sf**	**133,277**	0.00%
					Keyway 4"	1312.35 lf	**66**	5,924	**648**				5.01 /lf	**6,572**	**4,760**	**9 /lf**	**11,332**	0.00%
					Waterstop 6" Bulb	1312.35 lf	**131**	11,756	**7,606**				14.75 /lf	**19,362**	**12,765**	**24 /lf**	**32,127**	0.00%
					Strip & Oil Footing Forms	3936.9 sf	**20**	1,763	**276**				0.52 /sf	**2,039**	**1,462**	**1 /sf**	**3,501**	0.00%
					Footing Rebar	8.1 tn	**162**	16,607	**15,309**				3,940.24 /tn	**31,916**	**20,175**	**6,431 /tn**	**52,091**	0.00%
					Pump Place Wall Footings	219.15 cy	**122**	12,918			**1,052**		63.75 /cy	**13,970**	**9,972**	**109 /cy**	**23,942**	0.00%
					4500 psi Concrete	219.15 cy			**46,022**				210.00 /cy	**46,022**	**24,085**	**320 /cy**	**70,106**	0.00%
					Div. 03 Concrete	**3,936.900 hsf**	**1,288**	**120,060**	**75,854**		**1,052**		**50.03 /hsf**	**196,966**	**129,411**	**82.90 /hsf**	**326,377**	**0.01%**
					Footing Footing	**219.150 cy**	**1,288**	**120,060**	**75,854**		**1,052**		**898.77 /cy**	**196,966**	**129,411**	**1,489.29 /cy**	**326,377**	**0.01%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	**Concrete**													
					Keyway 4"	197.25 lf	**10**	890	**97**				5.01 /lf	**988**	**716**	**9 /lf**	**1,703**	0.00%
					Rented Form System 16'->	7888.65 sf	**1,972**	178,063	**82,831**				33.07 /sf	**260,893**	**176,237**	**55 /sf**	**437,131**	0.01%
					Wall Bulkhead Forms	394.5 sf	**217**	19,590	**2,071**				54.91 /sf	**21,661**	**15,704**	**95 /sf**	**37,366**	0.00%
					Waterstop 6" Bulb	394.5 lf	**39**	3,534	**2,287**				14.75 /lf	**5,820**	**3,837**	**24 /lf**	**9,658**	0.00%
					Strip & Oil Wall Forms	7888.65 sf	**39**	3,533	**552**				0.52 /sf	**4,085**	**2,929**	**1 /sf**	**7,015**	0.00%
					Hot Water Charge	292.2 cy			**2,454**				8.40 /cy	**2,454**	**1,285**	**13 /cy**	**3,739**	0.00%
					Wall Rebar	25.65 tn	**590**	60,477	**48,479**				4,247.81 /tn	**108,956**	**69,667**	**6,964 /tn**	**178,623**	0.00%
					Finish- Top of Wall & Curb	328.65 sf	**18**	1,619					4.93 /sf	**1,619**	**1,210**	**9 /sf**	**2,829**	0.00%
					Pump Place Walls	292.2 cy	**409**	43,449			**2,103**		155.89 /cy	**45,552**	**32,780**	**268 /cy**	**78,332**	0.00%
					4500 psi Concrete	292.2 cy			**61,362**				210.00 /cy	**61,362**	**32,113**	**320 /cy**	**93,475**	0.00%
					Grind/Patch Walls	7888.65 sf	**631**	56,522	**276**				7.20 /sf	**56,799**	**42,381**	**13 /sf**	**99,179**	0.00%
					Liquid Curing Compounds	7888.65 sf	**24**	2,120	**6,212**				1.06 /sf	**8,332**	**4,835**	**2 /sf**	**13,167**	0.00%
					Div. 03 Concrete	**7,888.650 hsf**	**3,950**	**369,798**	**206,622**		**2,103**		**73.34 /hsf**	**578,523**	**383,693**	**121.97 /hsf**	**962,216**	**0.02%**
					Foundation Wall Foundation Wall	**292.200 cy**	**3,950**	**369,798**	**206,622**		**2,103**		**1,979.89 /cy**	**578,523**	**383,693**	**3,293.01 /cy**	**962,216**	**0.02%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	3739.2 sf	**1,271**	114,786	**5,693**				32.22 /sf	**120,479**	**88,644**	**56 /sf**	**209,123**	0.00%
					S-O-G Const Joints > 1'	6981.9 sf	**2,513**	226,937	**10,630**				34.03 /sf	**237,567**	**174,927**	**59 /sf**	**412,495**	0.01%
					Strip & Oil SOG Form	10720.95 sf	**54**	4,802	**750**				0.52 /sf	**5,552**	**3,981**	**1 /sf**	**9,533**	0.00%
					SOG Rebar	336.15 tn	**5,042**	516,891	**635,324**				3,427.68 /tn	**1,152,216**	**711,080**	**5,543 /tn**	**1,863,295**	0.04%
					Mesh Support - bricks	5379 ea	**11**	1,103	**2,768**				0.72 /ea	**3,870**	**2,256**	**1 /ea**	**6,126**	0.00%
					Finish- Hard Trowel	46545.6 sf	**1,071**	95,877					2.06 /sf	**95,877**	**71,644**	**4 /sf**	**167,522**	0.00%
					Pump Place Slab on Grade	5171.85 cy	**6,206**	659,175			**14,893**		130.33 /cy	**674,069**	**488,320**	**225 /cy**	**1,162,389**	0.03%
					4500 psi Concrete	5171.85 cy			**1,086,089**				210.00 /cy	**1,086,089**	**568,393**	**320 /cy**	**1,654,481**	0.04%
					Liquid Curing Compounds	46545.6 sf	**140**	12,508	**36,655**				1.06 /sf	**49,163**	**28,529**	**2 /sf**	**77,692**	0.00%
					Seal Floors	46545.6 sf	**233**	20,847	**9,775**				0.66 /sf	**30,622**	**20,693**	**1 /sf**	**51,315**	0.00%
					Div. 03 Concrete	**46,545.600 hsf**	**16,541**	**1,652,927**	**1,787,683**		**14,893**		**74.24 /hsf**	**3,455,503**	**2,158,468**	**120.61 /hsf**	**5,613,972**	**0.13%**
					Slab Slab	**5,171.850 cy**	**16,541**	**1,652,927**	**1,787,683**		**14,893**		**668.14 /cy**	**3,455,503**	**2,158,468**	**1,085.49 /cy**	**5,613,972**	**0.13%**
					620. Generator Pad	**1.000 ls**	**21,778**	**2,142,785**	**2,070,160**		**18,048**		**4,230,992.40 /ls**	**4,230,992**	**2,671,573**	**6,902,564.94 /ls**	**6,902,565**	**0.16%**
		630.			**EB3 UV AOP Electric Building**													
			Building		**Building**													
				Div. 04	**Masonry**													
					Interior Staging over 10 '	10728.45 sf	**54**	5,539	**5,364**				1.02 /sf	**10,903**	**6,694**	**2 /sf**	**17,597**	0.00%
					Staging to 30'	10728.45 sf	**54**	5,539	**8,046**				1.27 /sf	**13,585**	**8,098**	**2 /sf**	**21,683**	0.00%
					Rub Block	10728.45 sf	**143**	14,767					1.38 /sf	**14,767**	**10,805**	**2 /sf**	**25,573**	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Mortar	768.6 cf			5,996				7.80 /cf	5,996	3,138	12 /cf	9,134	0.00%
					Mortar	1286.1 cf			10,034				7.80 /cf	10,034	5,251	12 /cf	15,284	0.00%
					Grout Fill 10" Block Cells	6634.65 cf	1,990	205,530	42,147				37.33 /cf	247,677	172,442	63 /cf	420,119	0.01%
					Grout Fill 10"Lintel Block	47.1 cf	14	1,459	299				37.33 /cf	1,758	1,224	63 /cf	2,982	0.00%
					Grout Fill 10 "Bond Beam	78.45 cf	24	2,430	498				37.33 /cf	2,929	2,039	63 /cf	4,968	0.00%
					Dur-O-Wall 10"	8720.7 lf			4,029				0.46 /lf	4,029	2,108	1 /lf	6,137	0.00%
					Wall Ties	12407 ea	165	17,078	1,563				1.50 /ea	18,641	13,314	3 /ea	31,955	0.00%
					Extruded Control Joints 1/2"	1035.15 lf	6	610	2,424				2.93 /lf	3,034	1,715	5 /lf	4,749	0.00%
					Masonry Rebar # 5	50599.05 lbs	607	62,699	35,622				1.94 /lbs	98,321	64,519	3 /lbs	162,839	0.00%
					Masonry Rebar # 5	188.25 lbs	2	233	133				1.94 /lbs	366	240	3 /lbs	606	0.00%
					Standard Brick	71758 ea	2,870	296,398	75,346				5.18 /ea	371,744	256,304	9 /ea	628,048	0.01%
					10" Block Bond Beam	377 ea	31	3,251	8,649				31.57 /ea	11,901	6,906	50 /ea	18,806	0.00%
					10" Block Lintels	142 ea	12	1,225	3,258				31.57 /ea	4,483	2,601	50 /ea	7,084	0.00%
					10" Fire Rated 3 hr	11011 ea	920	94,963	78,619				15.76 /ea	173,581	110,628	26 /ea	284,209	0.01%
					Div. 04 Masonry	**10,728.450 vsf**	6,892	711,722	282,026				**92.63 /vsf**	993,749	668,026	**154.89 /vsf**	1,661,774	**0.04%**
				Div. 05 -15	**Div 5/6/7/8/9/10/11/12/22/23**													
					Div 5 - $/SF	15684.75 sf				888,384			56.64 /sf	888,384	298,354	76 /sf	1,186,738	0.03%
					Div 6 - $/SF	15684.75 sf				26,978			1.72 /sf	26,978	9,060	2 /sf	36,038	0.00%
					Div 7 - $/SF	15684.75 sf				641,977			40.93 /sf	641,977	215,601	55 /sf	857,578	0.02%
					Div 8 - $/SF	15684.75 sf				143,672			9.16 /sf	143,672	48,251	12 /sf	191,923	0.00%
					Div 9 - $/SF	15684.75 sf				564,651			36.00 /sf	564,651	189,632	48 /sf	754,283	0.02%
					Div 10 - $/SF	15684.75 sf				30,115			1.92 /sf	30,115	10,114	3 /sf	40,228	0.00%
					Div 11 - $/SF	15684.75 sf				14,901			0.95 /sf	14,901	5,004	1 /sf	19,905	0.00%
					Div 12 - $/SF	15684.75 sf				5,803			0.37 /sf	5,803	1,949	0 /sf	7,752	0.00%
					Div 22 - $/SF	15684.75 sf				95,834			6.11 /sf	95,834	32,185	8 /sf	128,019	0.00%
					Div 23 - $/SF	15684.75 sf				920,224			58.67 /sf	920,224	309,047	78 /sf	1,229,272	0.03%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	**15,684.750 hsf**				3,332,539			**212.47 /hsf**	3,332,539	1,119,197	**283.83 /hsf**	4,451,736	**0.10%**
				Div. 25	**Integrated Automation (I&C)**													
					I&C	15684.75 sf				455,171			29.02 /sf	455,171	152,864	39 /sf	608,036	0.01%
					Div. 25 Integrated Automation (I&C)	**150.000 mgd**				455,171			**3,034.48 /mgd**	455,171	152,864	**4,053.57 /mgd**	608,036	**0.01%**
				Div. 26	**Electrical**													
					Electrical	15684.75 sf				1,219,176			77.73 /sf	1,219,176	409,447	104 /sf	1,628,623	0.04%
					Div. 26 Electrical	**150.000 mgd**				1,219,176			**8,127.84 /mgd**	1,219,176	409,447	**10,857.48 /mgd**	1,628,623	**0.04%**
					Building Building	**15,684.750 hsf**	6,892	711,722	282,026	5,006,886			**382.58 /hsf**	6,000,635	2,349,534	**532.37 /hsf**	8,350,169	**0.19%**
			Footing		**Footing**													
				Div. 03	**Concrete**													
					Continuous Footing Forms > 12"	2682.15 sf	536	48,433	4,084				19.58 /sf	52,517	38,283	34 /sf	90,800	0.00%
					Keyway 4"	894 lf	45	4,036	441				5.01 /lf	4,477	3,243	9 /lf	7,720	0.00%
					Waterstop 6" Bulb	894 lf	89	8,008	5,182				14.75 /lf	13,190	8,696	24 /lf	21,886	0.00%
					Strip & Oil Footing Forms	2682.15 sf	13	1,201	188				0.52 /sf	1,389	996	1 /sf	2,385	0.00%
					Footing Rebar	17.64 tn	353	36,166	33,340				3,940.24 /tn	69,506	43,937	6,431 /tn	113,443	0.00%
					Pump Place Wall Footings	141.15 cy	78	8,320			677		63.75 /cy	8,998	6,422	109 /cy	15,420	0.00%
					4500 psi Concrete	141.15 cy			29,642				210.00 /cy	29,642	15,513	320 /cy	45,154	0.00%
					Div. 03 Concrete	**2,682.150 hsf**	1,115	106,165	72,875		677		**67.01 /hsf**	179,718	117,090	**110.66 /hsf**	296,808	**0.01%**
					Footing Footing	**141.150 cy**	1,115	106,165	72,875		677		**1,273.24 /cy**	179,718	117,090	**2,102.78 /cy**	296,808	**0.01%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	**Concrete**													
					Keyway 4"	141.15 lf	7	637	70				5.01 /lf	707	512	9 /lf	1,219	0.00%
					Rented Form System 16'->	5364.15 sf	1,341	121,080	56,324				33.07 /sf	177,403	119,838	55 /sf	297,242	0.01%
					Wall Bulkhead Forms	266.55 sf	147	13,236	1,399				54.91 /sf	14,636	10,611	95 /sf	25,247	0.00%
					Waterstop 6" Bulb	266.55 lf	27	2,388	1,545				14.75 /lf	3,933	2,593	24 /lf	6,525	0.00%
					Strip & Oil Wall Forms	5364.15 sf	27	2,403	375				0.52 /sf	2,778	1,992	1 /sf	4,770	0.00%
					Hot Water Charge	203.85 cy			1,712				8.40 /cy	1,712	896	13 /cy	2,608	0.00%
					Wall Rebar	15.75 tn	362	37,135	29,768				4,247.83 /tn	66,903	42,778	6,964 /tn	109,681	0.00%
					Finish- Top of Wall & Curb	219.6 sf	12	1,082					4.93 /sf	1,082	808	9 /sf	1,890	0.00%
					Pump Place Walls	203.85 cy	285	30,312			1,467		155.89 /cy	31,779	22,868	268 /cy	54,647	0.00%
					4500 psi Concrete	203.85 cy			42,809				210.00 /cy	42,809	22,403	320 /cy	65,212	0.00%
					Grind/Patch Walls	5364.15 sf	429	38,434	188				7.20 /sf	38,622	28,818	13 /sf	67,440	0.00%
					Liquid Curing Compounds	5364.15 sf	16	1,442	4,224				1.06 /sf	5,666	3,288	2 /sf	8,954	0.00%
					Div. 03 Concrete	**5,364.150 hsf**	2,653	248,148	138,414		1,467		**72.34 /hsf**	388,029	257,406	**120.32 /hsf**	645,435	**0.01%**
					Foundation Wall Foundation Wall	**203.850 cy**	2,653	248,148	138,414		1,467		**1,903.51 /cy**	388,029	257,406	**3,166.23 /cy**	645,435	**0.01%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	1254.75 sf	427	38,518	1,910				32.22 /sf	40,429	29,746	56 /sf	70,175	0.00%
					S-O-G Const Joints > 1'	2352.75 sf	847	76,473	3,582				34.03 /sf	80,055	58,947	59 /sf	139,002	0.00%
					Strip & Oil SOG Form	3607.5 sf	18	1,616	253				0.52 /sf	1,868	1,339	1 /sf	3,208	0.00%
					SOG Rebar	109.8 tn	1,647	168,837	207,522				3,427.68 /tn	376,359	232,267	5,543 /tn	608,626	0.01%
					Mesh Support - bricks	1820 ea	4	373	936				0.72 /ea	1,310	763	1 /ea	2,073	0.00%
					Finish- Hard Trowel	15684.75 sf	361	32,308					2.06 /sf	32,308	24,142	4 /sf	56,451	0.00%
					Pump Place Slab on Grade	1741.05 cy	2,089	221,904			5,014		130.33 /cy	226,918	164,388	225 /cy	391,306	0.01%
					4500 psi Concrete	1741.05 cy			365,621				210.00 /cy	365,621	191,344	320 /cy	556,964	0.01%
					Liquid Curing Compounds	15684.75 sf	47	4,215	12,352				1.06 /sf	16,567	9,614	2 /sf	26,180	0.00%
					Seal Floors	15684.75 sf	78	7,025	3,294				0.66 /sf	10,319	6,973	1 /sf	17,292	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 03 Concrete	15,684.750 hsf	5,518	551,270	595,469		5,014		73.43 /hsf	1,151,754	719,523	119.31 /hsf	1,871,277	0.04%
					Slab Slab	1,741.050 cy	5,518	551,270	595,469		5,014		661.53 /cy	1,151,754	719,523	1,074.80 /cy	1,871,277	0.04%
					630. EB3 UV AOP Electric Building	15,684.750 sf	16,178	1,617,306	1,088,786	5,006,886	7,158		492.21 /sf	7,720,136	3,443,553	711.75 /sf	11,163,689	0.25%
		640.			EB4 MF/Ozone/BAC Electrical Building													
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	7899.6 sf	39	4,079	3,950				1.02 /sf	8,028	4,929	2 /sf	12,957	0.00%
					Staging to 30'	7899.6 sf	39	4,079	5,925				1.27 /sf	10,003	5,963	2 /sf	15,966	0.00%
					Rub Block	7899.6 sf	105	10,874					1.38 /sf	10,874	7,956	2 /sf	18,830	0.00%
					Mortar	569.7 cf			4,445				7.80 /cf	4,445	2,326	12 /cf	6,770	0.00%
					Mortar	953.25 cf			7,437				7.80 /cf	7,437	3,892	12 /cf	11,329	0.00%
					Grout Fill 10" Block Cells	4886.7 cf	1,466	151,382	31,043				37.33 /cf	182,424	127,011	63 /cf	309,435	0.01%
					Grout Fill 10"Lintel Block	43.8 cf	13	1,357	278				37.33 /cf	1,635	1,138	63 /cf	2,774	0.00%
					Grout Fill 10 "Bond Beam	65.7 cf	20	2,035	417				37.33 /cf	2,453	1,708	63 /cf	4,160	0.00%
					Dur-O-Wall 10"	6420.45 lf			2,966				0.46 /lf	2,966	1,552	1 /lf	4,519	0.00%
					Wall Ties	9138 ea	122	12,578	1,151				1.50 /ea	13,730	9,806	3 /ea	23,535	0.00%
					Extruded Control Joints 1/2"	766.95 lf	4	452	1,796				2.93 /lf	2,248	1,271	5 /lf	3,519	0.00%
					Masonry Rebar # 5	37263.15 lbs	447	46,174	26,233				1.94 /lbs	72,407	47,514	3 /lbs	119,921	0.00%
					Masonry Rebar # 5	142.35 lbs	2	176	100				1.94 /lbs	277	182	3 /lbs	458	0.00%
					Standard Brick	52855 ea	2,114	218,319	55,498				5.18 /ea	273,817	188,786	9 /ea	462,603	0.01%
					10" Block Bond Beam	274 ea	23	2,363	6,286				31.57 /ea	8,649	5,019	50 /ea	13,668	0.00%
					10" Block Lintels	99 ea	8	854	2,271				31.57 /ea	3,125	1,813	50 /ea	4,938	0.00%
					10" Fire Rated 3 hr	8108 ea	677	69,926	57,891				15.76 /ea	127,817	81,461	26 /ea	209,279	0.00%
					Div. 04 Masonry	7,899.600 vsf	5,081	524,647	207,688				92.71 /vsf	732,335	492,327	155.03 /vsf	1,224,662	0.03%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	10956.45 sf				620,573			56.64 /sf	620,573	208,413	76 /sf	828,986	0.02%
					Div 6 - $/SF	10956.45 sf				18,845			1.72 /sf	18,845	6,329	2 /sf	25,174	0.00%
					Div 7 - $/SF	10956.45 sf				448,448			40.93 /sf	448,448	150,606	55 /sf	599,054	0.01%
					Div 8 - $/SF	10956.45 sf				100,361			9.16 /sf	100,361	33,705	12 /sf	134,066	0.00%
					Div 9 - $/SF	10956.45 sf				394,432			36.00 /sf	394,432	132,466	48 /sf	526,898	0.01%
					Div 10 - $/SF	10956.45 sf				21,036			1.92 /sf	21,036	7,065	3 /sf	28,101	0.00%
					Div 11 - $/SF	10956.45 sf				10,409			0.95 /sf	10,409	3,496	1 /sf	13,904	0.00%
					Div 12 - $/SF	10956.45 sf				4,054			0.37 /sf	4,054	1,361	0 /sf	5,415	0.00%
					Div 22 - $/SF	10956.45 sf				66,944			6.11 /sf	66,944	22,482	8 /sf	89,426	0.00%
					Div 23 - $/SF	10956.45 sf				642,815			58.67 /sf	642,815	215,882	78 /sf	858,697	0.02%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	10,956.450 hsf				2,327,917			212.47 /hsf	2,327,917	781,806	283.83 /hsf	3,109,723	0.07%
				Div. 25	Integrated Automation (I&C)													
					I&C	10956.45 sf				317,956			29.02 /sf	317,956	106,782	39 /sf	424,738	0.01%
					Div. 25 Integrated Automation (I&C)	150.000 mgd				317,956			2,119.71 /mgd	317,956	106,782	2,831.59 /mgd	424,738	0.01%
				Div. 26	Electrical													
					Electrical	10956.45 sf				851,645			77.73 /sf	851,645	286,016	104 /sf	1,137,661	0.03%
					Div. 26 Electrical	150.000 mgd				851,645			5,677.63 /mgd	851,645	286,016	7,584.40 /mgd	1,137,661	0.03%
					Building Building	10,956.450 hsf	5,081	524,647	207,688	3,497,518			386.06 /hsf	4,229,853	1,666,931	538.20 /hsf	5,896,783	0.13%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	1972.2 sf	394	35,613	3,003				19.58 /sf	38,616	28,150	34 /sf	66,766	0.00%
					Keyway 4"	657.45 lf	33	2,968	324				5.01 /lf	3,292	2,385	9 /lf	5,677	0.00%
					Waterstop 6" Bulb	657.45 lf	66	5,889	3,811				14.75 /lf	9,700	6,395	24 /lf	16,095	0.00%
					Strip & Oil Footing Forms	1972.2 sf	10	883	138				0.52 /sf	1,021	732	1 /sf	1,754	0.00%
					Footing Rebar	13.69 tn	274	28,068	25,875				3,940.31 /tn	53,943	34,099	6,431 /tn	88,042	0.00%
					Pump Place Wall Footings	109.5 cy	61	6,455			526		63.75 /cy	6,980	4,982	109 /cy	11,963	0.00%
					4500 psi Concrete	109.5 cy			22,995				210.00 /cy	22,995	12,034	320 /cy	35,029	0.00%
					Div. 03 Concrete	1,972.200 hsf	837	79,876	56,146		526		69.24 /hsf	136,548	88,777	114.25 /hsf	225,325	0.01%
					Footing Footing	109.500 cy	837	79,876	56,146		526		1,247.01 /cy	136,548	88,777	2,057.76 /cy	225,325	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	98.55 lf	5	445	49				5.01 /lf	494	358	9 /lf	851	0.00%
					Rented Form System 16'->	3944.4 sf	986	89,033	41,416				33.07 /sf	130,449	88,120	55 /sf	218,570	0.00%
					Wall Bulkhead Forms	197.25 sf	108	9,795	1,036				54.91 /sf	10,831	7,852	95 /sf	18,683	0.00%
					Waterstop 6" Bulb	197.25 lf	20	1,767	1,143				14.75 /lf	2,910	1,919	24 /lf	4,829	0.00%
					Strip & Oil Wall Forms	3944.4 sf	20	1,767	276				0.52 /sf	2,043	1,465	1 /sf	3,507	0.00%
					Hot Water Charge	142.35 cy			1,196				8.40 /cy	1,196	626	13 /cy	1,822	0.00%
					Wall Rebar	10.95 tn	252	25,818	20,696				4,247.86 /tn	46,514	29,741	6,964 /tn	76,255	0.00%
					Finish- Top of Wall & Curb	164.4 sf	9	810					4.93 /sf	810	605	9 /sf	1,415	0.00%
					Pump Place Walls	142.35 cy	199	21,167			1,025		155.89 /cy	22,192	15,969	268 /cy	38,161	0.00%
					4500 psi Concrete	142.35 cy			29,894				210.00 /cy	29,894	15,644	320 /cy	45,538	0.00%
					Grind/Patch Walls	3944.4 sf	316	28,262	138				7.20 /sf	28,400	21,191	13 /sf	49,591	0.00%
					Liquid Curing Compounds	3944.4 sf	12	1,060	3,106				1.06 /sf	4,166	2,418	2 /sf	6,584	0.00%
					Div. 03 Concrete	3,944.400 hsf	1,927	179,923	98,950		1,025		70.96 /hsf	279,897	185,907	118.09 /hsf	465,804	0.01%
					Foundation Wall Foundation Wall	142.350 cy	1,927	179,923	98,950		1,025		1,966.26 /cy	279,897	185,907	3,272.25 /cy	465,804	0.01%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	876.6 sf	298	26,910	1,335				32.22 /sf	28,244	20,781	56 /sf	49,026	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					S-O-G Const Joints > 1'	1643.55 sf	592	53,421	2,502				34.03 /sf	55,924	41,178	59 /sf	97,102	0.00%
					Strip & Oil SOG Form	2520 sf	13	1,129	176				0.52 /sf	1,305	936	1 /sf	2,241	0.00%
					SOG Rebar	76.65 tn	1,150	117,863	144,869				3,427.69 /tn	262,733	162,143	5,543 /tn	424,876	0.01%
					Mesh Support - bricks	1271 ea	3	261	654				0.72 /ea	915	533	1 /ea	1,448	0.00%
					Finish- Hard Trowel	10956.45 sf	252	22,569					2.06 /sf	22,569	16,864	4 /sf	39,433	0.00%
					Pump Place Slab on Grade	1216.2 cy	1,459	155,010			3,502		130.33 /cy	158,512	114,832	225 /cy	273,345	0.01%
					4500 psi Concrete	1216.2 cy			255,402				210.00 /cy	255,402	133,662	320 /cy	389,064	0.01%
					Liquid Curing Compounds	10956.45 sf	33	2,944	8,628				1.06 /sf	11,573	6,716	2 /sf	18,288	0.00%
					Seal Floors	10956.45 sf	55	4,907	2,301				0.66 /sf	7,208	4,871	1 /sf	12,079	0.00%
					Div. 03 Concrete	10,956.450 hsf	3,854	385,014	415,868		3,502		73.42 /hsf	804,384	502,517	119.28 /hsf	1,306,901	0.03%
					Slab Slab	1,216.200 cy	3,854	385,014	415,868		3,502		661.39 /cy	804,384	502,517	1,074.58 /cy	1,306,901	0.03%
					640. EB4 MF/Ozone/BAC Electrical Building	10,956.450 sf	11,699	1,169,460	778,651	3,497,518	5,052		497.49 /sf	5,450,682	2,444,132	720.56 /sf	7,894,813	0.18%
		679.			Duct Bank - SUB-EB1													
			Duct Bank		Duct Bank													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2168 sf	434	39,149	3,301				19.58 /sf	42,450	30,944	34 /sf	73,394	0.00%
					Keyway 4"	542 lf	27	2,447	267				5.01 /lf	2,714	1,966	9 /lf	4,680	0.00%
					Strip & Oil Footing Forms	2168 sf	11	971	152				0.52 /sf	1,123	805	1 /sf	1,928	0.00%
					Footing Rebar	9.214 tn	184	18,891	17,415				3,940.30 /tn	36,306	22,950	6,431 /tn	59,256	0.00%
					Truck Place Wall Footings	120.324 cy	159	16,933					140.73 /cy	16,933	12,342	243 /cy	29,275	0.00%
					4000 psi Concrete	120.324 cy			25,268				210.00 /cy	25,268	13,224	320 /cy	38,492	0.00%
					Div. 03 Concrete	2,168.000 hsf	815	78,391	46,403				57.56 /hsf	124,794	82,232	95.49 /hsf	207,026	0.00%
					Duct Bank Duct Bank	10,840.350 lf	815	78,391	46,403				11.51 /lf	124,794	82,232	19.10 /lf	207,026	0.00%
					679. Duct Bank - SUB-EB1	10,840.350 lf	815	78,391	46,403				11.51 /lf	124,794	82,232	19.10 /lf	207,026	0.00%
		680.			Duct Bank - SUB-EB2													
			Duct Bank		Duct Bank													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	3678.15 sf	736	66,419	5,600				19.58 /sf	72,019	52,499	34 /sf	124,518	0.00%
					Keyway 4"	919.5 lf	46	4,151	454				5.01 /lf	4,605	3,335	9 /lf	7,940	0.00%
					Strip & Oil Footing Forms	3678.15 sf	18	1,647	257				0.52 /sf	1,905	1,366	1 /sf	3,271	0.00%
					Footing Rebar	15.45 tn	309	31,676	29,201				3,940.30 /tn	60,878	38,483	6,431 /tn	99,361	0.00%
					Truck Place Wall Footings	204.45 cy	271	28,772					140.73 /cy	28,772	20,971	243 /cy	49,744	0.00%
					4000 psi Concrete	204.45 cy			42,935				210.00 /cy	42,935	22,469	320 /cy	65,404	0.00%
					Div. 03 Concrete	3,678.150 hsf	1,380	132,666	78,447				57.40 /hsf	211,113	139,124	95.22 /hsf	350,237	0.01%
				Div. 25	Integrated Automation (I&C)													
					Pull Wire	18391.35 lf	55	5,743	668				0.35 /lf	6,411	4,547	1 /lf	10,958	0.00%
					Sch 80 PVC PVC Conduit 4"	18391.35 lf	3,384	352,245	92,692				24.19 /lf	444,937	305,959	41 /lf	750,896	0.02%
					Sch 80 PVC 45 Degree Elbow 4"	105 ea	105	10,930	2,997				132.64 /ea	13,927	9,557	224 /ea	23,484	0.00%
					Intermediate Spacer 1-1/2" Space 4"	3679 ea	147	15,318	4,102				5.28 /ea	19,420	13,342	9 /ea	32,763	0.00%
					Div. 25 Integrated Automation (I&C)	150.000 mgd	3,691	384,236	100,459				3,231.30 /mgd	484,695	333,405	5,454.00 /mgd	818,100	0.02%
				Div. 31	Earthwork													
					Excavate Footings Haul Offsite	1021.8 cy	62	7,550			2,731		10.06 /cy	10,280	6,847	17 /cy	17,127	0.00%
					Fill Gravel Process	715.2 cy			35,145				49.14 /cy	35,145	18,393	75 /cy	53,538	0.00%
					Bldg Fill Gravel	715.2 cy	87	9,903	34,544		3,100		66.48 /cy	47,548	26,866	104 /cy	74,414	0.00%
					Div. 31 Earthwork	1,021.800 cy	148	17,453	69,689		5,831		90.99 /cy	92,973	52,106	141.98 /cy	145,079	0.00%
					Duct Bank Duct Bank	18,391.350 lf	5,220	534,354	248,596		5,831		42.89 /lf	788,781	524,635	71.41 /lf	1,313,416	0.03%
					680. Duct Bank - SUB-EB2	18,391.350 lf	5,220	534,354	248,596		5,831		42.89 /lf	788,781	524,635	71.41 /lf	1,313,416	0.03%
		681.			Duct Bank - SUB-EB3													
			Duct Bank		Duct Bank													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	4904.4 sf	981	88,562	7,467				19.58 /sf	96,029	70,002	34 /sf	166,030	0.00%
					Keyway 4"	1226.1 lf	61	5,535	605				5.01 /lf	6,140	4,448	9 /lf	10,588	0.00%
					Strip & Oil Footing Forms	4904.4 sf	25	2,197	343				0.52 /sf	2,540	1,821	1 /sf	4,361	0.00%
					Footing Rebar	20.85 tn	417	42,748	39,407				3,940.28 /tn	82,155	51,933	6,431 /tn	134,088	0.00%
					Truck Place Wall Footings	272.25 cy	361	38,314					140.73 /cy	38,314	27,926	243 /cy	66,240	0.00%
					4000 psi Concrete	272.25 cy			57,173				210.00 /cy	57,173	29,921	320 /cy	87,093	0.00%
					Div. 03 Concrete	4,904.400 hsf	1,844	177,355	104,995				57.57 /hsf	282,350	186,050	95.51 /hsf	468,400	0.01%
				Div. 25	Integrated Automation (I&C)													
					Pull Wire	24521.7 lf	74	7,657	890				0.35 /lf	8,548	6,063	1 /lf	14,610	0.00%
					Sch 80 PVC PVC Conduit 4"	24521.7 lf	4,512	469,658	123,589				24.19 /lf	593,247	407,944	41 /lf	1,001,191	0.02%
					Sch 80 PVC 45 Degree Elbow 4"	139 ea	139	14,469	3,968				132.64 /ea	18,437	12,651	224 /ea	31,088	0.00%
					Intermediate Spacer 1-1/2" Space 4"	4904.4 ea	196	20,420	5,468				5.28 /ea	25,889	17,787	9 /ea	43,675	0.00%
					Div. 25 Integrated Automation (I&C)	150.000 mgd	4,921	512,204	133,916				4,307.47 /mgd	646,120	444,444	7,270.43 /mgd	1,090,564	0.02%
				Div. 31	Earthwork													
					Excavate Footings Haul Offsite	1362.15 cy	82	10,064			3,641		10.06 /cy	13,705	9,128	17 /cy	22,832	0.00%
					Fill Gravel Process	953.85 cy			46,872				49.14 /cy	46,872	24,530	75 /cy	71,402	0.00%
					Bldg Fill Gravel	953.85 cy	116	13,208	46,071		4,135		66.48 /cy	63,414	35,831	104 /cy	99,245	0.00%
					Div. 31 Earthwork	953.850 cy	198	23,272	92,943		7,775		129.99 /cy	123,991	69,489	202.84 /cy	193,479	0.00%
					Duct Bank Duct Bank	24,521.700 lf	6,963	712,831	331,854		7,775		42.92 /lf	1,052,461	699,983	71.47 /lf	1,752,444	0.04%
					681. Duct Bank - SUB-EB3	24,521.700 lf	6,963	712,831	331,854		7,775		42.92 /lf	1,052,461	699,983	71.47 /lf	1,752,444	0.04%
		682.			Duct Bank - SUB-EB4													
			Duct Bank		Duct Bank													
				Div. 03	Concrete													

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Continuous Footing Forms > 12"	6991.35 sf	1,398	126,247	10,644				19.58 /sf	136,891	99,789	34 /sf	236,681	0.01%
					Keyway 4"	1747.8 lf	87	7,890	863				5.01 /lf	8,753	6,340	9 /lf	15,093	0.00%
					Strip & Oil Footing Forms	6991.35 sf	35	3,131	489				0.52 /sf	3,621	2,596	1 /sf	6,217	0.00%
					Footing Rebar	29.7 tn	594	60,892	56,133				3,940.24 /tn	117,025	73,976	6,431 /tn	191,001	0.00%
					Truck Place Wall Footings	388.05 cy	514	54,611					140.73 /cy	54,611	39,804	243 /cy	94,415	0.00%
					4000 psi Concrete	388.05 cy			81,491				210.00 /cy	81,491	42,647	320 /cy	124,138	0.00%
					Div. 03 Concrete	**6,991.350 hsf**	**2,629**	**252,771**	**149,620**				**57.56 /hsf**	**402,391**	**265,152**	**95.48 /hsf**	**667,544**	**0.02%**
				Div. 25	**Integrated Automation (I&C)**													
					Pull Wire	34956.6 lf	105	10,916	1,269				0.35 /lf	12,185	8,642	1 /lf	20,827	0.00%
					Sch 80 PVC PVC Conduit 4"	34956.6 lf	6,432	669,515	176,181				24.19 /lf	845,696	581,539	41 /lf	1,427,235	0.03%
					Sch 80 PVC 45 Degree Elbow 4"	198 ea	198	20,610	5,652				132.64 /ea	26,262	18,021	224 /ea	44,284	0.00%
					Intermediate Spacer 1-1/2" Space 4"	6992 ea	280	29,112	7,796				5.28 /ea	36,908	25,358	9 /ea	62,266	0.00%
					Div. 25 Integrated Automation (I&C)	**150.000 mgd**	**7,015**	**730,153**	**190,898**				**6,140.34 /mgd**	**921,051**	**633,561**	**10,364.08 /mgd**	**1,554,612**	**0.04%**
				Div. 31	**Earthwork**													
					Excavate Footings Haul Offsite	1941.9 cy	117	14,348			5,190		10.06 /cy	19,538	13,012	17 /cy	32,550	0.00%
					Fill Gravel Process	1359.9 cy			66,825				49.14 /cy	66,825	34,972	75 /cy	101,798	0.00%
					Bldg Fill Gravel	1359.9 cy	165	18,831	65,683		5,895		66.48 /cy	90,409	51,084	104 /cy	141,493	0.00%
					Div. 31 Earthwork	**1,359.900 cy**	**282**	**33,178**	**132,509**		**11,085**		**129.99 /cy**	**176,772**	**99,069**	**202.84 /cy**	**275,841**	**0.01%**
					Duct Bank Duct Bank	**34,956.600 lf**	**9,926**	**1,016,103**	**473,027**		**11,085**		**42.92 /lf**	**1,500,214**	**997,782**	**71.46 /lf**	**2,497,996**	**0.06%**
					682. Duct Bank - SUB-EB4	**34,956.600 lf**	**9,926**	**1,016,103**	**473,027**		**11,085**		**42.92 /lf**	**1,500,214**	**997,782**	**71.46 /lf**	**2,497,996**	**0.06%**
					007. - El/Pd/DB Electrical Buildings, Pads & Ductbanks	**150.000 MGD**	**126,782**	**12,597,213**	**9,020,776**	**192,378,096**	**85,306**		**1,427,209.27 /MGD**	**214,081,391**	**78,640,510**	**1,951,479.34 /MGD**	**292,721,901**	**6.63%**
	008. - Yard Piping				**Yard Piping**													
		010.-020			**Filtrate Pump to MBR Filtrate Tank Piping**													
			Yard Piping		**Yard Piping**													
				Div. 40	**Process Integration (Process Piping)**													
					Trench Excav & Lay Pipe 10-12'	300 lf	498	58,914			6,886		219.33 /lf	65,800	45,980	373 /lf	111,780	0.00%
					CY Trench Excavation (Volume Calculation Only)	***1,333.200 cy***							***/cy***			***/cy***		
					Utility Bed Sand	111 cy	13	1,484	7,481		689		86.97 /cy	9,654	5,354	135 /cy	15,008	0.00%
					Utility Cover Gravel-Process	85.2 cy	10	1,139	3,936		529		65.78 /cy	5,605	3,165	103 /cy	8,769	0.00%
					Spoils to Waste	623.7 cy	75	7,641		14,969	1,707	6,237	48.99 /cy	30,554	14,793	73 /cy	45,346	0.00%
					Backfill Trench-Backhoe/Truck	1137 cy	136	16,220			2,861		16.78 /cy	19,081	13,163	28 /cy	32,244	0.00%
					Trench Box 12' Deep (piggy back)	300 lf					7,200		24.00 /lf	7,200	3,804	37 /lf	11,004	0.00%
					Prestressed Conc Pipe 84	311.4 lf	1,071		230,598				740.52 /lf	230,598	131,929	1,164 /lf	362,527	0.01%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**1,804**	**85,399**	**242,015**	**14,969**	**19,872**	**6,237**	**2,456.61 /mgd**	**368,492**	**218,187**	**3,911.19 /mgd**	**586,679**	**0.01%**
					Yard Piping Yard Piping	**300.000 lf**	**1,804**	**85,399**	**242,015**	**14,969**	**19,872**	**6,237**	**1,228.31 /lf**	**368,492**	**218,187**	**1,955.60 /lf**	**586,679**	**0.01%**
					010.-020 Filtrate Pump to MBR Filtrate Tank Piping	**300.000 lf**	**1,804**	**85,399**	**242,015**	**14,969**	**19,872**	**6,237**	**1,228.31 /lf**	**368,492**	**218,187**	**1,955.60 /lf**	**586,679**	**0.01%**
		020.-040			**MBR Filtrate to Ozone Piping**													
			Yard Piping		**Yard Piping**													
				Div. 40	**Process Integration (Process Piping)**													
					Trench Excav & Lay Pipe 10-12'	1215.5 lf	2,016	238,701			27,899		219.33 /lf	266,600	186,294	373 /lf	452,895	0.01%
					CY Trench Excavation (Volume Calculation Only)	***5,401.682 cy***							***/cy***			***/cy***		
					Utility Bed Sand	449.735 cy	54	6,014	30,309		2,793		86.98 /cy	39,115	21,693	135 /cy	60,808	0.00%
					Utility Cover Gravel-Process	345.202 cy	41	4,616	15,948		2,144		65.78 /cy	22,708	12,822	103 /cy	35,530	0.00%
					Spoils to Waste	2527.025 cy	303	30,959		60,649	6,915	25,270	48.99 /cy	123,793	59,935	73 /cy	183,728	0.00%
					Backfill Trench-Backhoe/Truck	4606.745 cy	553	65,718			11,593		16.78 /cy	77,311	53,332	28 /cy	130,643	0.00%
					Trench Box 12' Deep (piggy back)	1215.5 lf					29,172		24.00 /lf	29,172	15,413	37 /lf	44,585	0.00%
					Prestressed Conc Pipe 84	1261.689 lf	4,340		934,306				740.52 /lf	934,306	534,531	1,164 /lf	1,468,837	0.03%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**7,308**	**346,009**	**980,563**	**60,649**	**80,515**	**25,270**	**9,953.37 /mgd**	**1,493,005**	**884,021**	**15,846.84 /mgd**	**2,377,026**	**0.05%**
					Yard Piping Yard Piping	**1,215.500 lf**	**7,308**	**346,009**	**980,563**	**60,649**	**80,515**	**25,270**	**1,228.31 /lf**	**1,493,005**	**884,021**	**1,955.60 /lf**	**2,377,026**	**0.05%**
					020.-040 MBR Filtrate to Ozone Piping	**1,215.500 lf**	**7,308**	**346,009**	**980,563**	**60,649**	**80,515**	**25,270**	**1,228.31 /lf**	**1,493,005**	**884,021**	**1,955.60 /lf**	**2,377,026**	**0.05%**
		080.-050			**RO Feed Tank to BAC Backwash Piping**													
			Yard Piping		**Yard Piping**													
				Div. 31	**Earthwork**													
					Trench Excav & Lay Pipe 8-10'	1000.04 lf	224	26,520			3,100		29.62 /lf	29,620	20,698	50 /lf	50,318	0.00%
					CY Trench Excavation (Volume Calculation Only)	***2,333.350 cy***							***/cy***			***/cy***		
					Utility Bed Stone 1/2"	259.325 cy	31	3,468	11,981		1,610		65.78 /cy	17,059	9,632	103 /cy	26,691	0.00%
					Spoils to Waste	615.595 cy	74	7,542			1,685		14.99 /cy	9,226	6,417	25 /cy	15,643	0.00%
					Backfill Trench-Backhoe/Truck	2074.025 cy	249	29,587			5,219		16.78 /cy	34,806	24,011	28 /cy	58,817	0.00%
					Trench Box 10' Deep	1000.04 lf					5,000		5.00 /lf	5,000	2,642	8 /lf	7,642	0.00%
					Div. 31 Earthwork	**2,333.350 cy**	**578**	**67,117**	**11,981**		**16,614**		**41.02 /cy**	**95,712**	**63,400**	**68.19 /cy**	**159,112**	**0.00%**
				Div. 40	**Process Integration (Process Piping)**													
					Prestressed Conc Pipe 42	1000.04 lf	1,650		370,275				370.26 /lf	370,275	211,105	581 /lf	581,380	0.01%
					PCCP 45 deg ell 42	9 ea	2		4,500				500.00 /ea	4,500	2,379	764 /ea	6,879	0.00%
					PCCP 90 deg ell 42	4 ea	1		2,280				570.00 /ea	2,280	1,204	871 /ea	3,484	0.00%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**1,653**		**377,055**				**2,513.70 /mgd**	**377,055**	**214,687**	**3,944.95 /mgd**	**591,742**	**0.01%**
					Yard Piping Yard Piping	**1,000.000 lf**	**2,231**	**67,117**	**389,036**		**16,614**		**472.77 /lf**	**472,767**	**278,087**	**750.85 /lf**	**750,854**	**0.02%**
					080.-050 RO Feed Tank to BAC Backwash Piping	**1,000.000 lf**	**2,231**	**67,117**	**389,036**		**16,614**		**472.77 /lf**	**472,767**	**278,087**	**750.85 /lf**	**750,854**	**0.02%**
		130.-140			**RO Feed Pump to RO (1st Stage) Piping**													
			Yard Piping		**Yard Piping**													
				Div. 31	**Earthwork**													
					Trench Excav & Lay Pipe 8-10'	579.945 lf	130	15,380			1,798		29.62 /lf	17,177	12,003	50 /lf	29,180	0.00%
					CY Trench Excavation (Volume Calculation Only)	***1,718.560 cy***							***/cy***			***/cy***		
					Utility Bed Stone 1/2"	171.81 cy	21	2,298	7,938		1,067		65.78 /cy	11,302	6,382	103 /cy	17,684	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Spoils to Waste	593.63 cy	71	7,273			1,624		14.99 /cy	8,897	6,188	25 /cy	15,085	0.00%
					Backfill Trench-Backhoe/Truck	1546.635 cy	186	22,064			3,892		16.78 /cy	25,956	17,905	28 /cy	43,861	0.00%
					Trench Box 10' Deep	580 lf					2,900		5.00 /lf	2,900	1,532	8 /lf	4,432	0.00%
					Div. 31 Earthwork	**1,718.560 cy**	**407**	**47,014**	**7,938**		**11,281**		**38.54 /cy**	**66,232**	**44,011**	**64.15 /cy**	**110,243**	**0.00%**
				Div. 40	**Process Integration (Process Piping)**													
					Prestressed Conc Pipe 60	579.945 lf	**1,450**		**306,756**				528.94 /lf	**306,756**	**175,761**	**832 /lf**	**482,517**	0.01%
					PCCP 45 deg ell 60	4 ea	**1**		**2,700**				675.00 /ea	**2,700**	**1,424**	**1,031 /ea**	**4,124**	0.00%
					PCCP 90 deg ell 60	2 ea	**1**		**1,500**				750.00 /ea	**1,500**	**790**	**1,145 /ea**	**2,290**	0.00%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**1,451**		**310,956**				**2,073.04 /mgd**	**310,956**	**177,975**	**3,259.54 /mgd**	**488,931**	**0.01%**
					Yard Piping Yard Piping	**579.950 lf**	**1,859**	**47,014**	**318,894**		**11,281**		**650.38 /lf**	**377,188**	**221,985**	**1,033.15 /lf**	**599,174**	**0.01%**
					130.-140 RO Feed Pump to RO (1st Stage) Piping	**579.950 lf**	**1,859**	**47,014**	**318,894**		**11,281**		**650.38 /lf**	**377,188**	**221,985**	**1,033.15 /lf**	**599,174**	**0.01%**
		140.-190			**RO (1st Stage) to UV/AOP Piping**													
			Yard Piping		**Yard Piping**													
				Div. 31	**Earthwork**													
					Trench Excav & Lay Pipe 10-12'	99.935 lf	**28**	3,313			**387**		37.02 /lf	**3,700**	**2,585**	**63 /lf**	**6,285**	0.00%
					CY Trench Excavation (Volume Calculation Only)	***414.805 cy***							***/cy***			***/cy***		
					Utility Bed Stone 1/2"	37.03 cy	**4**	495	**1,711**		**230**		65.78 /cy	**2,436**	**1,375**	**103 /cy**	**3,811**	0.00%
					Spoils to Waste	109.825 cy	**13**	1,345			**301**		14.99 /cy	**1,646**	**1,145**	**25 /cy**	**2,791**	0.00%
					Backfill Trench-Backhoe/Truck	377.775 cy	**45**	5,389			**951**		16.78 /cy	**6,340**	**4,374**	**28 /cy**	**10,713**	0.00%
					Trench Box 12' Deep (piggy back)	100 lf					**2,400**		24.00 /lf	**2,400**	**1,268**	**37 /lf**	**3,668**	0.00%
					Div. 31 Earthwork	**414.810 cy**	**91**	**10,543**	**1,711**		**4,268**		**39.83 /cy**	**16,522**	**10,747**	**65.74 /cy**	**27,269**	**0.00%**
				Div. 40	**Process Integration (Process Piping)**													
					Prestressed Conc Pipe 74	99.935 lf	**586**		**63,432**				634.73 /lf	**63,432**	**39,345**	**1,028 /lf**	**102,777**	0.00%
					PCCP 45 deg ell 72	4 ea	**1**		**2,800**				700.00 /ea	**2,800**	**1,476**	**1,069 /ea**	**4,276**	0.00%
					PCCP 90 deg ell 72	2 ea	**1**		**1,600**				800.00 /ea	**1,600**	**843**	**1,221 /ea**	**2,443**	0.00%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**587**		**67,832**				**452.21 /mgd**	**67,832**	**41,664**	**729.97 /mgd**	**109,496**	**0.00%**
					Yard Piping Yard Piping	**100.000 lf**	**678**	**10,543**	**69,543**		**4,268**		**843.54 /lf**	**84,353**	**52,411**	**1,367.64 /lf**	**136,764**	**0.00%**
					140.-190 RO (1st Stage) to UV/AOP Piping	**100.000 lf**	**678**	**10,543**	**69,543**		**4,268**		**843.54 /lf**	**84,353**	**52,411**	**1,367.64 /lf**	**136,764**	**0.00%**
		148.-170			**RO (3rd Stage) to Brine to Ocean Outfall Piping**													
			Yard Piping		**Yard Piping**													
				Div. 31	**Earthwork**													
					Trench Excav & Lay Pipe 10-12'	800.055 lf	**224**	26,521			**3,100**		37.02 /lf	**29,621**	**20,698**	**63 /lf**	**50,319**	0.00%
					CY Trench Excavation (Volume Calculation Only)	***2,933.420 cy***							***/cy***			***/cy***		
					Utility Bed Stone 1/2"	266.685 cy	**32**	3,566	**12,321**		**1,656**		65.78 /cy	**17,543**	**9,906**	**103 /cy**	**27,449**	0.00%
					Spoils to Waste	848.47 cy	**102**	10,395			**2,322**		14.99 /cy	**12,717**	**8,845**	**25 /cy**	**21,561**	0.00%
					Backfill Trench-Backhoe/Truck	2666.735 cy	**320**	38,043			**6,711**		16.78 /cy	**44,753**	**30,873**	**28 /cy**	**75,626**	0.00%
					Trench Box 12' Deep (piggy back)	801 lf					**19,224**		24.00 /lf	**19,224**	**10,157**	**37 /lf**	**29,381**	0.00%
					Div. 31 Earthwork	**2,933.420 cy**	**678**	**78,525**	**12,321**		**33,012**		**42.22 /cy**	**123,858**	**80,478**	**69.66 /cy**	**204,336**	**0.00%**
				Div. 40	**Process Integration (Process Piping)**													
					Prestressed Conc Pipe 60	801 lf	**2,003**		**423,681**				528.94 /lf	**423,681**	**242,755**	**832 /lf**	**666,436**	0.02%
					PCCP 45 deg ell 60	9 ea	**2**		**6,075**				675.00 /ea	**6,075**	**3,203**	**1,031 /ea**	**9,278**	0.00%
					PCCP 90 deg ell 60	4 ea	**1**		**3,000**				750.00 /ea	**3,000**	**1,581**	**1,145 /ea**	**4,581**	0.00%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**2,006**		**432,756**				**2,885.04 /mgd**	**432,756**	**247,538**	**4,535.30 /mgd**	**680,294**	**0.02%**
					Yard Piping Yard Piping	**800.000 lf**	**2,684**	**78,525**	**445,077**		**33,012**		**695.77 /lf**	**556,614**	**328,017**	**1,105.79 /lf**	**884,631**	**0.02%**
					148.-170 RO (3rd Stage) to Brine to Ocean Outfall Piping	**800.000 lf**	**2,684**	**78,525**	**445,077**		**33,012**		**695.77 /lf**	**556,614**	**328,017**	**1,105.79 /lf**	**884,631**	**0.02%**
		190.-260			**UV/AOP to Wetwell Piping**													
			Yard Piping		**Yard Piping**													
				Div. 31	**Earthwork**													
					Trench Excav & Lay Pipe 10-12'	260.015 lf	**73**	8,619			**1,007**		37.02 /lf	**9,627**	**6,727**	**63 /lf**	**16,354**	0.00%
					CY Trench Excavation (Volume Calculation Only)	***1,078.585 cy***							***/cy***			***/cy***		
					Utility Bed Stone 1/2"	96.255 cy	**12**	1,287	**4,447**		**598**		65.78 /cy	**6,332**	**3,575**	**103 /cy**	**9,907**	0.00%
					Spoils to Waste	285.43 cy	**34**	3,497			**781**		14.99 /cy	**4,278**	**2,975**	**25 /cy**	**7,253**	0.00%
					Backfill Trench-Backhoe/Truck	982.215 cy	**118**	14,012			**2,472**		16.78 /cy	**16,484**	**11,371**	**28 /cy**	**27,855**	0.00%
					Trench Box 12' Deep (piggy back)	261 lf					**6,264**		24.00 /lf	**6,264**	**3,310**	**37 /lf**	**9,574**	0.00%
					Div. 31 Earthwork	**1,078.590 cy**	**236**	**27,415**	**4,447**		**11,122**		**39.85 /cy**	**42,984**	**27,958**	**65.77 /cy**	**70,942**	**0.00%**
				Div. 40	**Process Integration (Process Piping)**													
					Prestressed Conc Pipe 74	260.015 lf	**1,524**		**165,039**				634.73 /lf	**165,039**	**102,370**	**1,028 /lf**	**267,410**	0.01%
					PCCP 45 deg ell 72	4 ea	**1**		**2,800**				700.00 /ea	**2,800**	**1,476**	**1,069 /ea**	**4,276**	0.00%
					PCCP 90 deg ell 72	2 ea	**1**		**1,600**				800.00 /ea	**1,600**	**843**	**1,221 /ea**	**2,443**	0.00%
					Div. 40 Process Integration (Process Piping)	**150.000 mgd**	**1,525**		**169,439**				**1,129.60 /mgd**	**169,439**	**104,689**	**1,827.52 /mgd**	**274,128**	**0.01%**
					Yard Piping Yard Piping	**260.000 lf**	**1,762**	**27,415**	**173,886**		**11,122**		**817.01 /lf**	**212,423**	**132,647**	**1,327.19 /lf**	**345,070**	**0.01%**
					190.-260 UV/AOP to Wetwell Piping	**260.000 lf**	**1,762**	**27,415**	**173,886**		**11,122**		**817.01 /lf**	**212,423**	**132,647**	**1,327.19 /lf**	**345,070**	**0.01%**
		270.-280			**Effluent Pump to Distribution Piping**													
			Yard Piping		**Yard Piping**													
				Div. 31	**Earthwork**													
					Trench Excav & Lay Pipe 10-12'	1160.005 lf	**325**	38,453			**4,494**		37.02 /lf	**42,947**	**30,011**	**63 /lf**	**72,958**	0.00%
					CY Trench Excavation (Volume Calculation Only)	***4,810.220 cy***							***/cy***			***/cy***		
					Utility Bed Stone 1/2"	429.525 cy	**52**	5,744	**19,844**		**2,667**		65.78 /cy	**28,255**	**15,954**	**103 /cy**	**44,210**	0.00%
					Spoils to Waste	1272.82 cy	**153**	15,594			**3,483**		14.99 /cy	**19,077**	**13,268**	**25 /cy**	**32,345**	0.00%
					Backfill Trench-Backhoe/Truck	4380.695 cy	**526**	62,493			**11,024**		16.78 /cy	**73,517**	**50,715**	**28 /cy**	**124,232**	0.00%
					Trench Box 12' Deep (piggy back)	1160.005 lf					**27,840**		24.00 /lf	**27,840**	**14,709**	**37 /lf**	**42,549**	0.00%
					Div. 31 Earthwork	**4,810.220 cy**	**1,055**	**122,284**	**19,844**		**49,508**		**39.84 /cy**	**191,636**	**124,657**	**65.75 /cy**	**316,294**	**0.01%**
				Div. 40	**Process Integration (Process Piping)**													

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Prestressed Conc Pipe 74	1160.005 lf	6,798		736,290				634.73 /lf	736,290	456,705	1,028 /lf	1,192,994	0.03%
					PCCP 45 deg ell 72	9 ea	2		6,300				700.00 /ea	6,300	3,321	1,069 /ea	9,621	0.00%
					PCCP 90 deg ell 72	4 ea	1		3,200				800.00 /ea	3,200	1,685	1,221 /ea	4,885	0.00%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	6,801		745,790				4,971.93 /mgd	745,790	461,710	8,050.00 /mgd	1,207,500	0.03%
					Yard Piping Yard Piping	1,160.000 lf	7,856	122,284	765,634		49,508		808.13 /lf	937,426	586,368	1,313.62 /lf	1,523,794	0.03%
					270.-280 Effluent Pump to Distribution Piping	1,160.000 lf	7,856	122,284	765,634		49,508		808.13 /lf	937,426	586,368	1,313.62 /lf	1,523,794	0.03%
		500.			Yard Piping Percentage Adder													
		Unidentified Process Yard Pipe			Unidentified Process Yard Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Yard Piping	1 ls			32,154,701			299,322	32,454,022.29 /ls	32,454,022	16,984,460	49,438,482 /ls	49,438,482	1.12%
					Estimate Placeholder - Additional Unidentified Yard Pipe Installation Labor/Equip.	1 ls	74,510	7,451,026		718,374	2,148,871		10,318,270.41 /ls	10,318,270	6,629,632	16,947,902 /ls	16,947,902	0.38%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	74,510	7,451,026	32,154,701	718,374	2,148,871	299,322	285,148.62 /mgd	42,772,293	23,614,092	442,575.90 /mgd	66,386,385	1.50%
					Unidentified Process Yard Pipe Unidentified Process Yard Pipe	1.000 ls	74,510	7,451,026	32,154,701	718,374	2,148,871	299,322	42,772,292.70 /ls	42,772,293	23,614,092	66,386,384.83 /ls	66,386,385	1.50%
					500. Yard Piping Percentage Adder	1.000 ls	74,510	7,451,026	32,154,701	718,374	2,148,871	299,322	42,772,292.70 /ls	42,772,293	23,614,092	66,386,384.83 /ls	66,386,385	1.50%
					008. - Yard Piping Yard Piping	150.000 MGD	100,691	8,235,331	35,539,347	793,991	2,375,063	330,829	315,163.75 /MGD	47,274,562	26,315,815	490,602.51 /MGD	73,590,377	1.67%
	009. - MBR				Membrane Bioreactor													
		010.			Filtrate Pump													
			Feed Pump		Feed Pump													
				Div. 46	Water and Wastewater Equipment													
					Filtrate Pumps 24 DUTY + 1 SB = 150 MGD	25 ea	6,000	625,464	150,000		49,856	12,500,000	533,012.78 /ea	13,325,320	7,103,629	817,158 /ea	20,428,948	0.46%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	6,000	625,464	150,000		49,856	12,500,000	88,835.46 /mgd	13,325,320	7,103,629	136,192.99 /mgd	20,428,948	0.46%
					Feed Pump Feed Pump	25.000 ea	6,000	625,464	150,000		49,856	12,500,000	533,012.78 /ea	13,325,320	7,103,629	817,157.93 /ea	20,428,948	0.46%
					010. Filtrate Pump	150.000 MGD	6,000	625,464	150,000		49,856	12,500,000	88,835.46 /MGD	13,325,320	7,103,629	136,192.99 /MGD	20,428,948	0.46%
		020-2.			Membrane Tanks for MBR													
			Elevated Slab		Elevated Slab													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	71974 sf	1,439	137,010	61,178				2.75 /sf	198,188	129,338	5 /sf	327,526	0.01%
					Form Suspended Slab 15-up	71974 sf	17,994	1,624,597	169,283				24.92 /sf	1,793,880	1,301,035	43 /sf	3,094,915	0.07%
					Slab Edge Form > 1'	3886.596 sf	972	87,728	11,660				25.57 /sf	99,388	71,574	44 /sf	170,962	0.00%
					Pour Strips	75860.596 lf	3,793	339,772	318,615				8.68 /lf	658,387	420,630	14 /lf	1,079,016	0.02%
					Strip & Oil Suspended Slab Frm	71974 sf	360	32,236	5,038				0.52 /sf	37,275	26,725	1 /sf	63,999	0.00%
					Suspended Slab Rebar	503.818 tn	15,115	1,549,422	952,216				4,965.36 /tn	2,501,638	1,633,185	8,207 /tn	4,134,822	0.09%
					Finish- Hard Trowel	71974 sf	1,655	148,256					2.06 /sf	148,256	110,784	4 /sf	259,041	0.01%
					Pump Place Suspended Slab	5326.076 cy	6,924	735,401			27,806		143.30 /cy	763,207	550,701	247 /cy	1,313,908	0.03%
					4500 psi Concrete	5326.076 cy			1,118,476				210.00 /cy	1,118,476	585,342	320 /cy	1,703,818	0.04%
					Liquid Curing Compounds	71974 sf	216	19,342	56,680				1.06 /sf	76,021	44,115	2 /sf	120,137	0.00%
					Div. 03 Concrete	71,974.000 hsf	48,467	4,673,764	2,693,145		27,806		102.74 /hsf	7,394,715	4,873,430	170.45 /hsf	12,268,145	0.28%
					Elevated Slab Elevated Slab	5,326.080 cy	48,467	4,673,764	2,693,145		27,806		1,388.40 /cy	7,394,715	4,873,430	2,303.41 /cy	12,268,145	0.28%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	4476 sf	895	80,826	6,815				19.58 /sf	87,641	63,887	34 /sf	151,528	0.00%
					Keyway 4"	1492 lf	75	6,735	736				5.01 /lf	7,472	5,412	9 /lf	12,884	0.00%
					Waterstop 6" Bulb	1492 lf	149	13,365	8,648				14.75 /lf	22,013	14,512	24 /lf	36,525	0.00%
					Strip & Oil Footing Forms	4476 sf	22	2,005	313				0.52 /sf	2,318	1,662	1 /sf	3,980	0.00%
					Footing Rebar	27.602 tn	552	56,591	52,168				3,940.23 /tn	108,758	68,750	6,431 /tn	177,509	0.00%
					Pump Place Wall Footings	235.736 cy	131	13,896			1,131		63.75 /cy	15,028	10,726	109 /cy	25,754	0.00%
					4500 psi Concrete	235.736 cy			49,505				210.00 /cy	49,505	25,908	320 /cy	75,412	0.00%
					Div. 03 Concrete	4,476.000 hsf	1,824	173,418	118,184		1,131		65.40 /hsf	292,733	190,858	108.04 /hsf	483,591	0.01%
					Footing Footing	235.740 cy	1,824	173,418	118,184		1,131		1,241.76 /cy	292,733	190,858	2,051.38 /cy	483,591	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	2198.768 lf	110	9,926	1,085				5.01 /lf	11,011	7,976	9 /lf	18,987	0.00%
					Rented Form System 16'->	84568 sf	21,142	1,908,869	887,964				33.07 /sf	2,796,833	1,889,302	55 /sf	4,686,135	0.11%
					Wall Bulkhead Forms	4143.832 sf	2,279	205,776	21,755				54.91 /sf	227,531	164,957	95 /sf	392,488	0.01%
					Waterstop 6" Bulb	4143.832 lf	414	37,120	24,018				14.75 /lf	61,137	40,306	24 /lf	101,443	0.00%
					Strip & Oil Wall Forms	84568 sf	423	37,877	5,920				0.52 /sf	43,797	31,401	1 /sf	75,198	0.00%
					Hot Water Charge	3213.584 cy			26,994				8.40 /cy	26,994	14,127	13 /cy	41,121	0.00%
					Wall Rebar	169.136 tn	3,890	398,785	319,667				4,247.78 /tn	718,452	459,379	6,964 /tn	1,177,831	0.03%
					Finish- Top of Wall & Curb	3551.856 sf	195	17,496					4.93 /sf	17,496	13,074	9 /sf	30,569	0.00%
					Pump Place Walls	3213.584 cy	4,499	477,850			23,129		155.89 /cy	500,978	360,509	268 /cy	861,487	0.02%
					4500 psi Concrete	3213.584 cy			674,853				210.00 /cy	674,853	353,177	320 /cy	1,028,029	0.02%
					Grind/Patch Walls	84568 sf	6,765	605,933	2,960				7.20 /sf	608,893	454,330	13 /sf	1,063,223	0.02%
					Liquid Curing Compounds	84568 sf	254	22,726	66,597				1.06 /sf	89,324	51,835	2 /sf	141,158	0.00%
					Div. 03 Concrete	84,568.000 hsf	39,972	3,722,357	2,031,813		23,129		68.32 /hsf	5,777,299	3,840,371	113.73 /hsf	9,617,670	0.22%
					Foundation Wall Foundation Wall	3,213.580 cy	39,972	3,722,357	2,031,813		23,129		1,797.78 /cy	5,777,299	3,840,371	2,992.82 /cy	9,617,670	0.22%
			Interior Tank Walls 1' Thk		Interior Tank Walls 1' Thk													
				Div. 03	Concrete													
					Keyway 4"	3213.6 lf	161	14,507	1,586				5.01 /lf	16,093	11,657	9 /lf	27,750	0.00%
					Rented Form System 16'->	123600 sf	30,900	2,789,899	1,297,800				33.07 /sf	4,087,699	2,761,302	55 /sf	6,849,001	0.16%
					Wall Bulkhead Forms	3090 sf	1,700	153,444	16,223				54.91 /sf	169,667	123,006	95 /sf	292,673	0.01%
					Waterstop 6" Bulb	6056.4 lf	606	54,252	35,103				14.75 /lf	89,355	58,909	24 /lf	148,264	0.00%
					Strip & Oil Wall Forms	123600 sf	618	55,359	8,652				0.52 /sf	64,011	45,894	1 /sf	109,905	0.00%
					Hot Water Charge	4696.8 cy			39,453				8.40 /cy	39,453	20,647	13 /cy	60,100	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Wall Rebar	247.2 tn	5,686	582,842	467,208				4,247.78 /tn	1,050,050	671,403	6,964 /tn	1,721,453	0.04%
					Finish- Top of Wall & Curb	2595.6 sf	143	12,785					4.93 /sf	12,785	9,554	9 /sf	22,339	0.00%
					Pump Place Walls	4696.8 cy	6,576	698,399			33,804		155.89 /cy	732,203	526,901	268 /cy	1,259,103	0.03%
					4500 psi Concrete	4696.8 cy			986,328				210.00 /cy	986,328	516,184	320 /cy	1,502,512	0.03%
					Grind/Patch Walls	123600 sf	9,888	885,599	4,326				7.20 /sf	889,925	664,023	13 /sf	1,553,948	0.04%
					Liquid Curing Compounds	123600 sf	371	33,216	97,335				1.06 /sf	130,551	75,759	2 /sf	206,309	0.00%
					Div. 03 Concrete	**123,600.000 hsf**	**56,646**	**5,280,303**	**2,954,013**		**33,804**		**66.89 /hsf**	**8,268,120**	**5,485,238**	**111.27 /hsf**	**13,753,359**	**0.31%**
					Interior Tank Walls 1' Thk Interior Tank Walls 1' Thk	**4,696.800 cy**	**56,646**	**5,280,303**	**2,954,013**		**33,804**		**1,760.37 /cy**	**8,268,120**	**5,485,238**	**2,928.24 /cy**	**13,753,359**	**0.31%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	5763.84 sf	1,960	176,938	8,775				32.22 /sf	185,713	136,642	56 /sf	322,355	0.01%
					S-O-G Const Joints > 1'	10807.2 sf	3,891	351,274	16,454				34.03 /sf	367,728	270,768	59 /sf	638,496	0.01%
					Strip & Oil SOG Form	16571.04 sf	83	7,422	1,160				0.52 /sf	8,582	6,153	1 /sf	14,735	0.00%
					SOG Rebar	504.336 tn	7,565	775,507	953,195				3,427.68 /tn	1,728,703	1,066,854	5,543 /tn	2,795,557	0.06%
					Mesh Support - bricks	8285.52 ea	17	1,699	4,263				0.72 /ea	5,962	3,475	1 /ea	9,437	0.00%
					Finish- Hard Trowel	72048 sf	1,657	148,409					2.06 /sf	148,409	110,898	4 /sf	259,307	0.01%
					Pump Place Slab on Grade	7997.328 cy	9,597	1,019,295			23,030		130.33 /cy	1,042,325	755,099	225 /cy	1,797,424	0.04%
					4500 psi Concrete	7997.328 cy			1,679,439				210.00 /cy	1,679,439	878,916	320 /cy	2,558,355	0.06%
					Liquid Curing Compounds	72048 sf	216	19,362	56,738				1.06 /sf	76,100	44,161	2 /sf	120,260	0.00%
					Seal Floors	72048 sf	360	32,270	15,130				0.66 /sf	47,400	32,031	1 /sf	79,430	0.00%
					Div. 03 Concrete	**72,048.000 hsf**	**25,345**	**2,532,174**	**2,735,154**		**23,030**		**73.43 /hsf**	**5,290,359**	**3,304,997**	**119.30 /hsf**	**8,595,356**	**0.19%**
					Slab Slab	**7,997.330 cy**	**25,345**	**2,532,174**	**2,735,154**		**23,030**		**661.52 /cy**	**5,290,359**	**3,304,997**	**1,074.78 /cy**	**8,595,356**	**0.19%**
					020-2. Membrane Tanks for MBR	**72,048.000 hsf**	**172,255**	**16,382,017**	**10,532,310**		**108,899**		**375.07 /hsf**	**27,023,226**	**17,694,894**	**620.67 /hsf**	**44,718,120**	**1.01%**
		020-3.			**Bioreactor Tanks fro MBR**													
			Elevated Slab		**Elevated Slab**													
				Div. 03	**Concrete**													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	420000 sf	8,400	799,512	357,000				2.75 /sf	1,156,512	754,747	5 /sf	1,911,259	0.04%
					Form Suspended Slab 15-up	420000 sf	105,000	9,480,240	987,840				24.92 /sf	10,468,080	7,592,113	43 /sf	18,060,193	0.41%
					Slab Edge Form > 1'	22680 sf	5,670	511,933	68,040				25.57 /sf	579,973	417,665	44 /sf	997,638	0.02%
					Pour Strips	442680 lf	22,134	1,982,719	1,859,256				8.68 /lf	3,841,975	2,454,560	14 /lf	6,296,535	0.14%
					Strip & Oil Suspended Slab Frm	420000 sf	2,100	188,114	29,400				0.52 /sf	217,514	155,950	1 /sf	373,463	0.01%
					Suspended Slab Rebar	2940 tn	88,200	9,041,558	5,556,600				4,965.36 /tn	14,598,158	9,530,351	8,207 /tn	24,128,509	0.55%
					Finish- Hard Trowel	420000 sf	9,660	865,140					2.06 /sf	865,140	646,476	4 /sf	1,511,616	0.03%
					Pump Place Suspended Slab	31080 cy	40,404	4,291,390			162,258		143.30 /cy	4,453,648	3,213,584	247 /cy	7,667,232	0.17%
					4500 psi Concrete	31080 cy			6,526,800				210.00 /cy	6,526,800	3,415,730	320 /cy	9,942,530	0.23%
					Liquid Curing Compounds	420000 sf	1,260	112,868	330,750				1.06 /sf	443,618	257,432	2 /sf	701,051	0.02%
					Div. 03 Concrete	**420,000.000 hsf**	**282,828**	**27,273,474**	**15,715,686**		**162,258**		**102.74 /hsf**	**43,151,419**	**28,438,608**	**170.45 /hsf**	**71,590,027**	**1.62%**
					Elevated Slab Elevated Slab	**31,080.000 cy**	**282,828**	**27,273,474**	**15,715,686**		**162,258**		**1,388.40 /cy**	**43,151,419**	**28,438,608**	**2,303.41 /cy**	**71,590,027**	**1.62%**
			Footing		**Footing**													
				Div. 03	**Concrete**													
					Continuous Footing Forms > 12"	8200.92 sf	1,640	148,089	12,486				19.58 /sf	160,575	117,054	34 /sf	277,628	0.01%
					Keyway 4"	2735.46 lf	137	12,349	1,350				5.01 /lf	13,699	9,923	9 /lf	23,622	0.00%
					Waterstop 6" Bulb	2735.46 lf	274	24,504	15,855				14.75 /lf	40,358	26,607	24 /lf	66,966	0.00%
					Strip & Oil Footing Forms	8200.92 sf	41	3,673	574				0.52 /sf	4,247	3,045	1 /sf	7,292	0.00%
					Footing Rebar	16.38 tn	328	33,583	30,958				3,940.24 /tn	64,541	40,799	6,431 /tn	105,340	0.00%
					Pump Place Wall Footings	455.91 cy	253	26,875			2,188		63.75 /cy	29,063	20,744	109 /cy	49,807	0.00%
					4500 psi Concrete	455.91 cy			95,741				210.00 /cy	95,741	50,105	320 /cy	145,846	0.00%
					Div. 03 Concrete	**8,200.920 hsf**	**2,672**	**249,072**	**156,964**		**2,188**		**49.78 /hsf**	**408,225**	**268,277**	**82.49 /hsf**	**676,502**	**0.02%**
					Footing Footing	**455.910 cy**	**2,672**	**249,072**	**156,964**		**2,188**		**895.41 /cy**	**408,225**	**268,277**	**1,483.85 /cy**	**676,502**	**0.02%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	**Concrete**													
					Keyway 4"	3832.92 lf	192	17,303	1,892				5.01 /lf	19,195	13,903	9 /lf	33,098	0.00%
					Rented Form System 16'->	147420 sf	36,855	3,327,564	1,547,910				33.07 /sf	4,875,474	3,293,455	55 /sf	8,168,930	0.19%
					Wall Bulkhead Forms	7223.58 sf	3,973	358,711	37,924				54.91 /sf	396,635	287,555	95 /sf	684,190	0.02%
					Waterstop 6" Bulb	7223.58 lf	722	64,707	41,868				14.75 /lf	106,575	70,262	24 /lf	176,837	0.00%
					Strip & Oil Wall Forms	147420 sf	737	66,028	10,319				0.52 /sf	76,347	54,738	1 /sf	131,086	0.00%
					Hot Water Charge	5601.96 cy			47,056				8.40 /cy	47,056	24,626	13 /cy	71,683	0.00%
					Wall Rebar	294.84 tn	6,781	695,167	557,248				4,247.78 /tn	1,252,414	800,795	6,964 /tn	2,053,209	0.05%
					Finish- Top of Wall & Curb	6191.64 sf	341	30,498					4.93 /sf	30,498	22,790	9 /sf	53,288	0.00%
					Pump Place Walls	5601.96 cy	7,843	832,994			40,318		155.89 /cy	873,312	628,444	268 /cy	1,501,756	0.03%
					4500 psi Concrete	5601.96 cy			1,176,412				210.00 /cy	1,176,412	615,662	320 /cy	1,792,074	0.04%
					Grind/Patch Walls	147420 sf	11,794	1,056,270	5,160				7.20 /sf	1,061,430	791,993	13 /sf	1,853,423	0.04%
					Liquid Curing Compounds	147420 sf	442	39,617	116,093				1.06 /sf	155,710	90,359	2 /sf	246,069	0.01%
					Div. 03 Concrete	**147,420.000 hsf**	**69,680**	**6,488,860**	**3,541,881**		**40,318**		**68.32 /hsf**	**10,071,059**	**6,694,583**	**113.73 /hsf**	**16,765,642**	**0.38%**
					Foundation Wall Foundation Wall	**5,601.960 cy**	**69,680**	**6,488,860**	**3,541,881**		**40,318**		**1,797.77 /cy**	**10,071,059**	**6,694,583**	**2,992.82 /cy**	**16,765,642**	**0.38%**
			Interior Tank Walls 1' Thk		**Interior Tank Walls 1' Thk**													
				Div. 03	**Concrete**													
					Keyway 4"	5751.2 lf	288	25,963	2,838				5.01 /lf	28,801	20,862	9 /lf	49,663	0.00%
					Rented Form System 16'->	221200 sf	55,300	4,992,926	2,322,600				33.07 /sf	7,315,526	4,941,747	55 /sf	12,257,273	0.28%
					Wall Bulkhead Forms	5530 sf	3,042	274,611	29,033				54.91 /sf	303,643	220,137	95 /sf	523,780	0.01%
					Waterstop 6" Bulb	10838.8 lf	1,084	97,092	62,822				14.75 /lf	159,913	105,427	24 /lf	265,340	0.01%
					Strip & Oil Wall Forms	221200 sf	1,106	99,073	15,484				0.52 /sf	114,557	82,133	1 /sf	196,691	0.00%
					Hot Water Charge	8405.6 cy			70,607				8.40 /cy	70,607	36,951	13 /cy	107,558	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Wall Rebar	442.4 tn	10,175	1,043,080	836,136				4,247.78 /tn	1,879,216	1,201,572	6,964 /tn	3,080,788	0.07%
					Finish- Top of Wall & Curb	4645.2 sf	255	22,881					4.93 /sf	22,881	17,098	9 /sf	39,979	0.00%
					Pump Place Walls	8405.6 cy	11,768	1,249,886			60,496		155.89 /cy	1,310,382	942,964	268 /cy	2,253,346	0.05%
					4500 psi Concrete	8405.6 cy			1,765,176				210.00 /cy	1,765,176	923,786	320 /cy	2,688,962	0.06%
					Grind/Patch Walls	221200 sf	17,696	1,584,907	7,742				7.20 /sf	1,592,649	1,188,366	13 /sf	2,781,014	0.06%
					Liquid Curing Compounds	221200 sf	664	59,444	174,195				1.06 /sf	233,639	135,581	2 /sf	369,220	0.01%
					Div. 03 Concrete	**221,200.000 hsf**	**101,377**	**9,449,863**	**5,286,632**		**60,496**		**66.89 /hsf**	**14,796,992**	**9,816,624**	**111.27 /hsf**	**24,613,616**	**0.56%**
					Interior Tank Walls 1' Thk Interior Tank Walls 1' Thk	**8,405.600 cy**	**101,377**	**9,449,863**	**5,286,632**		**60,496**		**1,760.37 /cy**	**14,796,992**	**9,816,624**	**2,928.24 /cy**	**24,613,616**	**0.56%**
			Slab		**Slab**													
				Div. 03	**Concrete**													
					S.O.G. Edge Form > 1'	33600 sf	11,424	1,031,450	51,156				32.22 /sf	1,082,606	796,547	56 /sf	1,879,153	0.04%
					S-O-G Const Joints > 1'	63000 sf	22,680	2,047,732	95,918				34.03 /sf	2,143,649	1,578,427	59 /sf	3,722,076	0.08%
					Strip & Oil SOG Form	96600 sf	483	43,266	6,762				0.52 /sf	50,028	35,868	1 /sf	85,897	0.00%
					SOG Rebar	2940 tn	44,100	4,520,779	5,556,600				3,427.68 /tn	10,077,379	6,219,168	5,543 /tn	16,296,548	0.37%
					Mesh Support - bricks	48300 ea	97	9,903	24,850				0.72 /ea	34,753	20,258	1 /ea	55,011	0.00%
					Finish- Hard Trowel	420000 sf	9,660	865,140					2.06 /sf	865,140	646,476	4 /sf	1,511,616	0.03%
					Pump Place Slab on Grade	46620 cy	55,944	5,941,924			134,253		130.33 /cy	6,076,177	4,401,809	225 /cy	10,477,986	0.24%
					4500 psi Concrete	46620 cy			9,790,200				210.00 /cy	9,790,200	5,123,595	320 /cy	14,913,795	0.34%
					Liquid Curing Compounds	420000 sf	1,260	112,868	330,750				1.06 /sf	443,618	257,432	2 /sf	701,051	0.02%
					Seal Floors	420000 sf	2,100	188,114	88,200				0.66 /sf	276,314	186,722	1 /sf	463,036	0.01%
					Div. 03 Concrete	**420,000.000 hsf**	**147,748**	**14,761,176**	**15,944,436**		**134,253**		**73.43 /hsf**	**30,839,865**	**19,266,304**	**119.30 /hsf**	**50,106,169**	**1.14%**
					Slab Slab	**46,620.000 cy**	**147,748**	**14,761,176**	**15,944,436**		**134,253**		**661.52 /cy**	**30,839,865**	**19,266,304**	**1,074.78 /cy**	**50,106,169**	**1.14%**
					020-3. Bioreactor Tanks fro MBR	**420,000.000 hsf**	**604,304**	**58,222,446**	**40,645,600**		**399,513**		**236.35 /hsf**	**99,267,559**	**64,484,396**	**389.89 /hsf**	**163,751,955**	**3.71%**
		020-4.			**MBR - Odor Control Facility**													
			Building		**Building**													
				Div. 04	**Masonry**													
					Interior Staging over 10 '	10500 sf	53	5,421	5,250				1.02 /sf	10,671	6,552	2 /sf	17,223	0.00%
					Staging to 30'	10500 sf	53	5,421	7,875				1.27 /sf	13,296	7,925	2 /sf	21,222	0.00%
					Rub Block	10500 sf	140	14,453					1.38 /sf	14,453	10,575	2 /sf	25,028	0.00%
					Mortar	756 cf			5,898				7.80 /cf	5,898	3,087	12 /cf	8,985	0.00%
					Mortar	1260 cf			9,830				7.80 /cf	9,830	5,144	12 /cf	14,974	0.00%
					Grout Fill 10" Block Cells	6499.5 cf	1,950	201,343	41,288				37.33 /cf	242,632	168,929	63 /cf	411,561	0.01%
					Grout Fill 10"Lintel Block	52.5 cf	16	1,626	334				37.33 /cf	1,960	1,365	63 /cf	3,324	0.00%
					Grout Fill 10 "Bond Beam	84 cf	25	2,602	534				37.33 /cf	3,136	2,183	63 /cf	5,319	0.00%
					Dur-O-Wall 10"	8536.5 lf			3,944				0.46 /lf	3,944	2,064	1 /lf	6,008	0.00%
					Wall Ties	12148.5 ea	162	16,722	1,531				1.50 /ea	18,253	13,036	3 /ea	31,289	0.00%
					Extruded Control Joints 1/2"	1018.5 lf	6	601	2,385				2.93 /lf	2,985	1,688	5 /lf	4,673	0.00%
					Masonry Rebar # 5	189 lbs	2	234	133				1.94 /lbs	367	241	3 /lbs	608	0.00%
					Masonry Rebar # 5	49539 lbs	594	61,385	34,875				1.94 /lbs	96,261	63,167	3 /lbs	159,428	0.00%
					Standard Brick	70255.5 ea	2,810	290,192	73,768				5.18 /ea	363,960	250,937	9 /ea	614,898	0.01%
					10" Block Bond Beam	367.5 ea	31	3,169	8,431				31.57 /ea	11,601	6,732	50 /ea	18,332	0.00%
					10" Block Lintels	136.5 ea	11	1,177	3,132				31.57 /ea	4,309	2,500	50 /ea	6,809	0.00%
					10" Fire Rated 3 hr	10783.5 ea	901	93,001	76,994				15.76 /ea	169,995	108,342	26 /ea	278,337	0.01%
					Div. 04 Masonry	**10,500.000 vsf**	**6,753**	**697,349**	**276,201**				**92.72 /vsf**	**973,550**	**654,467**	**155.05 /vsf**	**1,628,017**	**0.04%**
				Div. 05 -15	**Div 5/6/7/8/9/10/11/12/22/23**													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	12060 sf				2,854,602			236.70 /sf	2,854,602	958,687	316 /sf	3,813,289	0.09%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	**12,060.000 hsf**				**2,854,602**			**236.70 /hsf**	**2,854,602**	**958,687**	**316.19 /hsf**	**3,813,289**	**0.09%**
					Building Building	**12,060.000 hsf**	**6,753**	**697,349**	**276,201**	**2,854,602**			**317.43 /hsf**	**3,828,152**	**1,613,154**	**451.19 /hsf**	**5,441,306**	**0.12%**
			Footing		**Footing**													
				Div. 03	**Concrete**													
					Continuous Footing Forms > 12"	1500 sf	300	27,086	2,284				19.58 /sf	29,370	21,410	34 /sf	50,780	0.00%
					Keyway 4"	500 lf	25	2,257	247				5.01 /lf	2,504	1,814	9 /lf	4,318	0.00%
					Waterstop 6" Bulb	500 lf	50	4,479	2,898				14.75 /lf	7,377	4,863	24 /lf	12,240	0.00%
					Strip & Oil Footing Forms	1500 sf	8	672	105				0.52 /sf	777	557	1 /sf	1,334	0.00%
					Footing Rebar	9.5 tn	190	19,477	17,955				3,940.24 /tn	37,432	23,662	6,431 /tn	61,095	0.00%
					Pump Place Wall Footings	79 cy	44	4,657			379		63.75 /cy	5,036	3,595	109 /cy	8,631	0.00%
					4500 psi Concrete	79 cy			16,590				210.00 /cy	16,590	8,682	320 /cy	25,272	0.00%
					Div. 03 Concrete	**1,500.000 hsf**	**616**	**58,628**	**40,079**		**379**		**66.06 /hsf**	**99,086**	**64,583**	**109.11 /hsf**	**163,669**	**0.00%**
					Footing Footing	**79.000 cy**	**616**	**58,628**	**40,079**		**379**		**1,254.26 /cy**	**99,086**	**64,583**	**2,071.76 /cy**	**163,669**	**0.00%**
			Foundation Wall		**Foundation Wall**													
				Div. 03	**Concrete**													
					Keyway 4"	130 lf	7	587	64				5.01 /lf	651	472	9 /lf	1,123	0.00%
					Rented Form System 16'->	5000 sf	1,250	112,860	52,500				33.07 /sf	165,360	111,703	55 /sf	277,063	0.01%
					Wall Bulkhead Forms	245 sf	135	12,166	1,286				54.91 /sf	13,453	9,753	95 /sf	23,206	0.00%
					Waterstop 6" Bulb	245 lf	25	2,195	1,420				14.75 /lf	3,615	2,383	24 /lf	5,998	0.00%
					Strip & Oil Wall Forms	5000 sf	25	2,239	350				0.52 /sf	2,589	1,857	1 /sf	4,446	0.00%
					Hot Water Charge	190 cy			1,596				8.40 /cy	1,596	835	13 /cy	2,431	0.00%
					Wall Rebar	10 tn	230	23,578	18,900				4,247.78 /tn	42,478	27,160	6,964 /tn	69,638	0.00%
					Finish- Top of Wall & Curb	210 sf	12	1,034					4.93 /sf	1,034	773	9 /sf	1,807	0.00%
					Pump Place Walls	190 cy	266	28,252			1,367		155.89 /cy	29,620	21,315	268 /cy	50,935	0.00%
					4500 psi Concrete	190 cy			39,900				210.00 /cy	39,900	20,881	320 /cy	60,781	0.00%
					Grind/Patch Walls	5000 sf	400	35,825	175				7.20 /sf	36,000	26,862	13 /sf	62,862	0.00%
					Liquid Curing Compounds	5000 sf	15	1,344	3,938				1.06 /sf	5,281	3,065	2 /sf	8,346	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 03 Concrete	5,000.000 hsf	2,363	220,081	120,129		1,367		68.32 /hsf	341,577	227,058	113.73 /hsf	568,635	0.01%
					Foundation Wall Foundation Wall	190.000 cy	2,363	220,081	120,129		1,367		1,797.77 /cy	341,577	227,058	2,992.82 /cy	568,635	0.01%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	964.8 sf	328	29,617	1,469				32.22 /sf	31,086	22,872	56 /sf	53,959	0.00%
					S-O-G Const Joints > 1'	1809 sf	651	58,799	2,754				34.03 /sf	61,553	45,323	59 /sf	106,877	0.00%
					Strip & Oil SOG Form	2773.8 sf	14	1,242	194				0.52 /sf	1,437	1,030	1 /sf	2,466	0.00%
					SOG Rebar	84.42 tn	1,266	129,811	159,554				3,427.68 /tn	289,365	178,579	5,543 /tn	467,944	0.01%
					Mesh Support - bricks	1386.9 ea	3	284	714				0.72 /ea	998	582	1 /ea	1,580	0.00%
					Finish- Hard Trowel	12060 sf	277	24,842					2.06 /sf	24,842	18,563	4 /sf	43,405	0.00%
					Pump Place Slab on Grade	1338.66 cy	1,606	170,618			3,855		130.33 /cy	174,473	126,395	225 /cy	300,868	0.01%
					4500 psi Concrete	1338.66 cy			281,119				210.00 /cy	281,119	147,120	320 /cy	428,239	0.01%
					Liquid Curing Compounds	12060 sf	36	3,241	9,497				1.06 /sf	12,738	7,392	2 /sf	20,130	0.00%
					Seal Floors	12060 sf	60	5,402	2,533				0.66 /sf	7,934	5,362	1 /sf	13,296	0.00%
					Div. 03 Concrete	12,060.000 hsf	4,242	423,857	457,833		3,855		73.43 /hsf	885,545	553,218	119.30 /hsf	1,438,763	0.03%
					Slab Slab	1,338.660 cy	4,242	423,857	457,833		3,855		661.52 /cy	885,545	553,218	1,074.78 /cy	1,438,763	0.03%
					020-4. MBR - Odor Control Facility	12,060.000 hsf	13,975	1,399,915	894,242	2,854,602	5,602		427.39 /hsf	5,154,360	2,458,014	631.21 /hsf	7,612,374	0.17%
		050.C			Process Components													
			Air Scour Blower		Air Scour Blower													
				Div. 46	Water and Wastewater Equipment													
					Blower 800 hp 5 duty + 1 SB	6 ea	2,400	266,291			8,135	1,680,000	325,737.52 /ea	1,954,425	1,076,473	505,150 /ea	3,030,898	0.07%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	2,400	266,291			8,135	1,680,000	13,029.50 /mgd	1,954,425	1,076,473	20,205.99 /mgd	3,030,898	0.07%
					Air Scour Blower Air Scour Blower	6.000 ea	2,400	266,291			8,135	1,680,000	325,737.52 /ea	1,954,425	1,076,473	505,149.70 /ea	3,030,898	0.07%
			Blower / Compressor System		Blower / Compressor System													
				Div. 46	Water and Wastewater Equipment													
					Package Air Compressor 200cfm 1 duty + 1 SB	2 ea	80	8,876	12,000		1,356	55,000	38,616.04 /ea	77,232	42,212	59,722 /ea	119,444	0.00%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	80	8,876	12,000		1,356	55,000	514.88 /mgd	77,232	42,212	796.30 /mgd	119,444	0.00%
					Blower / Compressor System Blower / Compressor System	1.000 ls	80	8,876	12,000		1,356	55,000	77,232.08 /ls	77,232	42,212	119,444.25 /ls	119,444	0.00%
			Diffuser System		Diffuser System													
				Div. 46	Water and Wastewater Equipment													
					Furnish & Install Distribution Systems & Diffusers (fine bublers)	155136 sf	19,392	1,835,620	1,939,200		297,582	1,551,360	36.25 /sf	5,623,761	3,344,044	58 /sf	8,967,805	0.20%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	19,392	1,835,620	1,939,200		297,582	1,551,360	37,491.74 /mgd	5,623,761	3,344,044	59,785.37 /mgd	8,967,805	0.20%
					Diffuser System Diffuser System	155,136.000 hsf	19,392	1,835,620	1,939,200		297,582	1,551,360	36.25 /hsf	5,623,761	3,344,044	57.81 /hsf	8,967,805	0.20%
			Membranes		Membranes													
				Div. 46	Water and Wastewater Equipment													
					Membrane System	177 MGD	113,280	11,808,760	40,168		941,272	43,472,353	317,867.53 /MGD	56,262,553	31,898,183	498,083 /MGD	88,160,736	2.00%
					Div. 46 Water and Wastewater Equipment	177.000 mgd	113,280	11,808,760	40,168		941,272	43,472,353	317,867.53 /mgd	56,262,553	31,898,183	498,083.25 /mgd	88,160,736	2.00%
					Membranes Membranes	177.000 mgd	113,280	11,808,760	40,168		941,272	43,472,353	317,867.53 /mgd	56,262,553	31,898,183	498,083.25 /mgd	88,160,736	2.00%
			Process Aeration Blowers		Process Aeration Blowers													
				Div. 46	Water and Wastewater Equipment													
					Blower 1430 hp 2 duty	2 ea	800	88,764			2,712	1,001,000	546,237.52 /ea	1,092,475	589,617	841,046 /ea	1,682,092	0.04%
					Blower 2000 hp 2 duty	2 ea	800	88,764			2,712	1,400,000	745,737.52 /ea	1,491,475	798,429	1,144,952 /ea	2,289,904	0.05%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,600	177,527			5,423	2,401,000	17,226.33 /mgd	2,583,950	1,388,046	26,479.97 /mgd	3,971,996	0.09%
					Process Aeration Blowers Process Aeration Blowers	4.000 ea	1,600	177,527			5,423	2,401,000	645,987.52 /ea	2,583,950	1,388,046	992,999.06 /ea	3,971,996	0.09%
			RAS Pump		RAS Pump													
				Div. 46	Water and Wastewater Equipment													
					RAS Pumps 12 DUTY + 0 SB = 35 MGD	12 ea	2,880	300,223	72,000		23,931	7,200,000	633,012.78 /ea	7,596,153	4,037,749	969,492 /ea	11,633,902	0.26%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	2,880	300,223	72,000		23,931	7,200,000	50,641.02 /mgd	7,596,153	4,037,749	77,559.35 /mgd	11,633,902	0.26%
					RAS Pump RAS Pump	12.000 ea	2,880	300,223	72,000		23,931	7,200,000	633,012.78 /ea	7,596,153	4,037,749	969,491.85 /ea	11,633,902	0.26%
			Slide Gates		Slide Gates													
				Div. 46	Water and Wastewater Equipment													
					Slide Gate 48" x 48"	25 ea	3,000	332,862	50,000		424	400,000	31,331.43 /ea	783,286	476,933	50,409 /ea	1,260,218	0.03%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	3,000	332,862	50,000		424	400,000	5,221.91 /mgd	783,286	476,933	8,401.45 /mgd	1,260,218	0.03%
					Slide Gates Slide Gates	25.000 ea	3,000	332,862	50,000		424	400,000	31,331.43 /ea	783,286	476,933	50,408.73 /ea	1,260,218	0.03%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			14,217,543				14,217,542.60 /ls	14,217,543	7,440,597	21,658,139 /ls	21,658,139	0.49%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	82,037	8,203,653			5,331,578		13,535,231.68 /ls	13,535,232	8,600,532	22,135,764 /ls	22,135,764	0.50%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	82,037	8,203,653	14,217,543		5,331,578		185,018.49 /mgd	27,752,774	16,041,129	291,959.35 /mgd	43,793,903	0.99%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	82,037	8,203,653	14,217,543		5,331,578		185,018.49 /MGD	27,752,774	16,041,129	291,959.35 /MGD	43,793,903	0.99%
			WAS Pump		WAS Pump													
				Div. 46	Water and Wastewater Equipment													
					WAS Pumps 1 DUTY + 1 SB = 115 MGD	2 ea	480	50,037	12,000		3,988	100,000	83,012.78 /ea	166,026	97,285	131,655 /ea	263,311	0.01%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	480	50,037	12,000		3,988	100,000	1,106.84 /mgd	166,026	97,285	1,755.40 /mgd	263,311	0.01%
					WAS Pump WAS Pump	2.000 ea	480	50,037	12,000		3,988	100,000	83,012.78 /ea	166,026	97,285	131,655.33 /ea	263,311	0.01%
					050.C Process Components	150.000 MGD	225,149	22,983,849	16,342,910		6,613,688	56,859,713	685,334.40 /MGD	102,800,160	58,402,053	1,074,681.42 /MGD	161,202,214	3.65%
		066.			Bioreactor Tank Mixers													
			MBR Tank Mixer		MBR Tank Mixer													
				Div. 46	Water and Wastewater Equipment													
					Vertical Mixers	48 ea	2,304	223,283	12,000		25,526	1,728,000	41,433.52 /ea	1,988,809	1,088,959	64,120 /ea	3,077,768	0.07%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	2,304	223,283	12,000		25,526	1,728,000	13,258.73 /mgd	1,988,809	1,088,959	20,518.45 /mgd	3,077,768	0.07%
					MBR Tank Mixer MBR Tank Mixer	48.000 ea	2,304	223,283	12,000		25,526	1,728,000	41,433.52 /ea	1,988,809	1,088,959	64,120.16 /ea	3,077,768	0.07%
					066. Bioreactor Tank Mixers	48.000 ea	2,304	223,283	12,000		25,526	1,728,000	41,433.52 /ea	1,988,809	1,088,959	64,120.16 /ea	3,077,768	0.07%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					009. - MBR Membrane Bioreactor	150.000 MGD	1,023,987	99,836,974	68,577,062	2,854,602	7,203,084	71,087,713	1,663,729.56 /MGD	249,559,435	151,231,944	2,671,942.52 /MGD	400,791,379	9.08%
	009t. - MBR FiT				MBR Filtrate Tank													
		005.			MBR Effluent													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					005. MBR Effluent	150.000 MGD							/MGD			/MGD		
		010.			Filtrate Pump													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Unidentified		Unidentified													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					Unidentified Unidentified	1.000 ls							/ls			/ls		
					010. Filtrate Pump	150.000 MGD							/MGD			/MGD		
		020.			MBR Filtrate Tank													
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	745.212 sf	4	385	373				1.02 /sf	757	465	2 /sf	1,222	0.00%
					Staging to 30'	745.212 sf	4	385	559				1.27 /sf	944	562	2 /sf	1,506	0.00%
					Rub Block	725.322 sf	10	998					1.38 /sf	998	731	2 /sf	1,729	0.00%
					Mortar	54.366 cf			424				7.80 /cf	424	222	12 /cf	646	0.00%
					Mortar	91.494 cf			714				7.80 /cf	714	374	12 /cf	1,087	0.00%
					Grout Fill 10" Block Cells	469.404 cf	141	14,541	2,982				37.33 /cf	17,523	12,200	63 /cf	29,724	0.00%
					Grout Fill 10"Lintel Block	3.978 cf	1	123	25				37.33 /cf	149	103	63 /cf	252	0.00%
					Grout Fill 10 "Bond Beam	6.63 cf	2	205	42				37.33 /cf	248	172	63 /cf	420	0.00%
					Dur-O-Wall 10"	616.59 lf			285				0.46 /lf	285	149	1 /lf	434	0.00%
					Wall Ties	878 ea	12	1,209	111				1.50 /ea	1,319	942	3 /ea	2,261	0.00%
					Extruded Control Joints 1/2"	74.256 lf	0	44	174				2.93 /lf	218	123	5 /lf	341	0.00%
					Masonry Rebar # 5	14.586 lbs	0	18	10				1.94 /lbs	28	19	3 /lbs	47	0.00%
					Masonry Rebar # 5	3578.874 lbs	43	4,435	2,520				1.94 /lbs	6,954	4,563	3 /lbs	11,518	0.00%
					Standard Brick	5077.254 ea	203	20,972	5,331				5.18 /ea	26,303	18,135	9 /ea	44,438	0.00%
					10" Block Bond Beam	26.52 ea	2	229	608				31.57 /ea	837	486	50 /ea	1,323	0.00%
					10" Block Lintels	10.608 ea	1	91	243				31.57 /ea	335	194	50 /ea	529	0.00%
					10" Fire Rated 3 hr	780 ea	65	6,727	5,569				15.76 /ea	12,296	7,837	26 /ea	20,133	0.00%
					Div. 04 Masonry	745.210 vsf	488	50,362	19,970				94.38 /vsf	70,332	47,277	157.82 /vsf	117,609	0.00%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5/6/7/8/9/10/11/12/22/23 - $/SF	2652 sf				627,728			236.70 /sf	627,728	210,816	316 /sf	838,544	0.02%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	2,652.000 hsf				627,728			236.70 /hsf	627,728	210,816	316.19 /hsf	838,544	0.02%
					Building Building	2,652.000 hsf	488	50,362	19,970	627,728			263.22 /hsf	698,060	258,093	360.54 /hsf	956,153	0.02%
			Elevated Slab		Elevated Slab													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	1326 sf	27	2,524	1,127				2.75 /sf	3,651	2,383	5 /sf	6,034	0.00%
					Form Suspended Slab 15-up	1326 sf	332	29,930	3,119				24.92 /sf	33,049	23,969	43 /sf	57,019	0.00%
					Slab Edge Form > 1'	71.604 sf	18	1,616	215				25.57 /sf	1,831	1,319	44 /sf	3,150	0.00%
					Pour Strips	1397.604 lf	70	6,260	5,870				8.68 /lf	12,130	7,749	14 /lf	19,879	0.00%
					Strip & Oil Suspended Slab Frm	1326 sf	7	594	93				0.52 /sf	687	492	1 /sf	1,179	0.00%
					Suspended Slab Rebar	9.282 tn	278	28,545	17,543				4,965.34 /tn	46,088	30,089	8,207 /tn	76,177	0.00%
					Finish- Hard Trowel	1326 sf	30	2,731					2.06 /sf	2,731	2,041	4 /sf	4,772	0.00%
					Pump Place Suspended Slab	98.124 cy	128	13,549			512		143.30 /cy	14,061	10,146	247 /cy	24,207	0.00%
					4500 psi Concrete	98.124 cy			20,606				210.00 /cy	20,606	10,784	320 /cy	31,390	0.00%
					Liquid Curing Compounds	1326 sf	4	356	1,044				1.06 /sf	1,401	813	2 /sf	2,213	0.00%
					Div. 03 Concrete	1,326.000 hsf	893	86,106	49,616		512		102.74 /hsf	136,235	89,785	170.45 /hsf	226,020	0.01%
					Elevated Slab Elevated Slab	98.120 cy	893	86,106	49,616		512		1,388.45 /cy	136,235	89,785	2,303.50 /cy	226,020	0.01%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	553.8 sf	111	10,000	843				19.58 /sf	10,843	7,904	34 /sf	18,748	0.00%
					Keyway 4"	187.184 lf	9	845	92				5.01 /lf	937	679	9 /lf	1,616	0.00%
					Waterstop 6" Bulb	187.184 lf	19	1,677	1,085				14.75 /lf	2,762	1,821	24 /lf	4,582	0.00%
					Strip & Oil Footing Forms	553.8 sf	3	248	39				0.52 /sf	287	206	1 /sf	492	0.00%
					Footing Rebar	1.024 tn	20	2,099	1,935				3,939.89 /tn	4,034	2,550	6,431 /tn	6,585	0.00%
					Pump Place Wall Footings	27.69 cy	15	1,632			133		63.75 /cy	1,765	1,260	109 /cy	3,025	0.00%
					4500 psi Concrete	27.69 cy			5,815				210.00 /cy	5,815	3,043	320 /cy	8,858	0.00%
					Div. 03 Concrete	553.800 hsf	177	16,502	9,809		133		47.75 /hsf	26,444	17,463	79.28 /hsf	43,907	0.00%
					Footing Footing	27.690 cy	177	16,502	9,809		133		955.00 /cy	26,444	17,463	1,585.67 /cy	43,907	0.00%
			MBR Tank Grating		MBR Tank Grating													
				Div. 09	Finishes													
					Fiberglass Grating 1 1/2"	18431.4 sf	922	83,048	1,382,355		41,471		81.76 /sf	1,506,874	807,349	126 /sf	2,314,223	0.05%
					Fiberglass Grating Banding	748.8 lf			5,354				7.15 /lf	5,354	2,802	11 /lf	8,156	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 09 Finishes	18,431.400 sf	922	83,048	1,387,709		41,471		82.05 /sf	1,512,228	810,151	126.00 /sf	2,322,378	0.05%
					MBR Tank Grating MBR Tank Grating	18,431.400 sf	922	83,048	1,387,709		41,471		82.05 /sf	1,512,228	810,151	126.00 /sf	2,322,378	0.05%
			MBR Tank Slab		MBR Tank Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	106.08 sf	36	3,256	162				32.22 /sf	3,418	2,515	56 /sf	5,933	0.00%
					S-O-G Const Joints > 1'	198.9 sf	72	6,465	303				34.03 /sf	6,768	4,983	59 /sf	11,751	0.00%
					Strip & Oil SOG Form	304.98 sf	2	137	21				0.52 /sf	158	113	1 /sf	271	0.00%
					SOG Rebar	9.282 tn	139	14,273	17,543				3,427.66 /tn	31,816	19,635	5,543 /tn	51,450	0.00%
					Mesh Support - bricks	154 ea	0	32	79				0.72 /ea	111	65	1 /ea	175	0.00%
					Finish- Hard Trowel	1326 sf	30	2,731					2.06 /sf	2,731	2,041	4 /sf	4,772	0.00%
					Pump Place Slab on Grade	147.186 cy	177	18,760			424		130.33 /cy	19,183	13,897	225 /cy	33,080	0.00%
					4500 psi Concrete	147.186 cy			30,909				210.00 /cy	30,909	16,176	320 /cy	47,085	0.00%
					Liquid Curing Compounds	1326 sf	4	356	1,044				1.06 /sf	1,401	813	2 /sf	2,213	0.00%
					Seal Floors	1326 sf	7	594	278				0.66 /sf	872	590	1 /sf	1,462	0.00%
					Div. 03 Concrete	1,326.000 hsf	466	46,603	50,339		424		73.43 /hsf	97,367	60,827	119.30 /hsf	158,194	0.00%
					MBR Tank Slab MBR Tank Slab	150.000 MGD	466	46,603	50,339		424		649.11 /MGD	97,367	60,827	1,054.62 /MGD	158,194	0.00%
			MBR Tank Walls		MBR Tank Walls													
				Div. 03	Concrete													
					Keyway 4"	42.432 lf	2	192	21				5.01 /lf	213	154	9 /lf	366	0.00%
					Rented Form System 16'->	1703.91 sf	426	38,461	17,891				33.07 /sf	56,352	38,066	55 /sf	94,418	0.00%
					Wall Bulkhead Forms	84.864 sf	47	4,214	446				54.91 /sf	4,660	3,378	95 /sf	8,038	0.00%
					Waterstop 6" Bulb	84.864 lf	8	760	492				14.75 /lf	1,252	825	24 /lf	2,078	0.00%
					Strip & Oil Wall Forms	1703.91 sf	9	763	119				0.52 /sf	882	633	1 /sf	1,515	0.00%
					Hot Water Charge	63.648 cy			535				8.40 /cy	535	280	13 /cy	814	0.00%
					Wall Rebar	5.304 tn	122	12,506	10,024				4,247.71 /tn	22,530	14,406	6,964 /tn	36,935	0.00%
					Finish- Top of Wall & Curb	71.604 sf	4	353					4.93 /sf	353	264	9 /sf	616	0.00%
					Pump Place Walls	63.648 cy	89	9,464			458		155.89 /cy	9,922	7,140	268 /cy	17,063	0.00%
					4500 psi Concrete	63.648 cy			13,366				210.00 /cy	13,366	6,995	320 /cy	20,361	0.00%
					Grind/Patch Walls	1703.91 sf	136	12,209	60				7.20 /sf	12,268	9,154	13 /sf	21,422	0.00%
					Liquid Curing Compounds	1703.91 sf	5	458	1,342				1.06 /sf	1,800	1,044	2 /sf	2,844	0.00%
					Div. 03 Concrete	1,703.910 hsf	848	79,379	44,295		458		72.85 /hsf	124,132	82,339	121.17 /hsf	206,471	0.00%
					MBR Tank Walls MBR Tank Walls	150.000 MGD	848	79,379	44,295		458		827.55 /MGD	124,132	82,339	1,376.47 /MGD	206,471	0.00%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
				Estimate Placeholder - Additional Unidentified Process Piping		*ls*							*/ls*			*/ls*		
				Estimate Placeholder - Additional Unidentified Installation Labor/Equip.		*ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD							/MGD			/MGD		
					020. MBR Filtrate Tank	150.000 MGD	3,794	362,000	1,561,739	627,728	42,998		17,296.44 /MGD	2,594,466	1,318,658	26,087.49 /MGD	3,913,124	0.09%
					009t. - MBR FiT MBR Filtrate Tank	150.000 MGD	3,794	362,000	1,561,739	627,728	42,998		17,296.44 /MGD	2,594,466	1,318,658	26,087.49 /MGD	3,913,124	0.09%
010. - Post Tretment					Post Treatment													
		201.			Post Treatment Buildings Process E&I & Unidentified Piping													
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			3,845,455				3,845,455.02 /ls	3,845,455	2,012,477	5,857,932 /ls	5,857,932	0.13%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	17,235	1,723,515			498,485		2,221,999.71 /ls	2,222,000	1,478,463	3,700,463 /ls	3,700,463	0.08%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	17,235	1,723,515	3,845,455		498,485		40,449.70 /mgd	6,067,455	3,490,940	63,722.63 /mgd	9,558,395	0.22%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	17,235	1,723,515	3,845,455		498,485		40,449.70 /MGD	6,067,455	3,490,940	63,722.63 /MGD	9,558,395	0.22%
					201. Post Treatment Buildings Process E&I & Unidentified Piping	150.000 MGD	17,235	1,723,515	3,845,455		498,485		40,449.70 /MGD	6,067,455	3,490,940	63,722.63 /MGD	9,558,395	0.22%
		209.			Lime Storage / Clarifyer Building													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	2728.65 sf	546	49,273	4,154				19.58 /sf	53,427	38,947	34 /sf	92,374	0.00%
					Keyway 4"	909.6 lf	45	4,106	449				5.01 /lf	4,555	3,299	9 /lf	7,855	0.00%
					Waterstop 6" Bulb	909.6 lf	91	8,148	5,272				14.75 /lf	13,420	8,847	24 /lf	22,268	0.00%
					Strip & Oil Footing Forms	2728.65 sf	14	1,222	191				0.52 /sf	1,413	1,013	1 /sf	2,426	0.00%
					Footing Rebar	5.7 tn	114	11,686	10,773				3,940.24 /tn	22,459	14,197	6,431 /tn	36,657	0.00%
					Pump Place Wall Footings	151.95 cy	84	8,957			729		63.75 /cy	9,686	6,914	109 /cy	16,600	0.00%
					4500 psi Concrete	151.95 cy			31,910				210.00 /cy	31,910	16,700	320 /cy	48,609	0.00%
					Div. 03 Concrete	2,728.650 hsf	894	83,393	52,749		729		50.16 /hsf	136,871	89,918	83.11 /hsf	226,789	0.01%
					Footing Footing	151.950 cy	894	83,393	52,749		729		900.76 /cy	136,871	89,918	1,492.52 /cy	226,789	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	136.65 lf	7	617	67				5.01 /lf	684	496	9 /lf	1,180	0.00%
					Rented Form System 16'->	5467.8 sf	1,367	123,419	57,412				33.07 /sf	180,831	122,154	55 /sf	302,985	0.01%
					Wall Bulkhead Forms	273.45 sf	150	13,579	1,436				54.91 /sf	15,015	10,885	95 /sf	25,900	0.00%
					Waterstop 6" Bulb	273.45 lf	27	2,450	1,585				14.75 /lf	4,034	2,660	24 /lf	6,694	0.00%
					Strip & Oil Wall Forms	5467.8 sf	27	2,449	383				0.52 /sf	2,832	2,030	1 /sf	4,862	0.00%
					Hot Water Charge	202.5 cy			1,701				8.40 /cy	1,701	890	13 /cy	2,591	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Wall Rebar	17.85 tn	411	42,086	33,737				4,247.83 /tn	75,824	48,482	6,964 /tn	124,305	0.00%
					Finish- Top of Wall & Curb	227.85 sf	13	1,122					4.93 /sf	1,122	839	9 /sf	1,961	0.00%
					Pump Place Walls	202.5 cy	284	30,111			1,457		155.89 /cy	31,569	22,717	268 /cy	54,286	0.00%
					4500 psi Concrete	202.5 cy			42,525				210.00 /cy	42,525	22,255	320 /cy	64,780	0.00%
					Grind/Patch Walls	5467.8 sf	437	39,177	191				7.20 /sf	39,368	29,375	13 /sf	68,743	0.00%
					Liquid Curing Compounds	5467.8 sf	16	1,469	4,306				1.06 /sf	5,775	3,351	2 /sf	9,127	0.00%
					Div. 03 Concrete	5,467.800 hsf	2,739	256,480	143,343		1,457		73.39 /hsf	401,280	266,134	122.06 /hsf	667,415	0.02%
					Foundation Wall Foundation Wall	202.500 cy	2,739	256,480	143,343		1,457		1,981.63 /cy	401,280	266,134	3,295.87 /cy	667,415	0.02%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1"	1595.4 sf	542	48,975	2,429				32.22 /sf	51,404	37,822	56 /sf	89,226	0.00%
					S-O-G Const Joints > 1"	2978.85 sf	1,072	96,824	4,535				34.03 /sf	101,359	74,633	59 /sf	175,992	0.00%
					Strip & Oil SOG Form	4574.1 sf	23	2,049	320				0.52 /sf	2,369	1,698	1 /sf	4,067	0.00%
					SOG Rebar	143.4 tn	2,151	220,503	271,026				3,427.68 /tn	491,529	303,343	5,543 /tn	794,872	0.02%
					Mesh Support - bricks	2294.7 ea	5	470	1,181				0.72 /ea	1,651	962	1 /ea	2,614	0.00%
					Finish- Hard Trowel	19858.8 sf	457	40,906					2.06 /sf	40,906	30,567	4 /sf	71,474	0.00%
					Pump Place Slab on Grade	2206.5 cy	2,648	281,228			6,354		130.33 /cy	287,582	208,335	225 /cy	495,918	0.01%
					4500 psi Concrete	2206.5 cy			463,365				210.00 /cy	463,365	242,497	320 /cy	705,862	0.02%
					Liquid Curing Compounds	19858.8 sf	60	5,337	15,639				1.06 /sf	20,976	12,172	2 /sf	33,148	0.00%
					Seal Floors	19858.8 sf	99	8,895	4,170				0.66 /sf	13,065	8,829	1 /sf	21,894	0.00%
					Div. 03 Concrete	19,858.800 hsf	7,057	705,187	762,665		6,354		74.23 /hsf	1,474,207	920,859	120.60 /hsf	2,395,066	0.05%
					Slab Slab	2,206.500 cy	7,057	705,187	762,665		6,354		668.12 /cy	1,474,207	920,859	1,085.46 /cy	2,395,066	0.05%
					209. Lime Storage / Clarifyer Building	19,858.800 sf	10,690	1,045,060	958,757		8,541		101.33 /sf	2,012,358	1,276,911	165.63 /sf	3,289,269	0.07%
		210.			Lime													
			Lime Storage		Lime Storage													
				Div. 46	Water and Wastewater Equipment													
					Silos, and Lime Equipment	6 ea	1,440	139,552			15,954	7,710,666	1,311,028.62 /ea	7,866,172	4,146,761	2,002,156 /ea	12,012,933	0.27%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,440	139,552			15,954	7,710,666	52,441.14 /mgd	7,866,172	4,146,761	80,086.22 /mgd	12,012,933	0.27%
					Lime Storage Lime Storage	6.000 ea	1,440	139,552			15,954	7,710,666	1,311,028.62 /ea	7,866,172	4,146,761	2,002,155.51 /ea	12,012,933	0.27%
					210. Lime	1.000 ls	1,440	139,552			15,954	7,710,666	7,866,171.72 /ls	7,866,172	4,146,761	12,012,933.06 /ls	12,012,933	0.27%
		210.-220			Lime to Lime Saturator Clarifier Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					210.-220 Lime to Lime Saturator Clarifier Piping								/lf			/lf		
		220.			Lime Saturator Clarifier													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
					Lime Saturators; (3) 65' diam x 12' high Saturator	3 ea	7,200	697,759			79,769	1,267,500	681,676.00 /ea	2,045,028	1,220,672	1,088,567 /ea	3,265,700	0.07%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	7,200	697,759			79,769	1,267,500	13,633.52 /mgd	2,045,028	1,220,672	21,771.33 /mgd	3,265,700	0.07%
					* unassigned *		7,200	697,759			79,769	1,267,500		2,045,028	1,220,672		3,265,700	0.07%
					220. Lime Saturator Clarifier	1.000 ls	7,200	697,759			79,769	1,267,500	2,045,028.00 /ls	2,045,028	1,220,672	3,265,700.02 /ls	3,265,700	0.07%
		220.-250			Lime Saturator Clarifier to Free Chlorine Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					220.-250 Lime Saturator Clarifier to Free Chlorine Piping								/lf			/lf		
		229.			Co2 Building													
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	1405.95 sf	281	25,388	2,141				19.58 /sf	27,529	20,067	34 /sf	47,596	0.00%
					Keyway 4"	468.75 lf	23	2,116	231				5.01 /lf	2,347	1,700	9 /lf	4,048	0.00%
					Waterstop 6" Bulb	468.75 lf	47	4,199	2,717				14.75 /lf	6,916	4,559	24 /lf	11,475	0.00%
					Strip & Oil Footing Forms	1405.95 sf	7	630	98				0.52 /sf	728	522	1 /sf	1,250	0.00%
					Footing Rebar	3 tn	60	6,151	5,670				3,940.24 /tn	11,821	7,472	6,431 /tn	19,293	0.00%
					Pump Place Wall Footings	78.3 cy	43	4,616			376		63.75 /cy	4,991	3,563	109 /cy	8,554	0.00%
					4500 psi Concrete	78.3 cy			16,443				210.00 /cy	16,443	8,605	320 /cy	25,048	0.00%
					Div. 03 Concrete	1,406.000 hsf	462	43,099	27,300		376		50.34 /hsf	70,775	46,490	83.40 /hsf	117,265	0.00%
					Footing Footing	78.300 cy	462	43,099	27,300		376		903.90 /cy	70,775	46,490	1,497.63 /cy	117,265	0.00%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	70.5 lf	4	318	35				5.01 /lf	353	256	9 /lf	609	0.00%
					Rented Form System 16'->	2817.45 sf	704	63,595	29,583				33.07 /sf	93,179	62,944	55 /sf	156,122	0.00%
					Wall Bulkhead Forms	140.85 sf	77	6,994	739				54.91 /sf	7,734	5,607	95 /sf	13,341	0.00%
					Waterstop 6" Bulb	140.85 lf	14	1,262	816				14.75 /lf	2,078	1,370	24 /lf	3,448	0.00%
					Strip & Oil Wall Forms	2817.45 sf	14	1,262	197				0.52 /sf	1,459	1,046	1 /sf	2,505	0.00%
					Hot Water Charge	104.4 cy			877				8.40 /cy	877	459	13 /cy	1,336	0.00%
					Wall Rebar	9.15 tn	210	21,574	17,294				4,247.87 /tn	38,868	24,852	6,964 /tn	63,720	0.00%
					Finish- Top of Wall & Curb	117.45 sf	6	579					4.93 /sf	579	432	9 /sf	1,011	0.00%
					Pump Place Walls	104.4 cy	146	15,524			751		155.89 /cy	16,275	11,712	268 /cy	27,987	0.00%
					4500 psi Concrete	104.4 cy			21,924				210.00 /cy	21,924	11,474	320 /cy	33,398	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Grind/Patch Walls	2817.45 sf	225	20,187	99				7.20 /sf	20,286	15,136	13 /sf	35,422	0.00%
					Liquid Curing Compounds	2817.45 sf	8	757	2,219				1.06 /sf	2,976	1,727	2 /sf	4,703	0.00%
					Div. 03 Concrete	2,817.450 hsf	1,410	132,052	73,784		751		73.32 /hsf	206,587	137,015	121.95 /hsf	343,602	0.01%
					Foundation Wall Foundation Wall	104.400 cy	1,410	132,052	73,784		751		1,978.81 /cy	206,587	137,015	3,291.21 /cy	343,602	0.01%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	471.6 sf	160	14,477	718				32.22 /sf	15,195	11,180	56 /sf	26,375	0.00%
					S-O-G Const Joints > 1'	880.5 sf	317	28,619	1,341				34.03 /sf	29,960	22,060	59 /sf	52,020	0.00%
					Strip & Oil SOG Form	1351.95 sf	7	606	95				0.52 /sf	700	502	1 /sf	1,202	0.00%
					SOG Rebar	42.45 tn	637	65,275	80,231				3,427.70 /tn	145,506	89,798	5,543 /tn	235,304	0.01%
					Mesh Support - bricks	678.3 ea	1	139	349				0.72 /ea	488	284	1 /ea	773	0.00%
					Finish- Hard Trowel	5869.5 sf	135	12,090					2.06 /sf	12,090	9,035	4 /sf	21,125	0.00%
					Pump Place Slab on Grade	652.2 cy	783	83,126			1,878		130.33 /cy	85,004	61,580	225 /cy	146,584	0.00%
					4500 psi Concrete	652.2 cy			136,962				210.00 /cy	136,962	71,678	320 /cy	208,640	0.00%
					Liquid Curing Compounds	5869.5 sf	18	1,577	4,622				1.06 /sf	6,200	3,598	2 /sf	9,797	0.00%
					Seal Floors	5869.5 sf	29	2,629	1,233				0.66 /sf	3,861	2,609	1 /sf	6,471	0.00%
					Div. 03 Concrete	5,870.000 hsf	2,087	208,538	225,550		1,878		74.27 /hsf	435,967	272,324	120.66 /hsf	708,290	0.02%
					Slab Slab	652.200 cy	2,087	208,538	225,550		1,878		668.46 /cy	435,967	272,324	1,086.00 /cy	708,290	0.02%
					229. Co2 Building	5,870.000 sf	3,959	383,689	326,634		3,005		121.52 /sf	713,329	455,828	199.17 /sf	1,169,157	0.03%
		230.			Carbon Dioxide													
			* unassigned *															
				Div. 46	Water and Wastewater Equipment													
			Carbon Dioxide Storage & Feed System (10MGD), 50ton liquid CO2 storage, feed panel, vaporizers, heater, regulator, diffusers, controls			4 ea	6,400	620,230			70,906	4,814,260	1,376,349.00 /ea	5,505,396	3,014,904	2,130,075 /ea	8,520,300	0.19%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	6,400	620,230			70,906	4,814,260	36,702.64 /mgd	5,505,396	3,014,904	56,802.00 /mgd	8,520,300	0.19%
					* unassigned *		6,400	620,230			70,906	4,814,260		5,505,396	3,014,904		8,520,300	0.19%
		Sidestream Carrier Water Pump			Sidestream Carrier Water Pump													
				Div. 46	Water and Wastewater Equipment													
					Sidestream Carrier Water Pumps 4 DUTY + 0 SB	4 ea	960	100,074	24,000		7,977	450,000	145,512.78 /ea	582,051	325,405	226,864 /ea	907,456	0.02%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	960	100,074	24,000		7,977	450,000	3,880.34 /mgd	582,051	325,405	6,049.71 /mgd	907,456	0.02%
					Sidestream Carrier Water Pump Sidestream Carrier Water Pump	4.000 ea	960	100,074	24,000		7,977	450,000	145,512.78 /ea	582,051	325,405	226,864.02 /ea	907,456	0.02%
					230. Carbon Dioxide	1.000 ls	7,360	720,305	24,000		78,882	5,264,260	6,087,447.12 /ls	6,087,447	3,340,309	9,427,755.78 /ls	9,427,756	0.21%
		230.-250			Carbon Dioxide to Free Chlorine Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					230.-250 Carbon Dioxide to Free Chlorine Piping								/lf			/lf		
					010. - Post Tretment Post Treatment	150.000 MGD	47,884	4,709,880	5,154,847		684,636	14,242,426	165,278.59 /MGD	24,791,789	13,931,421	258,154.73 /MGD	38,723,210	0.88%
	011. - PWPS				Primary Water Pumping System													
		260.			Product Water Wet Well Tank (Clearwell/Chlor Contact Tank)/High Svc Pump Sta													
			Building		Building													
				Div. 04	Masonry													
					Interior Staging over 10 '	27978.15 sf	140	14,445	13,989				1.02 /sf	28,434	17,457	2 /sf	45,892	0.00%
					Staging to 30'	27978.15 sf	140	14,445	20,984				1.27 /sf	35,429	21,118	2 /sf	56,547	0.00%
					Rub Block	27978.15 sf	373	38,511					1.38 /sf	38,511	28,178	2 /sf	66,689	0.00%
					Mortar	2008.65 cf			15,670				7.80 /cf	15,670	8,201	12 /cf	23,871	0.00%
					Mortar	3371.7 cf			26,304				7.80 /cf	26,304	13,766	12 /cf	40,070	0.00%
					Grout Fill 10" Block Cells	17289.15 cf	5,187	535,588	109,829				37.33 /cf	645,418	449,364	63 /cf	1,094,782	0.02%
					Grout Fill 10"Lintel Block	143.4 cf	43	4,442	911				37.33 /cf	5,353	3,727	63 /cf	9,080	0.00%
					Grout Fill 10 "Bond Beam	215.25 cf	65	6,668	1,367				37.33 /cf	8,035	5,595	63 /cf	13,630	0.00%
					Dur-O-Wall 10"	22741.35 lf			10,507				0.46 /lf	10,507	5,498	1 /lf	16,005	0.00%
					Wall Ties	32354.4 ea	431	44,535	4,077				1.50 /ea	48,611	34,719	3 /ea	83,331	0.00%
					Extruded Control Joints 1/2"	2726.1 lf	16	1,607	6,383				2.93 /lf	7,991	4,517	5 /lf	12,507	0.00%
					Masonry Rebar # 5	502.2 lbs	6	622	354				1.94 /lbs	976	640	3 /lbs	1,616	0.00%
					Masonry Rebar # 5	131928.15 lbs	1,583	163,476	92,877				1.94 /lbs	256,354	168,221	3 /lbs	424,575	0.01%
					Standard Brick	187095.75 ea	7,484	772,803	196,451				5.18 /ea	969,254	668,265	9 /ea	1,637,519	0.04%
					10" Block Bond Beam	1004.4 ea	84	8,662	23,043				31.57 /ea	31,706	18,398	50 /ea	50,103	0.00%
					10" Block Lintels	358.8 ea	30	3,094	8,232				31.57 /ea	11,326	6,572	50 /ea	17,898	0.00%
					10" Fire Rated 3 hr	28695.6 ea	2,397	247,481	204,887				15.76 /ea	452,368	288,305	26 /ea	740,673	0.02%
					Div. 04 Masonry	27,978.150 vsf	17,978	1,856,382	735,865				92.65 /vsf	2,592,247	1,742,543	154.93 /vsf	4,334,790	0.10%
				Div. 05 -15	Div 5/6/7/8/9/10/11/12/22/23													
					Div 5 - $/SF	143478.3 sf				8,126,611			56.64 /sf	8,126,611	2,729,234	76 /sf	10,855,845	0.25%
					Div 6 - $/SF	143478.3 sf				246,783			1.72 /sf	246,783	82,879	2 /sf	329,662	0.01%
					Div 7 - $/SF	143478.3 sf				5,872,567			40.93 /sf	5,872,567	1,972,238	55 /sf	7,844,805	0.18%
					Div 8 - $/SF	143478.3 sf				1,314,261			9.16 /sf	1,314,261	441,380	12 /sf	1,755,642	0.04%
					Div 9 - $/SF	143478.3 sf				5,165,219			36.00 /sf	5,165,219	1,734,683	48 /sf	6,899,901	0.16%
					Div 10 - $/SF	143478.3 sf				275,478			1.92 /sf	275,478	92,516	3 /sf	367,995	0.01%
					Div 11 - $/SF	143478.3 sf				136,304			0.95 /sf	136,304	45,776	1 /sf	182,081	0.00%
					Div 12 - $/SF	143478.3 sf				53,087			0.37 /sf	53,087	17,829	0 /sf	70,916	0.00%
					Div 22 - $/SF	143478.3 sf				876,652			6.11 /sf	876,652	294,414	8 /sf	1,171,067	0.03%
					Div 23 - $/SF	143478.3 sf				8,417,872			58.67 /sf	8,417,872	2,827,051	78 /sf	11,244,923	0.25%
					Div. 05 -15 Div 5/6/7/8/9/10/11/12/22/23	143,478.300 hsf				30,484,834			212.47 /hsf	30,484,834	10,238,001	283.83 /hsf	40,722,835	0.92%
					Building Building	143,478.300 hsf	17,978	1,856,382	735,865	30,484,834			230.54 /hsf	33,077,082	11,980,543	314.04 /hsf	45,057,625	1.02%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
			Elevated Slab		Elevated Slab													
				Div. 03	Concrete													
					Scaffolding - Elevated Deck Shoring from 10' to 24' height	72464.4 sf	1,449	137,943	61,595				2.75 /sf	199,538	130,220	5 /sf	329,758	0.01%
					Form Suspended Slab 15-up	72464.4 sf	18,116	1,635,666	170,436				24.92 /sf	1,806,103	1,309,900	43 /sf	3,116,003	0.07%
					Slab Edge Form > 1'	3913.05 sf	978	88,325	11,739				25.57 /sf	100,065	72,061	44 /sf	172,126	0.00%
					Pour Strips	76377.3 lf	3,819	342,086	320,785				8.68 /lf	662,871	423,495	14 /lf	1,086,366	0.02%
					Strip & Oil Suspended Slab Frm	72464.4 sf	362	32,456	5,073				0.52 /sf	37,529	26,907	1 /sf	64,435	0.00%
					Suspended Slab Rebar	507.3 tn	15,219	1,560,130	958,797				4,965.36 /tn	2,518,927	1,644,472	8,207 /tn	4,163,399	0.09%
					Finish- Hard Trowel	72464.4 sf	1,667	149,266					2.06 /sf	149,266	111,539	4 /sf	260,806	0.01%
					Pump Place Suspended Slab	5362.35 cy	6,971	740,410			27,995		143.30 /cy	768,405	554,452	247 /cy	1,322,857	0.03%
					4500 psi Concrete	5362.35 cy			1,126,094				210.00 /cy	1,126,094	589,329	320 /cy	1,715,422	0.04%
					Liquid Curing Compounds	72464.4 sf	217	19,474	57,066				1.06 /sf	76,539	44,416	2 /sf	120,955	0.00%
					Div. 03 Concrete	72,464.400 hsf	48,799	4,705,757	2,711,584		27,995		102.75 /hsf	7,445,336	4,906,790	170.46 /hsf	12,352,125	0.28%
					Elevated Slab Elevated Slab	5,362.350 cy	48,799	4,705,757	2,711,584		27,995		1,388.45 /cy	7,445,336	4,906,790	2,303.49 /cy	12,352,125	0.28%
			Footing		Footing													
				Div. 03	Concrete													
					Continuous Footing Forms > 12"	5362.35 sf	1,072	96,831	8,164				19.58 /sf	104,995	76,538	34 /sf	181,533	0.00%
					Keyway 4"	1811.55 lf	91	8,178	894				5.01 /lf	9,072	6,571	9 /lf	15,643	0.00%
					Waterstop 6" Bulb	1811.55 lf	181	16,228	10,500				14.75 /lf	26,727	17,621	24 /lf	44,348	0.00%
					Strip & Oil Footing Forms	5362.35 sf	27	2,402	375				0.52 /sf	2,777	1,991	1 /sf	4,768	0.00%
					Footing Rebar	36.23 tn	725	74,280	68,476				3,940.27 /tn	142,756	90,241	6,431 /tn	232,997	0.01%
					Pump Place Wall Footings	289.8 cy	161	17,083			1,391		63.75 /cy	18,474	13,186	109 /cy	31,660	0.00%
					4500 psi Concrete	289.8 cy			60,858				210.00 /cy	60,858	31,849	320 /cy	92,707	0.00%
					Div. 03 Concrete	5,362.350 hsf	2,256	215,002	149,267		1,391		68.19 /hsf	365,659	237,998	112.57 /hsf	603,657	0.01%
					Footing Footing	289.800 cy	2,256	215,002	149,267		1,391		1,261.77 /cy	365,659	237,998	2,083.01 /cy	603,657	0.01%
			Foundation Wall		Foundation Wall													
				Div. 03	Concrete													
					Keyway 4"	2173.95 lf	109	9,814	1,073				5.01 /lf	10,887	7,886	9 /lf	18,773	0.00%
					Rented Form System 16'->	86087.55 sf	21,522	1,943,168	903,919				33.07 /sf	2,847,087	1,923,250	55 /sf	4,770,337	0.11%
					Wall Bulkhead Forms	4275.45 sf	2,351	212,312	22,446				54.91 /sf	234,758	170,196	95 /sf	404,954	0.01%
					Waterstop 6" Bulb	4275.45 lf	428	38,299	24,781				14.75 /lf	63,079	41,586	24 /lf	104,665	0.00%
					Strip & Oil Wall Forms	86087.55 sf	430	38,558	6,026				0.52 /sf	44,584	31,965	1 /sf	76,549	0.00%
					Hot Water Charge	3188.4 cy			26,783				8.40 /cy	26,783	14,016	13 /cy	40,799	0.00%
					Wall Rebar	289.8 tn	6,665	683,283	547,722				4,247.78 /tn	1,231,005	787,106	6,964 /tn	2,018,111	0.05%
					Finish- Top of Wall & Curb	3550.8 sf	195	17,490					4.93 /sf	17,490	13,070	9 /sf	30,560	0.00%
					Pump Place Walls	3188.4 cy	4,464	474,105			22,947		155.89 /cy	497,052	357,684	268 /cy	854,736	0.02%
					4500 psi Concrete	3188.4 cy			669,564				210.00 /cy	669,564	350,409	320 /cy	1,019,973	0.02%
					Grind/Patch Walls	86087.55 sf	6,887	616,821	3,013				7.20 /sf	619,834	462,493	13 /sf	1,082,327	0.02%
					Liquid Curing Compounds	86087.55 sf	258	23,135	67,794				1.06 /sf	90,929	52,766	2 /sf	143,695	0.00%
					Div. 03 Concrete	86,087.550 hsf	43,310	4,056,985	2,273,120		22,947		73.80 /hsf	6,353,053	4,212,427	122.73 /hsf	10,565,480	0.24%
					Foundation Wall Foundation Wall	3,188.400 cy	43,310	4,056,985	2,273,120		22,947		1,992.55 /cy	6,353,053	4,212,427	3,313.72 /cy	10,565,480	0.24%
			Slab		Slab													
				Div. 03	Concrete													
					S.O.G. Edge Form > 1'	5797.2 sf	1,971	177,962	8,826				32.22 /sf	186,788	137,433	56 /sf	324,221	0.01%
					S-O-G Const Joints > 1'	10869.6 sf	3,913	353,302	16,549				34.03 /sf	369,851	272,331	59 /sf	642,182	0.01%
					Strip & Oil SOG Form	16666.8 sf	83	7,465	1,167				0.52 /sf	8,632	6,189	1 /sf	14,820	0.00%
					SOG Rebar	507.3 tn	7,610	780,065	958,797				3,427.68 /tn	1,738,862	1,073,124	5,543 /tn	2,811,986	0.06%
					Mesh Support - bricks	8405.85 ea	17	1,723	4,325				0.72 /ea	6,048	3,526	1 /ea	9,574	0.00%
					Finish- Hard Trowel	72464.4 sf	1,667	149,266					2.06 /sf	149,266	111,539	4 /sf	260,806	0.01%
					Pump Place Slab on Grade	8043.6 cy	9,652	1,025,192			23,163		130.33 /cy	1,048,356	759,468	225 /cy	1,807,823	0.04%
					4500 psi Concrete	8043.6 cy			1,689,156				210.00 /cy	1,689,156	884,001	320 /cy	2,573,157	0.06%
					Liquid Curing Compounds	72464.4 sf	217	19,474	57,066				1.06 /sf	76,539	44,416	2 /sf	120,955	0.00%
					Seal Floors	72464.4 sf	362	32,456	15,218				0.66 /sf	47,674	32,216	1 /sf	79,890	0.00%
					Div. 03 Concrete	72,464.400 hsf	25,492	2,546,906	2,751,103		23,163		73.43 /hsf	5,321,172	3,324,243	119.31 /hsf	8,645,414	0.20%
					Slab Slab	8,043.600 cy	25,492	2,546,906	2,751,103		23,163		661.54 /cy	5,321,172	3,324,243	1,074.82 /cy	8,645,414	0.20%
			Unidentified Process Pipe		Unidentified Process Pipe													
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - Additional Unidentified Process Piping	1 ls			11,154,000				11,154,000.00 /ls	11,154,000	5,837,325	16,991,325 /ls	16,991,325	0.39%
					Estimate Placeholder - Additional Unidentified Installation Labor/Equip.	1 ls	41,310	4,131,000			1,155,000		5,286,000.00 /ls	5,286,000	3,522,624	8,808,624 /ls	8,808,624	0.20%
					Div. 40 Process Integration (Process Piping)	150.000 mgd	41,310	4,131,000	11,154,000		1,155,000		109,600.00 /mgd	16,440,000	9,359,949	171,999.66 /mgd	25,799,949	0.58%
					Unidentified Process Pipe Unidentified Process Pipe	150.000 MGD	41,310	4,131,000	11,154,000		1,155,000		109,600.00 /MGD	16,440,000	9,359,949	171,999.66 /MGD	25,799,949	0.58%
			260. Product Water Wet Well Tank (Clearwell/Chlor Contact Tank)/High Svc Pump Sta			1.000 ls	179,145	17,512,032	19,774,939	30,484,834	1,230,497		69,002,301.33 /ls	69,002,301	34,021,950	103,024,251.09 /ls	103,024,251	2.34%
		260.-270			Product Water Wet Well to Effluent Pump Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder - vertical piping from wet well to pumps	*1.000 ls*							/ls			/ls		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					260.-270 Product Water Wet Well to Effluent Pump Piping								/lf			/lf		
		270.			Effluent Pump													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							/ls			/ls		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
			Distribution Pump		Distribution Pump													
				Div. 46	Water and Wastewater Equipment													
					Final Distribution Pumps 5 Duty + 1 SB	6 ea	1,440	150,111	36,000		11,965	33,000,000	5,533,012.78 /ea	33,198,077	17,405,045	8,433,854 /ea	50,603,122	1.15%
					Div. 46 Water and Wastewater Equipment	150.000 mgd	1,440	150,111	36,000		11,965	33,000,000	221,320.51 /mgd	33,198,077	17,405,045	337,354.15 /mgd	50,603,122	1.15%
					Distribution Pump Distribution Pump	6.000 ea	1,440	150,111	36,000		11,965	33,000,000	5,533,012.78 /ea	33,198,077	17,405,045	8,433,853.64 /ea	50,603,122	1.15%
					270. Effluent Pump	1.000 ls	1,440	150,111	36,000		11,965	33,000,000	33,198,076.68 /ls	33,198,077	17,405,045	50,603,121.87 /ls	50,603,122	1.15%
		270.-280			Effluent Pump to Distribution Piping													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					270.-280 Effluent Pump to Distribution Piping								/lf			/lf		
		280.			Distribution													
			* unassigned *															
				Div. 40	Process Integration (Process Piping)													
					Estimate Placeholder	*1.000 ls*							*/ls*			*/ls*		
					Div. 40 Process Integration (Process Piping)	150.000 mgd							/mgd			/mgd		
					280. Distribution	1.000 ls							/ls			/ls		
					011. - PWPS Primary Water Pumping System	150.000 MGD	180,585	17,662,143	19,810,939	30,484,834	1,242,462	33,000,000	681,335.85 /MGD	102,200,378	51,426,995	1,024,182.49 /MGD	153,627,373	3.48%
	014. - Site Prep				Site Prep & Restoration													
		020.			MBR Filtrate Tank													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1112.514 cy	67	8,220		17,800	5,015	11,125	37.90 /cy	42,160	20,334	56 /cy	62,494	0.00%
					Bldg Fill Gravel	35.802 cy	4	479	1,729	573	214		83.65 /cy	2,995	1,557	127 /cy	4,552	0.00%
					Structure Sheeting 24'deep	1161.576 sf	74	7,752	52,271		1,217		52.72 /sf	61,240	33,663	82 /sf	94,902	0.00%
					Remove Sheeting 24'deep	1161.576 sf	34	3,523			553		3.51 /sf	4,077	2,867	6 /sf	6,944	0.00%
					Div. 31 Earthwork	1,112.510 cy	180	19,974	54,000	18,373	7,000	11,125	99.30 /cy	110,471	58,420	151.81 /cy	168,892	0.00%
					Earthwork Earthwork	35.800 cy	180	19,974	54,000	18,373	7,000	11,125	3,085.79 /cy	110,471	58,420	4,717.65 /cy	168,892	0.00%
					020. MBR Filtrate Tank	150.000 MGD	180	19,974	54,000	18,373	7,000	11,125	736.48 /MGD	110,471	58,420	1,125.95 /MGD	168,892	0.00%
		020-2.			Membrane Tanks for MBR													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	68712 cy	4,149	507,678		1,099,392	309,750	687,120	37.90 /cy	2,603,940	1,255,871	56 /cy	3,859,812	0.09%
					Bldg Fill Gravel	2061.36 cy	247	27,566	99,564	32,982	12,313		83.65 /cy	172,424	89,652	127 /cy	262,076	0.01%
					Remove Sheeting 24'deep	54576 sf	1,588	165,546			25,996		3.51 /sf	191,542	134,701	6 /sf	326,242	0.01%
					Remove Sheeting 24'deep	54576 sf	1,588	165,546			25,996		3.51 /sf	191,542	134,701	6 /sf	326,242	0.01%
					Div. 31 Earthwork		7,571	866,337	99,564	1,132,374	374,054	687,120	/cy	3,159,448	1,614,924	/cy	4,774,372	0.11%
					Earthwork Earthwork		7,571	866,337	99,564	1,132,374	374,054	687,120	/cy	3,159,448	1,614,924	/cy	4,774,372	0.11%
					020-2. Membrane Tanks for MBR	72,048.000 hsf	7,571	866,337	99,564	1,132,374	374,054	687,120	43.85 /hsf	3,159,448	1,614,924	66.27 /hsf	4,774,372	0.11%
		020-3.			Bioreactor Tanks fro MBR													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	400769 cy	24,197	2,961,081		6,412,304	1,806,644	4,007,690	37.90 /cy	15,187,719	7,324,985	56 /cy	22,512,704	0.51%
					Bldg Fill Gravel	12023.07 cy	1,443	160,783	580,714	192,369	71,814		83.65 /cy	1,005,681	522,902	127 /cy	1,528,582	0.03%
					Structure Sheeting 24'deep	99144 sf	6,345	661,616	4,461,480		103,894		52.72 /sf	5,226,990	2,873,207	82 /sf	8,100,197	0.18%
					Structure Sheeting 24'deep	99144 sf	6,345	661,616	4,461,480		103,894		52.72 /sf	5,226,990	2,873,207	82 /sf	8,100,197	0.18%
					Div. 31 Earthwork		38,331	4,445,095	9,503,674	6,604,673	2,086,247	4,007,690	/cy	26,647,380	13,594,301	/cy	40,241,681	0.91%
					Earthwork Earthwork		38,331	4,445,095	9,503,674	6,604,673	2,086,247	4,007,690	/cy	26,647,380	13,594,301	/cy	40,241,681	0.91%
					020-3. Bioreactor Tanks fro MBR	420,000.000 hsf	38,331	4,445,095	9,503,674	6,604,673	2,086,247	4,007,690	63.45 /hsf	26,647,380	13,594,301	95.81 /hsf	40,241,681	0.91%
		020-4.			MBR - Odor Control Facility													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1390 cy	84	10,270		22,240	6,266	13,900	37.90 /cy	52,676	25,405	56 /cy	78,082	0.00%
					Bldg Fill Gravel	41.7 cy	5	558	2,014	667	249		83.65 /cy	3,488	1,814	127 /cy	5,302	0.00%
					Div. 31 Earthwork		89	10,828	2,014	22,907	6,515	13,900	/cy	56,164	27,219	/cy	83,383	0.00%
					Earthwork Earthwork		89	10,828	2,014	22,907	6,515	13,900	/cy	56,164	27,219	/cy	83,383	0.00%
					020-4. MBR - Odor Control Facility	12,060.000 hsf	89	10,828	2,014	22,907	6,515	13,900	4.66 /hsf	56,164	27,219	6.91 /hsf	83,383	0.00%
		089.			RO Feed Tank / RO Pump Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	17473.05 cy	1,055	129,100		279,569	78,768	174,731	37.90 /cy	662,166	319,361	56 /cy	981,527	0.02%
					Bldg Fill Gravel	524.4 cy	63	7,013	25,329	8,390	3,132		83.65 /cy	43,864	22,807	127 /cy	66,671	0.00%
					Structure Sheeting 24'deep	19784.25 sf	1,266	132,026	890,291		20,732		52.72 /sf	1,043,049	573,350	82 /sf	1,616,400	0.04%
					Remove Sheeting 24'deep	19784.25 sf	576	60,012			9,424		3.51 /sf	69,435	48,830	6 /sf	118,266	0.00%
					Div. 31 Earthwork		2,960	328,150	915,620	287,959	112,056	174,731	/cy	1,818,515	964,348	/cy	2,782,863	0.06%
					Earthwork Earthwork		2,960	328,150	915,620	287,959	112,056	174,731	/cy	1,818,515	964,348	/cy	2,782,863	0.06%
					089. RO Feed Tank / RO Pump Building	57,255.600 sf	2,960	328,150	915,620	287,959	112,056	174,731	31.76 /sf	1,818,515	964,348	48.60 /sf	2,782,863	0.06%
		139.			RO Facility													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	15571.2 cy	940	115,048		249,139	70,194	155,712	37.90 /cy	590,093	284,600	56 /cy	874,693	0.02%
					Bldg Fill Gravel	468.3 cy	56	6,263	22,619	7,493	2,797		83.65 /cy	39,171	20,367	127 /cy	59,538	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 31 Earthwork		996	121,310	22,619	256,632	72,991	155,712	/cy	629,264	304,967	/cy	934,231	0.02%
					Earthwork Earthwork		996	121,310	22,619	256,632	72,991	155,712	/cy	629,264	304,967	/cy	934,231	0.02%
					139. RO Facility	137,563.050 sf	996	121,310	22,619	256,632	72,991	155,712	4.57 /sf	629,264	304,967	6.79 /sf	934,231	0.02%
		190.			UV/AOP													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	3193.05 cy	193	23,592		51,089	14,394	31,931	37.90 /cy	121,005	58,360	56 /cy	179,366	0.00%
					Bldg Fill Gravel	96.45 cy	12	1,290	4,659	1,543	576		83.65 /cy	8,068	4,195	127 /cy	12,262	0.00%
					Div. 31 Earthwork		204	24,882	4,659	52,632	14,970	31,931	/cy	129,073	62,555	/cy	191,628	0.00%
					Earthwork Earthwork		204	24,882	4,659	52,632	14,970	31,931	/cy	129,073	62,555	/cy	191,628	0.00%
					190. UV/AOP	150.000 MGD	204	24,882	4,659	52,632	14,970	31,931	860.49 /MGD	129,073	62,555	1,277.52 /MGD	191,628	0.00%
		199.			Chemical Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	2508.3 cy	151	18,533		40,133	11,307	25,083	37.90 /cy	95,056	45,845	56 /cy	140,901	0.00%
					Bldg Fill Gravel	75.6 cy	9	1,011	3,651	1,210	452		83.65 /cy	6,324	3,288	127 /cy	9,612	0.00%
					Div. 31 Earthwork		161	19,544	3,651	41,342	11,759	25,083	/cy	101,379	49,133	/cy	150,512	0.00%
					Earthwork Earthwork		161	19,544	3,651	41,342	11,759	25,083	/cy	101,379	49,133	/cy	150,512	0.00%
					199. Chemical Building	32,869.500 sf	161	19,544	3,651	41,342	11,759	25,083	3.08 /sf	101,379	49,133	4.58 /sf	150,512	0.00%
		209.			Lime Storage / Clarifyer Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1515.6 cy	92	11,198		24,250	6,832	15,156	37.90 /cy	57,436	27,701	56 /cy	85,137	0.00%
					Bldg Fill Gravel	45.6 cy	5	610	2,202	730	272		83.65 /cy	3,814	1,983	127 /cy	5,797	0.00%
					Div. 31 Earthwork		97	11,808	2,202	24,979	7,105	15,156	/cy	61,250	29,684	/cy	90,934	0.00%
					Earthwork Earthwork		97	11,808	2,202	24,979	7,105	15,156	/cy	61,250	29,684	/cy	90,934	0.00%
					209. Lime Storage / Clarifyer Building	19,858.800 sf	97	11,808	2,202	24,979	7,105	15,156	3.08 /sf	61,250	29,684	4.58 /sf	90,934	0.00%
		229.			Co2 Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	447.45 cy	27	3,306		7,159	2,017	4,475	37.90 /cy	16,957	8,178	56 /cy	25,135	0.00%
					Bldg Fill Gravel	44.4 cy	5	594	2,145	710	265		83.65 /cy	3,714	1,931	127 /cy	5,645	0.00%
					Div. 31 Earthwork		32	3,900	2,145	7,870	2,282	4,475	/cy	20,671	10,109	/cy	30,780	0.00%
					Earthwork Earthwork		32	3,900	2,145	7,870	2,282	4,475	/cy	20,671	10,109	/cy	30,780	0.00%
					229. Co2 Building	5,870.000 sf	32	3,900	2,145	7,870	2,282	4,475	3.52 /sf	20,671	10,109	5.24 /sf	30,780	0.00%
		239.			Chlorine Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1939.5 cy	117	14,330		31,032	8,743	19,395	37.90 /cy	73,500	35,449	56 /cy	108,949	0.00%
					Bldg Fill Gravel	58.65 cy	7	784	2,833	938	350		83.65 /cy	4,906	2,551	127 /cy	7,457	0.00%
					Div. 31 Earthwork		124	15,114	2,833	31,970	9,093	19,395	/cy	78,406	38,000	/cy	116,406	0.00%
					Earthwork Earthwork		124	15,114	2,833	31,970	9,093	19,395	/cy	78,406	38,000	/cy	116,406	0.00%
					239. Chlorine Building	25,419.150 sf	124	15,114	2,833	31,970	9,093	19,395	3.09 /sf	78,406	38,000	4.58 /sf	116,406	0.00%
		260.			Product Water Wet Well Tank (Clearwell/Chlor Contact Tank)/High Svc Pump Sta													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	73767.3 cy	4,454	545,030		1,180,277	332,539	737,673	37.90 /cy	2,795,518	1,348,269	56 /cy	4,143,787	0.09%
					Bldg Fill Gravel	2213.25 cy	266	29,598	106,900	35,412	13,220		83.65 /cy	185,129	96,258	127 /cy	281,387	0.01%
					Structure Sheeting 24'deep	52386.15 sf	3,353	349,587	2,357,377		54,896		52.72 /sf	2,761,860	1,518,158	82 /sf	4,280,019	0.10%
					Remove Sheeting 24'deep	52386.15 sf	1,524	158,903			24,953		3.51 /sf	183,856	129,296	6 /sf	313,152	0.01%
					Div. 31 Earthwork		9,596	1,083,118	2,464,277	1,215,689	425,608	737,673	/cy	5,926,364	3,091,980	/cy	9,018,344	0.20%
					Earthwork Earthwork		9,596	1,083,118	2,464,277	1,215,689	425,608	737,673	/cy	5,926,364	3,091,980	/cy	9,018,344	0.20%
					260. Product Water Wet Well Tank (Clearwell/Chlor Contact Tank)/High Svc Pump Sta	1.000 ls	9,596	1,083,118	2,464,277	1,215,689	425,608	737,673	5,926,364.08 /ls	5,926,364	3,091,980	9,018,344.44 /ls	9,018,344	0.20%
		260.E			High Service PS Electrical Room													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1576.95 cy	95	11,651		25,231	7,109	15,770	37.90 /cy	59,761	28,822	56 /cy	88,583	0.00%
					Bldg Fill Gravel	65.25 cy	8	873	3,152	1,044	390		83.65 /cy	5,458	2,838	127 /cy	8,296	0.00%
					Div. 31 Earthwork		103	12,524	3,152	26,275	7,499	15,770	/cy	65,219	31,660	/cy	96,879	0.00%
					Earthwork Earthwork		103	12,524	3,152	26,275	7,499	15,770	/cy	65,219	31,660	/cy	96,879	0.00%
					260.E High Service PS Electrical Room	13,773.900 sf	103	12,524	3,152	26,275	7,499	15,770	4.74 /sf	65,219	31,660	7.03 /sf	96,879	0.00%
		550.			Site Restoration & Misc Site Improvements													
		Final Site Restoration & Misc Site			Final Site Restoration & Misc Site													
				Div. 32	Exterior Improvements													
					Final Restoration of Site Work: Paving, Seeding & Fencing	150 ls				7,630,500			50,870.00 /ls	7,630,500	2,562,621	67,954 /ls	10,193,121	0.23%
					Div. 32 Exterior Improvements					7,630,500			/ls	7,630,500	2,562,621	/ls	10,193,121	0.23%
					Final Site Restoration & Misc Site Final Site Restoration & Misc Site					7,630,500			/MGD	7,630,500	2,562,621	/MGD	10,193,121	0.23%
					550. Site Restoration & Misc Site Improvements	150.000 MGD				7,630,500			50,870.00 /MGD	7,630,500	2,562,621	67,954.14 /MGD	10,193,121	0.23%
		600.			EB2 - RO Electrical Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1657.8 cy	100	12,249		26,525	7,473	16,578	37.90 /cy	62,825	30,300	56 /cy	93,125	0.00%
					Bldg Fill Gravel	50.85 cy	6	680	2,456	814	304		83.65 /cy	4,253	2,212	127 /cy	6,465	0.00%

Pathway / Scenario	Location-1	Process System	Scope of Work -	CSI Division #	Description	Takeoff Quantity	Labor Hours	Labor Amount	Material Amount	Subcontract Amount	Const Equip Amount	Process Equipment / Other	Total Cost/Unit	Total Amount	Indirect Addon Costs	Grand Total Price UP	Grand Total Price	% Total
					Div. 31 Earthwork		106	12,929	2,456	27,338	7,777	16,578	/cy	67,078	32,512	/cy	99,590	0.00%
					Earthwork Earthwork		**106**	**12,929**	**2,456**	**27,338**	**7,777**	**16,578**	**/cy**	**67,078**	**32,512**	**/cy**	**99,590**	**0.00%**
					600. EB2 - RO Electrical Building	14,316.600 sf	106	12,929	2,456	27,338	7,777	16,578	4.69 /sf	67,078	32,512	6.96 /sf	99,590	0.00%
		610.			Battery Pad Generator													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	502.2 cy	30	3,711		8,035	2,264	5,022	37.90 /cy	19,032	9,179	56 /cy	28,210	0.00%
					Bldg Fill Gravel	39.15 cy	5	524	1,891	626	234		83.65 /cy	3,275	1,703	127 /cy	4,977	0.00%
					Div. 31 Earthwork		35	4,234	1,891	8,662	2,498	5,022	/cy	22,306	10,882	/cy	33,188	0.00%
					Earthwork Earthwork		**35**	**4,234**	**1,891**	**8,662**	**2,498**	**5,022**	**/cy**	**22,306**	**10,882**	**/cy**	**33,188**	**0.00%**
					610. Battery Pad Generator	1.000 ls	35	4,234	1,891	8,662	2,498	5,022	22,306.35 /ls	22,306	10,882	33,187.95 /ls	33,188	0.00%
		620.			Generator Pad													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	3551.85 cy	214	26,243		56,830	16,012	35,519	37.90 /cy	134,602	64,918	56 /cy	199,521	0.00%
					Bldg Fill Gravel	106.95 cy	13	1,430	5,166	1,711	639		83.65 /cy	8,946	4,651	127 /cy	13,597	0.00%
					Div. 31 Earthwork		227	27,673	5,166	58,541	16,650	35,519	/cy	143,548	69,570	/cy	213,118	0.00%
					Earthwork Earthwork		**227**	**27,673**	**5,166**	**58,541**	**16,650**	**35,519**	**/cy**	**143,548**	**69,570**	**/cy**	**213,118**	**0.00%**
					620. Generator Pad	1.000 ls	227	27,673	5,166	58,541	16,650	35,519	143,548.44 /ls	143,548	69,570	213,118.15 /ls	213,118	0.00%
		630.			EB3 UV AOP Electric Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	1141.35 cy	69	8,433		18,262	5,145	11,414	37.90 /cy	43,253	20,861	56 /cy	64,114	0.00%
					Bldg Fill Gravel	52.05 cy	6	696	2,514	833	311		83.65 /cy	4,354	2,264	127 /cy	6,618	0.00%
					Div. 31 Earthwork		75	9,129	2,514	19,094	5,456	11,414	/cy	47,607	23,125	/cy	70,731	0.00%
					Earthwork Earthwork		**75**	**9,129**	**2,514**	**19,094**	**5,456**	**11,414**	**/cy**	**47,607**	**23,125**	**/cy**	**70,731**	**0.00%**
					630. EB3 UV AOP Electric Building	15,684.750 sf	75	9,129	2,514	19,094	5,456	11,414	3.04 /sf	47,607	23,125	4.51 /sf	70,731	0.00%
		640.			EB4 MF/Ozone/BAC Electrical Building													
			Earthwork		Earthwork													
				Div. 31	Earthwork													
					Bldg Excavation Haul Offsite	832.65 cy	50	6,152		13,322	3,754	8,327	37.90 /cy	31,554	15,219	56 /cy	46,773	0.00%
					Bldg Fill Gravel	87.75 cy	11	1,173	4,238	1,404	524		83.65 /cy	7,340	3,816	127 /cy	11,156	0.00%
					Div. 31 Earthwork		61	7,326	4,238	14,726	4,278	8,327	/cy	38,894	19,035	/cy	57,929	0.00%
					Earthwork Earthwork		**61**	**7,326**	**4,238**	**14,726**	**4,278**	**8,327**	**/cy**	**38,894**	**19,035**	**/cy**	**57,929**	**0.00%**
					640. EB4 MF/Ozone/BAC Electrical Building	10,956.450 sf	61	7,326	4,238	14,726	4,278	8,327	3.55 /sf	38,894	19,035	5.29 /sf	57,929	0.00%
					014. - Site Prep Site Prep & Restoration	150.000 MGD	60,948	7,023,872	13,096,674	17,482,538	3,173,837	5,976,618	311,690.26 /MGD	46,753,539	22,595,045	462,323.89 /MGD	69,348,584	1.57%
	180. - 150 BBPL				150 MGD Backbone Pipeline Placeholder													
	* unassigned *																	
			* unassigned *															
				* unassigned *														
					Estimate Placeholder - Backbone Pipeline	***1.000 ls***							***/ls***			***/ls***		
					180. - 150 BBPL 150 MGD Backbone Pipeline Placeholder	150.000 MGD							/MGD			/MGD		
			01.02.01 Phase 2 (150 MGD) - 90 mgd IPR to Canyon SG + up to 60 mgd to Weymouth			150.000 MGD	2,683,503	263,726,021	287,456,577	390,408,069	39,211,419	470,052,215	9,672,362.02 /MGD	1,450,854,302	740,716,613	14,610,472.77 /MGD	2,191,570,915	49.67%

Estimate Totals										
Description	**Amount**	**Totals**		**Hours**	**Rate**		**Cost Basis**	**Cost per Unit**	**Percent of Total**	
Labor	456,177,393			2,683,503				3,966,759.943 /MGD	10.34%	
Overtime - 50 hr wk (w/ 1.5) 10%							C			
Material	437,893,856							3,807,772.662 /MGD	9.93%	
Subcontract	521,522,380							4,534,977.218 /MGD	11.82%	
Construction Equipment	59,928,347			323,943				521,116.058 /MGD	1.36%	
Process Equipment/Other Misc.	716,048,939							6,226,512.512 /MGD	16.23%	
Subtotal - Construction Cost w/ OH&P	**2,191,570,915**	**2,191,570,915**						**19,057,138.391 /MGD**	**49.67%**	**49.67%**
GC Allowances <list as req'd>							L			
Allowance 2- Non-Allocatable							L			
Allowance 3- Non-Allocatable							L			
Total Construction Costs (TCC)		**2,191,570,915**						**19,057,138.391 /MGD**		**49.67%**
BABA Allowances	2,874,566				1.00 %		C	24,996.224 /MGD	0.07%	
Allowance 1- Non-Allocatable Tarrifs	37,875,440				5.00 %		C	329,351.649 /MGD	0.86%	
Construction Contingency	547,892,729				25.00 %		T	4,764,284.599 /MGD	12.42%	
Total Construction Cost w/ Contingency	**588,642,735**	**2,780,213,650**						**24,175,770.870 /MGD**	**13.34%**	**63.02%**
Engineering & Design - Phase 1	55,604,273				2.00 %		T	483,515.417 /MGD	1.26%	
Engineering & Design - Phase 2	83,406,409				3.00 %		T	725,273.126 /MGD	1.89%	
Eng Services During Construct	166,812,819				6.00 %		T	1,450,546.252 /MGD	3.78%	
Engineering & Design Contingency (%)	139,010,682				5.00 %		T	1,208,788.543 /MGD	3.15%	
Engineering & Design Subtotal	**444,834,183**	**3,225,047,833**						**28,043,894.200 /MGD**	**10.08%**	**73.10%**
CM Fee - Phase 1							T			
CM Fee - Phase 2							T			
CMAR Fee		**3,225,047,833**						**28,043,894.200 /MGD**		**73.10%**
Owner's Allowance - ls							L			
Owner's Contingency	161,252,392				5.00 %		T	1,402,194.710 /MGD	3.65%	
Owner's Management Costs	225,753,348				7.00 %		T	1,963,072.594 /MGD	5.12%	
Owner's Soft Costs, Land, Legal etc.	64,500,957				2.00 %		T	560,877.884 /MGD	1.46%	
Owner's Costs and Allowances	**451,506,697**	**3,676,554,530**						**31,970,039.391 /MGD**	**10.23%**	**83.33%**
Escalation (4% per year to mid-point (2032))	735,310,906				20.00 %		T	6,394,007.879 /MGD	16.67%	
Grand Total:	**735,310,906**	**4,411,865,436**						**38,364,047.270 /MGD**	**16.67%**	**100.00%**
Total		***4,411,865,436***						***38,364,047.270 /MGD***		

Appendix D Basis of Engineer's Conceptual-Level Opinion of Probable Construction Cost for Pure Water Conveyance Facilities, Black & Veatch, 2025

FINAL DRAFT

BASIS OF ENGINEER'S CONCEPTUAL-LEVEL OPINION OF PROBABLE CONSTRUCTION COST FOR THE PURE WATER CONVEYANCE FACILITIES

B&V PROJECT NO. 410259

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PREPARED FOR

Metropolitan Water District of Southern California

17 DECEMBER 2025

In Association With:

BLACK & VEATCH | CDM Smith | DELVE underground

1.0 Introduction

The Metropolitan Water District of Southern California (Metropolitan) contracted Black & Veatch, with support from CDM Smith and Delve Underground (the BV Team), to complete conceptual-level design engineering services for the Pure Water Southern California (PWSC or Program) conveyance system and to prepare an Engineer's Opinion of Probable Construction Cost (OPCC). This Basis of Estimate (BOE) documents the OPCC's scope, methodology, assumptions, inclusions, exclusions, and accuracy.

1.1 Project Information

PWSC is a partnership between Metropolitan and the Los Angeles County Sanitation Districts (Sanitation Districts) to pursue the creation of a new, climate-resilient water supply by purifying the region's largest untapped source of treated wastewater, which is currently discharged to the ocean. Specifically, PWSC would include new treatment facilities and a new conveyance system to pump the purified water to select locations for beneficial reuse throughout Metropolitan's service area. This OPCC covers the conveyance system components. Metropolitan envisions implementing the Program in two phases. Phase 1 would produce approximately 115 million gallons per day (mgd) and Phase 2 would expand the Program capacity to 150 mgd.

The conveyance system would be comprised of a main "backbone pipeline" with two pump stations – the Whittier Narrows Pump Station (WNPS) and the Santa Fe Pump Station (SFPS). The 84-inch diameter backbone pipeline would be sized to convey 150 million gallons per day (mgd) and would extend approximately 40 miles from the new advanced water purification facility (AWPF) to the existing San Gabriel Canyon Spreading Grounds in the City of Azusa. The backbone pipeline would include nine service connections to deliver water to member agencies and recharge facilities. The backbone pipeline has been divided into eight reaches (Reaches 1 through 8), with Reach 8 further divided into Reach 8a and 8b.

To achieve raw water augmentation for direct potable reuse (DPR) in Phase 1, approximately ten miles of the San Gabriel Valley Municipal Water District's (SGVMWD's) existing 30-inch diameter Azusa Pipeline would be temporarily repurposed to send up to 25 mgd from the backbone pipeline east to the Satellite DPR Facility at Metropolitan's F. E. Weymouth Water Treatment Plant (Weymouth Plant). To repurpose the Azusa Pipeline, two new pump stations would be required, the Canyon Pump Station (PS) and the Big Dalton PS, as well as approximately 3 miles of new 30-inch diameter pipeline. The condition of the existing 30-inch pipeline is not fully known and may require rehabilitation to reuse.

DPR for Phase 2 would include a new 54-inch diameter DPR pipeline and DPR PS sized for 60 mgd. The DPR pipeline would extend approximately ten miles from the backbone pipeline at the SFPS to the Satellite DPR Facility. The DPR pipelines would connect to Metropolitan's existing infrastructure near the Weymouth Plant. A Program overview is provided on Figure 1-1.

Phase 1 Conveyance Facilities

1. Backbone pipeline – The main pipeline conveying purified water, extending approximately 40 miles from the AWPF to the existing San Gabriel Canyon Spreading Grounds (Canyon Spreading Grounds) in the City of Azusa.
2. Whittier Narrows Pump Station (WNPS) – A new pump station on the backbone pipeline located near the Whittier Narrows Dam.
3. Santa Fe Pump Station (SFPS) – A new pump station on the backbone pipeline located near the Santa Fe Dam.
4. San Gabriel Valley Muncipal Water District's Devil's Canyon-Azusa Pipeline (Azusa Pipeline) – An existing pipeline that would be repurposed and improved to convey up to 25 mgd of purified water from the backbone pipeline to the Satellite DPR Facility for DPR through raw water augmentation in Phase 1.
5. Canyon Pump Station (Canyon PS) – A new pump station on the Azusa Pipeline located near the backbone pipeline.
6. Big Dalton Pump Station (Big Dalton PS) – A new pump station on the Azusa Pipeline located near San Gabriel Valley Municipal Water District's (SGVMWD) Big Dalton Pressure Reducing Station.

Phase 2 Conveyance Facilities

7. DPR pipeline – A new pipeline conveying up to 60 mgd of water from the backbone pipeline to the Satellite DPR Facility for further treatment in Phase 2.
8. DPR Pump Station – A new pump station located near the middle of the DPR pipeline.

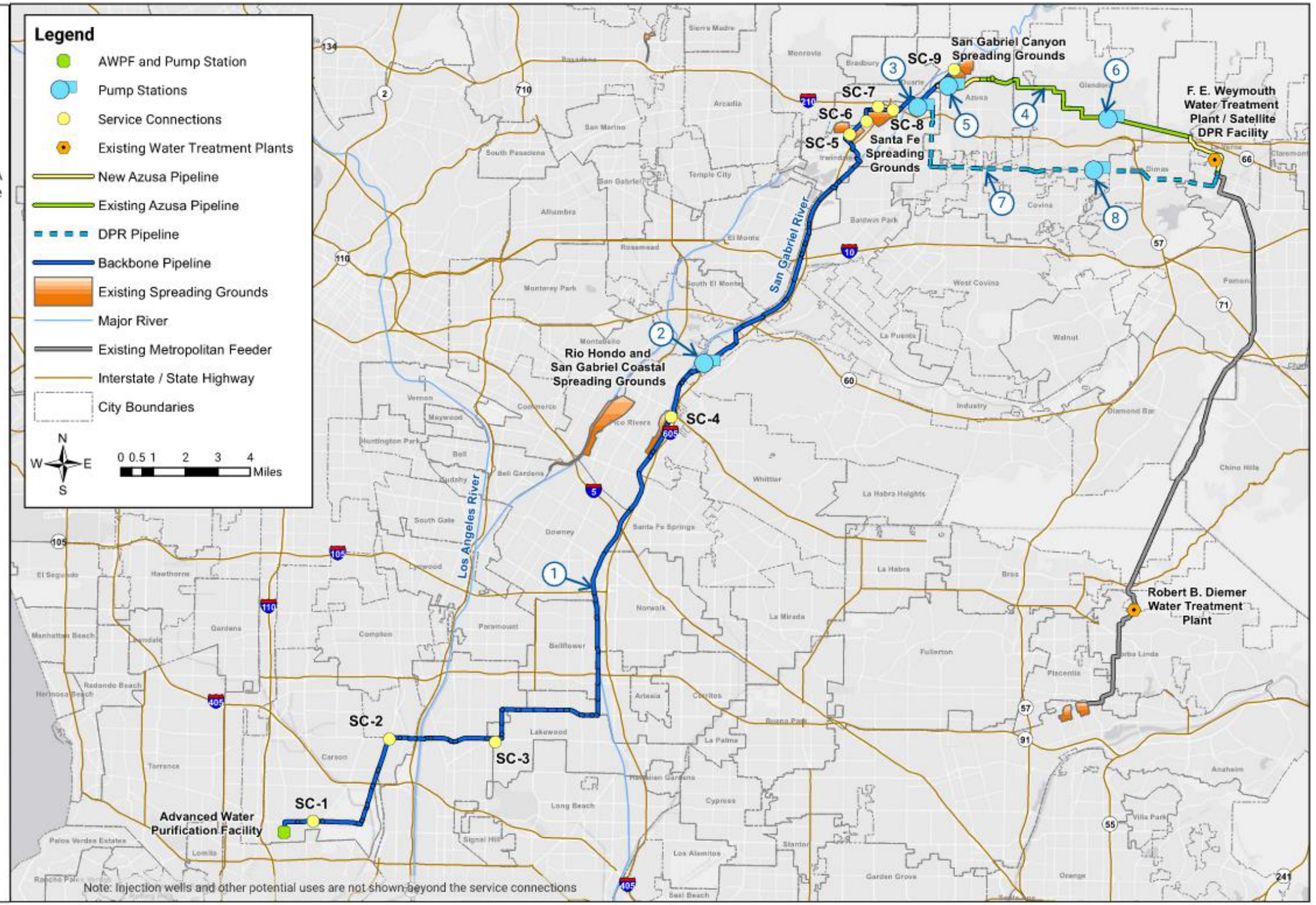


Figure 1-1. Pure Water Conveyance Facilities Overview Map

It should be noted that this Engineer's OPCC is based on the planning-level information and is intended to provide a cost range to assist with planning efforts. Any pipeline alignment refinements that occur after this cost update will be captured in the future OPCCs that will be prepared as part of the preliminary and final design of the respective component. Final costs will depend on actual labor and material costs, competitive market conditions, final scope, implementation schedule and contract packaging, and other variable factors, such as market conditions.

1.2 OPCC Classification Level

The OPCC classification level varies for the major components of the conveyance system based on the level of design definition. Components that had a greater level of definition received a Class 4 estimate in accordance with the American Association of Cost Estimators (AACE) standards, while components that had lower levels of definition received a Class 5 estimate. Class 4 estimates have a level of accuracy of -30% to +50%. Class 5 estimates have a level of accuracy of -50% to +100%.

Table 1-1 presents the OPCC classification level for each major component of the conveyance system.

Table 1-1. OPCC Classification Levels

Description	AACE Classification Level
Backbone Pipeline	Class 4
Backbone Pump Stations	Class 4
Phase 1 and 2 DPR Conveyance Facilities, including the DPR Pipeline, DPR Pump Stations, improvements to the Azusa Pipeline, Canyon PS, Big Dalton PS, and improvements to the Weymouth Plant	Class 5

1.3 Estimate Construction Cost Contingency

Estimate contingencies vary as a function of the design definition, as well as the level of effort applied to the preparation of the estimate. For a Class 4 and 5 estimate, the AACE International recommends using a contingency between 30 and 50 percent.

The estimating team assessed the design documents listed in Section 2.0 to generate this estimate. Based on this assessment, a contingency of 35 percent was applied to this OPCC, covering construction cost contingency based on the level of design definition.

It is anticipated that as the design progresses for the various facilities, the level of definition will increase and the contingency used in future estimates would decrease accordingly.

1.4 Detailed Scope of Work

1.4.1 Backbone Pipeline

Reach 1 through 8a of the backbone pipeline would be comprised of 84-inch inner diameter welded steel pipe (WSP), fabricated with steel plates or with coil steel for spiral-seam pipe. Reach 8b would be comprised of 48-inch inner diameter WSP. The pipelines would have working and design pressures as detailed in Section 6.1.4 of the Conceptual Design Report (CDR). The pipe interior would be lined with a polyurethane coating system, and the pipe exterior would be coated with a dielectric coating system, as specified in the CDR Section 6.1.8.

Sectionalizing valves would be 54-inch conical plug valves with electric motor actuators located in below grade valve vaults.

Service connections would consist of an isolation valve and a revenue flow meter, each installed in separate below grade vaults, and a check valve installed downstream of each flow meter. The revenue flow meter would be a Metropolitan standard venturi meter. The type and number of isolation valves varies depending on if the service connection is serving a typical pressurized system or a gravity fed spreading basin.

The pipeline would include appurtenant structures, including air/vacuum release valves, pump wells, blow off assemblies, and access manways. Each appurtenance would be located in a 9-foot diameter concrete manhole at its connection to the pipe.

The construction would also include removal and relocation of existing utilities, roadway and site restorations, and other required work.

1.4.2 Phase 1 DPR – Repurposing the Azusa Pipeline

The Phase 1 DPR pipeline includes repurposing the existing Azusa Pipeline. The improvements required to do this would include approximately 16,500 linear feet of new 30-inch inner diameter WSP to connect the Azusa Pipeline to the backbone pipeline on the west end and to Metropolitan's infrastructure near the Weymouth Plant on the east end. An isolation valve would be required at the connection to Metropolitan's existing infrastructure. Additional 30-inch piping and isolation valves would be required to bypass the Big Dalton Pressure Reducing Station. The condition of the existing Azusa Pipeline is not fully known. As such, an allowance has been provided for the rehabilitation of select areas of the existing pipeline, including the improvements at the Big Dalton Pressure Reducing Station and the connection to the La Verne Pipeline.

1.4.3 Phase 2 DPR Pipeline

The Phase 2 DPR pipeline would be comprised of 54-inch inner diameter WSP. The Phase 2 DPR pipeline was not studied at the same level of detail as the backbone pipeline and is only estimated at a Class 5 level with no sectionalizing valves or service connections assumed.

The pipeline would include appurtenant structures, including air/vacuum release valves, pump wells, blow off assemblies, and access manways. Each appurtenance would be located in a 9-foot diameter concrete manhole at its connection to the pipe.

1.4.4 Improvements at Weymouth Plant

The DPR pipelines would connect to existing infrastructure near the Weymouth Plant. Based on discussions with Metropolitan's operations staff, three tie-in connections are assumed for greater operational flexibility. As such, the connections would be on the La Verne Pipeline north of the Upper Feeder Junction Structure, the Yorba Linda Feeder south of the Upper Feeder Junction Structure, and the influent line into the Weymouth Plant west of the Upper Feeder Junction Structure. At each connection, new sectionalizing valves would be provided for isolation. Flow meters would be provided to measure flow to the Weymouth Plant and to the Robert B. Diemer Water Treatment Plant.

1.4.5 Pump Stations

Pump station cost opinions are based on horizontal split case pumps and would include a main pump building, electrical building, electrical substation/transformer farm, surge tank area, air compressor building, clearwell tanks, chemical building (where applicable), and administrative area. Each pump station would be as follows:

- The WNPS would have six pumps (5 duty / 1 standby) which would pump to the clearwell of the subsequent pump station. Each pump would be rated for 30 mgd at 465 feet of head. The WNPS is assumed to have a chemical booster facility.
- The SFPS would have two sets of pumps, which would be installed incrementally.
    - Set A would be installed in Phase 1 and would pump to the Canyon Spreading Grounds and the existing Azusa Pipeline. Set A would have 3 pumps (2 duty / 1 standby) rated at 20 mgd each at 130 feet of head.
    - Set B would be installed in Phase 2 and would pump east to the DPR pipeline and DPR PS. Set B would have four pumps (3 duty / 1 standby) rated at 20 mgd each at 350 feet of head.
- The Canyon PS would have 3 pumps (2 duty / 1 standby) rated at 12.5 mgd each at 475 feet of head. The Canyon PS is assumed to have a chemical booster facility.
- The Big Dalton PS would have 3 pumps (2 duty / 1 standby) rated at 12.5 mgd each at 425 feet of head.
- The DPR PS would have 4 pumps (3 duty / 1 standby) rated at 20 mgd each at 325 feet of head. The DPR PS is assumed to have a chemical booster facility.

1.5 Estimate Development

This estimate was developed by an estimating team familiar with the project elements and details, consisting of the following:

- Lead Estimating and Quality Control: CDM Smith
- Trenchless Estimating: Delve Underground
- Pump Stations and Phase 2 pipeline: Black & Veatch
- Quality Assurance: Black & Veatch

2.0 Estimate Documentation

The documents reviewed and utilized by the estimating team are as follows:

- *Pure Water Southern California Conveyance Facilities Conceptual Design Report*, Black & Veatch, April 2025 (CDR)
- *Pure Water Southern California Conveyance Facilities Feasibility Level Design Report*, Black & Veatch, May 2020 (FLDR)
- *Pure Water Southern California Conveyance System Reach 1 Preliminary Design Report and Preliminary Design Drawings*, BV Team, April 2024 (Reach 1 PDR)
- *Pure Water Southern California Conveyance System Reach 2 Preliminary Design Drawings*, HDR, April 2025 (Reach 2 PDR)
- *PWSC Cost Estimating Standards*, AECOM, September 2024
- *Residual Disinfectant Booster Pump Stations Analysis Draft Technical Memorandum*, Stantec, Carollo, and Trussell, October 2023 (Stantec Disinfectant BPS TM)
- Metropolitan Standard Details, May 2023

3.0 Estimating Methodology

3.1 Estimate Assumptions

The following assumptions have been made for the development of the OPCC:

- General:
    - This OPCC is based on the 7-foot backbone pipeline diameter option detailed in the CDR, with the refinements described below or noted elsewhere.
        - Minor refinements were made to the reach boundaries in the CDR to better align with Metropolitan's current planning. The revised reach extents are as described in Table 3-1.

Table 3-1. Reach Extents

Item	Description	Miles	Diameter
Reach 1	Main St to e/o LA River	6.7	84 inches
Reach 2	e/o LA River to n/o 91 fwy	7.8	84 inches
Reach 3	n/o 91 fwy to s/o Foster Rd	2.4	84 inches
Reach 4	s/o Foster Rd to n/o Slauson Rd	3.9	84 inches
Reach 5	n/o Slauson Rd to WNPS	4.2	84 inches
Reach 6	WNPS to n/o San Jose Creek	2.9	84 inches
Reach 7	n/o San Jose Creek to n/o Live Oak Ln	5.9	84 inches
Reach 8a	n/o Live Oak Ln to SFPS	4.1	84 inches
Reach 8b	SFPS to Canyon Spreading Grounds	1.5	48 inches
Total		39.4	

        - The alignment and construction methodology for Reaches 1 and 2 are based on their respective preliminary designs as of June 2025 with minor refinements to better align at their interface.
    - Geotechnical information was limited to desktop research for Reaches 3 through 8b, Pump Stations, and DPR Phase 1 and Phase 2.
    - All contracts are based on typical design-bid-build contracting methods.
    - All equipment and material are furnished by the contractor. There is no Metropolitan furnished equipment (MFE).
    - Construction would occur with "typical" conditions and do not account for non-typical constraints, including but not limited to:
        - Metropolitan's typical construction contract holidays are observed.
        - Minimal weather delay days.

        - No extended “no-work” or holiday moratorium durations.

- For open cut construction:
    - Work occurs 5-days per week, with each day consisting of a single 10-hour work shift.
    - Welded steel pipe is factory lined and coated.
    - Pipe spools are 20 feet long in roadways and 40 feet long in easements and private property.
    - Construction production averages 30 linear feet per day per crew within roadways and 100 linear feet per day per crew within easements or private property.
    - Trench width is 12’-0” for the 7-foot diameter pipeline and 9’-0” for the 4-foot diameter pipeline.
    - Depth of cover for the pipeline is:
        - Based on preliminary design profiles (June 2025) in Reaches 1 and 2.
        - 10 feet for open cut construction in streets and 7 feet in easements in Reaches 3 through 8.
    - Pipeline backfill:
        - Reaches 1 and 2 use slurry backfill for the pipe zone and trench zone to account for (1) the increased depth of cover as a result of utility congestion, (2) to minimize the potential for settlement, (3) the potential for contamination, and (4) to expedite construction to minimize traffic impacts.
        - The remaining Reaches use imported backfill material for the pipe zone and native soil for the trench zone as the assumed depth of cover is less and there is less potential for soil contamination.
    - Excavated soil handling and storage:
        - Excavated soil is transported to and stored at a staging area.
        - For Reaches 1 and 2, all soil is disposed of.
        - For the remaining reaches, soil required for backfill is transported back to the site.
        - Excess soil is transported to and disposed of at a landfill.
        - For Reaches 1 and 2, 30% of the excess soil volume is assumed to require a hazardous waste landfill per the Reach 1 PDR (April 2024).
        - For the remaining reaches, 6% of the excess soil volume is assumed to require a hazardous waste landfill.
- For trenchless/tunnel construction:
    - Each reach is its own contract requiring new equipment.

- Working hours:
  - Surface operations and shaft excavation work occurs 5 days per week, with each day consisting of a single 8-10-hour work shift.
  - Micro-tunneling and pipe jacking excavation and pipe installation occurs 5 days per week, with each day consisting of a single 8-10-hour work shift.
  - EPBM tunneling excavation and pipe work occurs 5 days per week, with three 8-hour shifts per day.
  - Some Saturday and Sunday maintenance occurs for micro-tunneling, pipe jacking, and EPBM tunneling.
- Shaft excavation support:
  - Excavations greater than 50-feet are supported with secant piles.
  - Excavations less than 50-feet are supported with sheet piles.
  - Rectangular shafts include internal bracing/walers.
  - Shaft excavation support is removed to 5-feet below grade at the end of construction.
  - No dewatering wells were assumed for sheet pile support but a nominal amount of inflow water (a few gallons per minute) would be removed.
- Minor utility relocations are required at shaft locations.
- Excavated diameter:
  - EPBM tunnels have 13-foot excavated diameter, which accounts for ventilation and tunnel train passing switch requirements.
  - Micro-tunneling and pipe jacking have 9-feet excavated diameter.
- All excavated soil is disposed; no re-use.
- Initial lining/casing:
  - EPBM tunnels' initial lining is pre-cast concrete segments.
  - Micro-tunneling and pipe jacking use steel casing pipe.
- Cellular grout is used for the annular backfill between casing/precast concrete segments and carrier pipe.
- Carrier pipe:
  - Carrier pipe is factory coated and lined for trenchless and tunnel installations. It should be noted that the factory coating of the carrier pipes for trenchless and tunnel installations was still being evaluated by Metropolitan as this OPCC was being prepared. If it is determined not to be required, this represents a potential cost savings for the program during future estimates.
  - For long tunnels, carrier pipe is field lined, as is common industry practice.

        - 20-30 foot spool lengths used for the carrier pipe.
        - Carrier pipe joints are not coated.
    - Roll-out facilities included with each EPBM tunnel.
    - EPBM tunnels include jet grouted safe havens.
    - For every reach except Reach 1, one microtunnel boring machine (MTBM) and/or pipe jacking operation is used and moved sequentially through the trenchless drives.
    - Reach 1 has two EPBM's operating concurrently in separate headings.
    - Reach 1 includes provision for encountering contaminated soil in the trenchless work, the remaining Reaches do not.
    - Reach 1 includes shafts and riser piping for service connections 1 and 2.
    - Reach 1 includes one southern launch shaft, one central launch/receiving shaft, and one north receiving shaft.
- For pump stations:
    - The pump station buildings are assumed to be of masonry construction (not pre-engineered) for budgeting purposes.
    - For planning purposes, the pump station building sizes shown on the drawings in the CDR were conservatively large. For this OPCC, the building footprints were refined based on similar size projects.
    - The WNPS includes the building, pumps, and facilities sized for 150 mgd (all constructed during Phase 1).
    - For the SFPS:
        - Phase 1 includes the building and facilities sized to accommodate the Set A (40 mgd) and Set B (60 mgd) pumps. However, only the Set A (40 mgd) pumps and associated electrical are installed.
        - Phase 2 includes the installation of the remaining Set B (60 mgd) pumps and associated electrical – no building expansion at Phase 2.
    - Expansion for potential future integration with other programs is not included in this cost estimate.
    - A demolition allowance has been included for the Big Dalton Pump Station as the only sites near its anticipated location require demolition of existing buildings or facilities.
    - Yard piping and sitework costs are allowances based on similar sized projects.
    - No dewatering costs are included.
    - No hazardous waste removal costs are included.

- The OPCC does not include any costs for special foundations like caissons, ground improvements, etc. It is assumed the pump station locations selected will be suitable for construction of facilities/scopes shown.
- Based on initial conversations with Southern California Edison (SCE) and the power requirements established in the CDR (Section 6.7.4), improvements to SCE's infrastructure may be required at the WNPS. Improvements may include a new substation, switchyard, and transmission lines. An allowance has been provided for these improvements based on the May 2025 AWPF power cost estimate completed by others and scaled down for the WNPS based on power demands.
- Power requirements at all other conveyance pump stations are anticipated to be small enough to not require additional substation facilities based on the power demands established in the CDR (Section 6.7.4).
- Chlorine booster pump facilities included at WNPS and Canyons PS for Phase 1, and at DPR PS for Phase 2. The costs of the facilities were based on the *Stantec Disinfectant BPS TM*.

- For service connections, the following mechanical equipment is included:

Table 3-2. Service Connections Mechanical Equipment

Service Connection	Metropolitan Owned Mechanical Facilities
SC-1	20-inch plug valve, 20-inch venturi meter, 20-inch check valve
SC-2	54-inch conical plug valve, 42-inch venturi meter, 42-inch check valve
SC-3	20-inch plug valve, 20-inch venturi meter, 20-inch check valve
SC-4	20-inch plug valve, 20-inch venturi meter, 20-inch check valve
SC-5	48-inch butterfly valve, 24-inch venturi meter, 42-inch check valve
SC-6	48-inch butterfly valve, 24-inch venturi meter, 42-inch check valve
SC-7	48-inch butterfly valve, 24-inch venturi meter, 42-inch check valve
SC-8	48-inch butterfly valve, 24-inch venturi meter, 42-inch check valve
SC-9	24-inch butterfly valve, 24-inch slide gate, 18-inch venturi meter, 24-inch check valve

- For DPR facilities:
  - This OPCC excludes the DPR satellite treatment facility and storage tanks, but includes lateral piping downstream of storage tanks, and valve and meter structures required to connect to existing pipelines/feeders.

  - Phase 2 DPR pipeline and pump stations are sized for 60 mgd. This assumes the Azusa Pipeline would no longer be used in Phase 2, requiring the DPR pipeline to convey they full 60 mgd flow to the Weymouth Plant. In the event the Azusa Pipeline can be used long term to convey 25 mgd, the DPR pipeline and pump station would only need to be sized for 35 mgd, resulting in potential cost savings.
  - The condition of the Azusa Pipeline is not known. An allowance has been included to account for minor rehabilitation of the existing pipeline, as well as new piping and isolation valves to bypass the Big Dalton Pressure Reducing Station and connections to the La Verne Pipeline.

- For Operating Expenses (OPEX):
  - OPEX costs were estimated for (1) labor, (2) maintenance and repair, and (3) energy costs for the pump stations. OPEX costs were not estimated for the pipeline.
  - Labor:
    - Annual labor costs were provided in June 2022 by Metropolitan for the AWPF PS and the WNPS based on similar sized pump stations. The labor costs were escalated to May 2025 using the Engineering News Report (ENR) Construction Cost Indices (CCI) for Los Angeles.
    - Labor costs for the SFPS, Canyon PS, Big Dalton PS, and DPR PS were scaled down from the labor for the WNPS.
    - Labor for the Disinfection Booster PS's at WNPS and Canyon PS were based on the *Stantec Disinfectant BPS TM* escalated to May 2025.
  - Maintenance and repair costs:
    - Maintenance and repair costs cover (1) materials and consumables required for operation of pumps, motors, and mechanical equipment and (2) a budget allowance for repair and replacement costs.
    - Maintenance and repair costs were estimated for the AWPF PS as part of the FLDR (May 2020) to provide a general order-of-magnitude for the material and repair costs required for the operation of the pumping stations. These costs were escalated to May 2025 using the ENR CCI for Los Angeles.
    - The WNPS is similar in size and was assumed to have the same maintenance and repair costs.
    - The maintenance and repair costs for the remaining pump stations were scaled down based on size.
    - Maintenance and repair costs for the Disinfection Booster PS's at WNPS and Canyon PS were based on the *Stantec Disinfectant BPS TM* escalated to May 2025.

- Energy costs:
  - An energy cost of $0.15/kWh was used.
  - No costs for demand fees or other ancillary power costs are included.
  - Pump efficiency of 85% used for the AWPF PS and 76% for all other pump stations based on initial pump selections.
  - The motor efficiency and variable frequency drive efficiency used was 95%, each.
  - For frictional hydraulic losses, a Hazen Coefficient of 130 was used.
  - Energy costs are based the full flow at each phase pumped 24 hours per day, 365 days per year; no downtime.

3.2 Estimate Exclusions

The following exclusions are made in the estimate. The exclusions are grouped into two categories, (1) items excluded from this OPCC but covered at the program level or (2) items excluded from this OPCC and not covered elsewhere:

- Items excluded from this OPCC but anticipated to be covered at the program level:
  - Pipeline laterals and other infrastructure downstream of the backbone service connections.
  - Provision/allowance for import tariffs and BABAA requirements.
  - Any costs for recharge facilities including improvements to existing facilities or purchase of new recharge facilities by Metropolitan.
  - AWPF product water pump station and product water pipeline from the clearwell to the centerline of Main Street (included in the AWPF OPCC prepared by others).
  - This OPCC is presented in May 2025 prices and was not escalated either to mid-point of construction or to start of construction for subsequent reaches.
  - Easements and land acquisition costs.
  - Soft costs were not included in this OPCC. These are typically applied as a percentage of the estimated construction costs to account for additional services. Some notable exclusions that are often covered by soft costs include:
    - CEQA permitting.
    - Metropolitan's staff time.
    - Engineering and construction management fees.
    - Public outreach.
    - Legal reviews.
    - Environmental and cultural resource monitoring during construction.

- Items excluded and not covered elsewhere:
    - Contingency for material cost fluctuation.
    - Fiber optic backbone conduit, pull boxes & cabling
    - Delays associated with environmental and cultural resource monitoring or findings.
    - Costs do not include backbone pipeline upsize or pump station expansions to accommodate water from other programs.
    - Differing site conditions.

3.3 Estimate Allowances

Allowances are included in the estimate to include the cost of unknown materials or quantities of known scope of work items, whether Lump Sum or Unit Priced. Allowances include all direct and indirect costs, as well as all contractor markups, unless indicated otherwise. Table 3-1 presents an overview of the allowances used in the estimate.

Table 3-3. Estimate Allowances Summary

Allowance	Description
Div. 00: Market / Location Difficulty Adjustment	Unit costs were derived from proprietary internal databases developed from similar projects in other markets / locations. This allowance was provided to adjust labor and equipment pricing to reflect the Los Angeles market.
Div. 00: Construction Activities Public Outreach (Non-Labor)	This allowance covers typical public outreach materials required of the Contractor by Div. 00 during construction.
Div. 00: Maintenance of Traffic	Traffic control requirements have not been defined at this conceptual level. This allowance covers the undefined features of the traffic control requirements which are not otherwise covered in the direct costs, such as reprogramming of traffic lights.
Div. 00: CEQA Mitigation Rules & Implementation	This allowance covers scope of work items that may be imposed on the Contractor as a result of the CEQA process and is based on the estimator's experience on similar projects.
Div. 02: Site Restoration not otherwise identified	This allowance covers site restoration not covered in the direct costs, which could include damage to pavement, curbs, gutters, driveways, etc. The allowance was based on the estimator's experience on similar projects and the existing conditions.
Div. 02: HAZMAT Disposal & Remediation (Non-Soil)	This allowance covers disposal of non-soil hazardous materials not otherwise covered in the direct costs. The allowance was based on the estimator's experience on similar projects.
Div. 26: Electrical, Fiber & Traffic Signalization	This allowance covers repairs to electrical, fiber, and traffic signals disturbed during construction. The allowance was based on the estimator's experience on similar projects and the existing conditions.
Div. 33: 54-inch conical plug valve	Direct material cost for each 54-inch conical plug valve. The allowance was based on input from Metropolitan.

Allowance	Description
Div. 33: Utility Temp Bypass & Relocation	This allowance covers temporary bypass and relocation of existing utilities for construction of the pipeline. The allowance was based on the estimator's experience on similar projects and the existing conditions.
Div. 33: Dewatering & Water Treatment	This allowance covers dewatering for pipeline exaction, including water treatment, where assumed. The allowance was based on the estimator's experience on similar projects and review of available data.
Div. 33: Dewatering & Water Treatment (Hazardous Removal)	This allowance covers the removal, treatment, and disposal of hazardous groundwater. The allowance was based on the estimator's experience on similar projects and review of available data.
Azusa Pipeline Rehabilitation	An allowance has been included to account for minor rehabilitation of the existing pipeline, as well as new piping and isolation valves to bypass the Big Dalton Pressure Reducing Station and connections to the La Verne Pipeline.
WNPS Substation	See Section 3.1 for description.

4.0 General Pricing Information

4.1 Labor Rates

Labor wage rates for the estimate are based on the July 2025 prevailing wage rate determinations for LA County, published by the California State Department of Industrial Relations rates (https://www.dir.ca.gov). These rates are segregated into base wages and fringes to calculate applicable payroll taxes. The rates also include insurance costs that are calculated on minimum rates with additional costs for insurance carrier markup. Overtime costs are calculated in each task's direct cost item for hours worked in excess of 8 hours per day or Saturday and Sunday. There is a straight time component and overtime component, as not all fringes are applied to overtime. The rate also includes a 2% adjustment for miscellaneous general unaccounted for overtime.

4.2 Equipment Rates

Equipment ownership and operating rates were tabulated using algorithms established in the latest edition (2022) of the *Corps of Engineers' Construction Equipment Ownership and Operating Expense Schedule for Region VII*, which covers the Southern California Region. These algorithms are based on historical records of equipment component usage and tied to specific requirements relating to the equipment model, horsepower, tire size, and so on. Other specialty equipment rates and pricing are based on vendor quotations, published data, and experience from other projects as applicable.

4.3 Material and Subcontractor Pricing

Where available, current budgetary vendor quotes for the main construction materials have been used in this estimate. For other items, a combination of sources such as published databases from RS Means or recent cost data from similar projects are used with adjustments as appropriate. State and local sales taxes are included on consumable and permanent materials incorporated into the Work.

4.4 General Conditions

Detailed General Conditions are indicated in the indirect cost section of the estimates.

4.5 Sales Tax

For the trenchless and open trench segments, local sales tax is included for all permanent and consumable materials and supplies, and equipment purchases and rentals included in the estimate. No tax-exempt status was assumed.

4.6 Escalation

No cost escalation has been included with the estimate to mid-point of construction or the start of the associated contract package. It is assumed the Program team will escalate the estimates as required.

5.0 Engineer's OPCC Summary

The table below presents a summary of the conceptual-level Engineer's OPCC in May 2025 dollars. The costs presented represent direct and indirect capital construction costs, inclusive of 35 percent contingency.

Table 5-1. Conceptual-Level Engineer's OPCC (May 2025 dollars)

Item	Construction Cost with 35% Contingency
Phase 1 Conveyance Facilities	
Backbone Pipeline	
Reach 1 (incl. SC-1, SC-2)	$796,400,000
Reach 2 (incl. SC-3)	$585,400,000
Reach 3	$160,500,000
Reach 4	$343,300,000
Reach 5 (incl. SC-4)	$493,000,000
Reach 6	$380,900,000
Reach 7	$453,600,000
Reach 8a (incl. SC-5, SC-6, SC-7, SC-8)	$418,500,000
Reach 8b (incl. SC-9)	$58,500,000
Backbone Pump Stations	
Whittier Narrows Pump Station (WNPS)	$197,900,000
Substation for WNPS	$78,000,000
Santa Fe Pump Station – Set A Pumps	$166,700,000
Azusa Pipeline Improvements & Pump Stations	$225,400,000
Subtotal Phase 1 Conveyance Facilities	**$4,358,100,000**
Phase 2 Conveyance Facilities	
Santa Fe Pump Station – Set B Pumps	$17,100,000
DPR Pump Station	$114,800,000
DPR Pipeline	$395,200,000
Improvements at Weymouth Plant	$20,900,000
Subtotal Phase 2 Conveyance Facilities	**$548,000,000**
Total Phase 1 + Phase 2 Conveyance Facilities	**$4,906,100,000**

Note: Costs presented represent direct and indirect capital construction costs, inclusive of 35 percent contingency, in May 2025 dollars. No soft costs are included.

Table 5-2 presents a summary of the conceptual-level annual operating expenses for the conveyance system in May 2025 dollars. The costs presented for each pump station represent annual costs for labor, O&M, and energy.

Table 5-2. Conceptual-Level Operating Expenses (May 2025 dollars)

Facility	Labor Cost	O&M Cost	Energy Cost	Total Cost
Phase 1 Conveyance Facilities				
AWPF	$590,000	$280,000	$6,970,000	$7,840,000
WNPS[1]	$671,000	$363,000	$11,018,000	$12,052,000
SFPS – Set A	$470,000	$240,000	$1,550,000	$2,260,000
Canyon PS[1]	$441,000	$220,000	$2,338,000	$2,999,000
Big Dalton PS	$360,000	$180,000	$2,250,000	$2,790,000
Total Phase 1 Conveyance Facilities Operating Costs				**$27,941,000**
Phase 2 Conveyance Facilities				
AWPF	$590,000	$280,000	$10,020,000	$10,890,000
WNPS[1]	$671,000	$363,000	$13,828,000	$14,862,000
SFPS – Set A	$470,000	$180,000	$490,000	$1,140,000
SFPS – Set B[1]	$551,000	$275,000	$5,068,000	$5,894,000
DPR PS	$470,000	$240,000	$4,560,000	$5,270,000
Total Phase 2 Conveyance Facilities Operating Costs				**$38,056,000**

1. Pump station operating expenses include costs for chemical booster facilities.

6.0 Key Drivers for Cost Increase Compared to Previous Estimate

The table below presents a comparison of the prior OPCC from June 2022 to this OPCC using May 2025 dollars. The costs presented represent direct and indirect capital construction costs, inclusive of 35 percent contingency. To compare the costs in equivalent dollars, the prior OPCC was escalated to May 2025 dollars using the ENR CCI for Los Angeles.

Table 6-1. Summary of Comparison to Previous Estimate (May 2025 Dollars)

Item	Prior June 2022 OPCC (escalated to May 2025)	Current OPCC (May 2025)
Phase 1 Conveyance Facilities		
Whittier Narrows Pump Station (WNPS)	$141,000,000	$197,900,000
Substation for WNPS	-	$78,000,000
Santa Fe Pump Station – Set A Pumps	$48,600,000	$166,700,000
Backbone Pipeline	$2,321,600,000	$3,690,100,000
Azusa Pipeline Improvements & Pump Stations	$98,800,000	$225,400,000
Subtotal Phase 1 Conveyance Facilities	**$2,610,000,000**	**$4,358,100,000**
Phase 2 Conveyance Facilities		
Santa Fe Pump Station – Set B Pumps	-	$17,100,000
DPR Pump Station	$63,800,000	$114,800,000
DPR Pipeline	$291,100,000	$395,200,000
Improvements at Weymouth Plant	-	$20,900,000
Subtotal Phase 2 Conveyance Facilities	**$354,900,000**	**$548,000,000**
Total Phase 1 + Phase 2 Conveyance Facilities	**$2,964,900,000**	**$4,906,100,000**

Notes:

1. *Costs presented represent direct and indirect capital construction costs, inclusive of 35 percent contingency, in May 2025 dollars. No soft costs are included.*
2. *June 2022 OPCC was escalated to May 2025 dollars using ENR CCI for Los Angeles. Escalation is 18.4%.*
3. *Prior costs in 2022 for the backbone pipeline included upsizing 14-miles to 9-foot diameter ($620,700,000 after escalation to May 2025 dollars). Current costs in 2025 do not include any upsizing.*
4. *June 2022 OPCC costs for Phase 2 Conveyance Facilities are from the June 7, 2022 Interim OPCC Update based on 60 mgd.*

The construction costs have increased between the prior June 2022 OPCC (escalated to May 2025 dollars) and this OPCC. The major factors driving the largest impact on the cost increase are as follows:

Materials and Market Conditions

- Steel pipe cost: The cost of steel pipe has increased at a rate exceeding the ENR CCI for Los Angeles.
- Trenchless material and installation costs: The unit costs for trenchless installations have increased at a rate exceeding the ENR CCI for Los Angeles.

Scope Refinements

- Additional trenchless required: As a result of design advancements and revisions to the alignment, this OPCC is based on additional trenchless construction. Please refer to Section 6.2 of the CDR for additional details on each trenchless drive.
- Additional utilities, soils handling & deeper alignments and shafts in Reach 1 and 2:
    - Detailed utility investigations have been completed as part of the preliminary design of Reach 1 and 2, which resulted in a significant increase in the number of existing utilities being identified. This OPCC reflects changes to construction methodology as a result, which includes deeper alignments and shafts, increased soils handling, and utility relocations.
    - Prior estimates assumed select backfill material (sand/gravel) around the pipe zone and native material for the remaining backfill for open cut construction. This OPCC is based on CLSM backfill in Reach 1 and 2 to more adequately account for the potential presence of hazardous materials, volume of truck traffic, and speed of installation.
- Pipeline lining and coating change: Prior estimates were based on cement mortar lined and coated steel pipe. This OPCC is based on a polyurethane lining system and a Novolac epoxy or polyurethane coating system. The lining system was selected based on an evaluation of the AWPF's anticipated product water quality. The coating system was selected to address corrosive ground conditions and separation requirements as a result of the additional investigations completed. Please refer to Section 6.1 of the CDR for details.
- Deeper trenchless crossings and shafts: Prior estimates applied a uniform assumption for the depth of cover as a multiplier of the excavated diameter. The design has progressed since then allowing for specific evaluation of each trenchless drive and consideration of existing features. As a result, this OPCC is based on an increased depth of cover for many of the trenchless installations to more appropriately provide separation from existing utilities or other sensitive infrastructure to prevent settlement or damage. As a result, the shafts have deepened, there are more impacts from groundwater, and more robust shaft construction is required. Please refer to Section 6.2 of the CDR for additional details on each trenchless drive.
- Hazardous materials disposal in Reach 1: As a result of the additional field investigations completed in Reach 1 to support the preliminary design, a greater amount of hazardous materials disposal has been assumed for this OPCC.
- Additional allowances:
    - An allowance has been included for requirements during construction as a result of CEQA.
    - An allowance has been included for public outreach requirements by the Contractor.
    - An allowance has been included for laydown rental.
    - A 5% allowance for mobilization has been included per the new program OPCC guidelines, which is higher than assumed in prior estimates.

- Depth of cover: Prior estimates were based on 8-feet of cover on average for open cut construction in streets and approximately 5-feet of cover in easements. This OPCC is based on 10-feet of cover in city streets and 7-feet of cover in easements due to the increased quantity of existing utilities that have been identified and additional conversations with the property owners for the easements.
- Shorter pipe spools: Prior estimates assumed 40-foot spools in city streets. As a result of the increased frequency of utilities that have been identified during the additional investigations completed and the challenges of handling longer pipe spools in a congested area, this OPCC is more appropriately based on 20-foot pipe spools in city streets. This results in an increased amount of work (welding, coating, lining, testing) due to the higher quantity of joints and subsequently in higher cost.
- Concrete encasement in SCE easements: Based on feedback from SCE during conceptual design development for the backbone pipeline, this OPCC assumes concrete encasement would be required in certain locations within SCE right-of-way near SCE transmission towers to protect the pipeline and allow for higher loading from SCE's maintenance vehicles and equipment.
- River Tunnel excavated diameter increase: Prior estimates assumed an excavated tunnel diameter of 11.58 feet for the SG River tunnel. During the more detailed evaluation of this tunnel, it was determined that intermediate shaft sites are not readily available. Due to the lack of intermediate shaft sites, this OPCC has increased the excavated tunnel diameter assumed to 13 feet to account for the utilities that are required as a result.
- Pavement restoration: Prior estimates assumed paving restoration of the trench excavation plus a grind and overlay extending 2 feet on either side of the trench, consistent with many cities' standard details. However, for large diameter pipelines, it is common for the cities to require a grind and overlay from curb to curb or curb to median, as applicable. This OPCC is based on a grind and overlay from curb to curb or curb to central median, as applicable.
- Azusa Pipeline improvements:
    - Prior estimates assumed ~7,000 linear feet of new 30-inch pipe required to connect the Azusa pipeline to Metropolitan facilities. As a result of the alignment evaluation completed, this OPCC is based on the latest alignment, which requires ~16,500 linear feet.
    - Prior estimates did not include improvements to the existing Azusa Pipeline, as the condition was not known to estimate improvements. To provide a more conservative budgeting purposes, this OPCC includes a $25M allowance for improvements to the Azusa Pipeline.
- Pump station design refinements:
    - Demolition of existing structures now assumed at select pump station sites.
    - This OPCC assumes the pumps and mechanical equipment are housed in a building for added security in highly urbanized areas, to match the aesthetics of the surrounding communities, and to reduce maintenance of the facility.

- The pump type assumed changed from vertical turbine to horizontal split case as they provide a lower lifecycle cost, are more familiar to Metropolitan staff, and improve operation and maintenance. See Section 6.3.1 of the CDR for additional details on the pump evaluation completed.
- The clearwell size increased from 7.5 million gallons to 16 million gallons at the WNPS and SFPS to improve operation and reduce maintenance by simplifying pumping control strategies, improving protection of Metropolitan infrastructure during surge events, providing operational storage, providing a buffer to meet regulatory requirements, and providing reserve storage for downtime due to pump trip issues. Clearwells added to Phase 1 DPR Pump Stations for similar reasons.
- Compressors were previously assumed to be housed in the electrical building. The CDR assumes the compressors have their own building.
- Addition of chemical booster and feed buildings and chemical injection vaults at WNPS and Canyon PS.
- Addition of SCE substation at WNPS as a result of additional coordination with SCE.
- Addition of bridge cranes to facilitate maintenance.

Contractor Markups

- Markups on trenchless work for hybrid reaches: At the time the prior estimate was prepared, the contract packaging and methodology had not been determined. One option being considered was to bid the trenchless construction separately. Therefore, the prior estimate did not assume secondary markups on the trenchless work by a General Contractor. It is currently anticipated that all work within each reach, whether it is open cut or trenchless, would be bid together. Therefore, this OPCC more appropriately assumes a General Contractor would have overhead and profit markups for the trenchless work for Reaches 2, 3, 5, 6, 7, 8A, and 8B. Reaches 1 and 4 are mostly tunnels and are assumed to have a tunneling contractor as the prime.
- Indirect construction cost markups: As is typical with high level planning estimates, the prior estimate used typical markup percentages for the Contractor's indirect costs, including overhead, profit, bonds, insurance, and general requirements. Together, these indirect costs totaled ~34.68% of the direct costs. Since then, two things lead to an increase in the indirect construction costs applied for this OPCC: (1) the engineering has progressed resulting in a greater level of design definition and understanding of the complexities of the general requirements and general conditions for the work; and (2) the *PWSC Cost Estimating Standards* were published. The *PWSC Cost Estimating Standards* provides markup percentages for indirect costs, which, along with the increased understanding of the complexities of the general requirements and general conditions, result in an increase in the indirect construction cost markups. In total, this OPCC applies an average of ~45.2% in indirect construction cost markups on the direct costs.

Appendix E Program Cost Comparison of PWSC & GWRS

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

PURE WATER SOUTHERN CALIFORNIA

Date: February 6, 2026

To: Mr. Craig Parker, Assistant General Manager, Water Services
Anaheim Public Utilities

From: Gloria Lai-Blüml, Interim Program Manager, Pure Water Southern California
Metropolitan Water District of Southern California

Subject: Program Cost Comparison of Pure Water Southern California and OCWD Groundwater Replenishment System

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Background

Pure Water Southern California (Pure Water, or PWSC) is a proposed partnership between Metropolitan and the Los Angeles County Sanitation Districts (Sanitation Districts) to beneficially reuse cleaned wastewater that is currently being discharged to the Pacific Ocean from the Sanitation Districts' A.K. Warren Water Resource Facility (Warren Facility) in the City of Carson. At full buildout, Pure Water would purify up to 150 million gallons per day (MGD), making it one of the largest programs of its kind in the world. Implementation of Pure Water would provide regional benefits to all Metropolitan member agencies by: (1) reducing reliance on imported water; (2) diversifying locally available supplies; (3) improving resilience to climate change and other stressors; and (4) enhancing operational reliability and flexibility.

Pure Water would include an Advanced Water Purification Facility (AWPF) and conveyance system to deliver purified water for indirect and direct potable reuse (IPR and DPR) applications. The AWPF would consist of the Advanced Water Treatment (AWT) facility owned and operated by Metropolitan, as well as the pretreatment and Membrane Bio-Reactors Facility (MBR) owned and operated by the Sanitation Districts. AWT processes for indirect potable reuse are anticipated to include reverse osmosis (RO) and ultraviolet/advanced oxidation process (UV/AOP) disinfection. Additional processes for DPR may include a combination of chlorine dioxide, UV, ozone, and granular/biological activated carbon (GAC/BAC) processes.

For environmental and conceptual planning purposes, Pure Water is envisioned to be implemented in two phases - Phase 1 (115 MGD) and Phase 2 (150 MGD) with ultimate buildout to 150 MGD. However, Metropolitan is also considering additional program staging options as a subset of Phase 1, which includes 45, 75, and 115 MGD. The capital and operation and maintenance (O&M) costs for both phases, as well as the staging options for Phase 1, were presented to Metropolitan's Board on September 23, 2025, and are summarized in the 2025 Pure Water Southern California Cost Estimate Memorandum prepared by Metropolitan's Pure Water program management consultant (PMC). This Memorandum is currently being finalized and is anticipated to be available shortly.

2025 Program Cost Update

The 2025 program cost update was benchmarked against historical data, vendor quotes, and comparable large-scale water reuse projects. Sensitivity analyses were performed to account for escalation, market volatility, and scope adjustments. The cost estimate for Phase 1 reflects an increase from the 2023

estimate from $4.9 billion to $8.3 billion, and from $5.8 billion to $9.8 billion for the full program build-out (Metropolitan costs only). Key drivers for this cost increase are highlighted below.

- Conveyance System: Costs increased from $1.8 billion to $3.7 billion in Phase 1 due primarily to the higher cost of steel and trenchless operations, as well as design refinements, and adjustments to contractor markups to be consistent across the program.
- Advanced Water Treatment: Costs increased from $0.9 billion to $1.1 billion due primarily to scope refinements, materials costs, escalation and market conditions.
- Indirect Costs, Allowances and Contingencies: Costs increased from $1.8 billion to $3.4 billion due to an increase in the assets' capital costs and allowances for contingency, program management, and engineering, which are all calculated as percentages of the higher construction costs. In addition, allowances have been included for tariffs and Build America/Buy America Act (BABAA) compliance as a percentage of the total program costs.

Summary of Comments from City of Anaheim

In February 2024 the Assistant General Manager of the City of Anaheim emailed the following comments for Metropolitan's consideration:

1. *Why are the Pure Water Project costs so much higher than OCWD GWRS? Recommendation to reach out to OCWD staff to fully understand how they completed and operate their GWRS Project at such lower costs.*
2. *Project currently has plans to build a new lab and employ 40 to 50 new employees. This seems excessive.*
3. *Project will be funding a new Workforce Training Center. While I support the Workforce Training Center, I believe you could find outside funding sources for an item such as this.*
4. *Regarding implementing Direct Potable Reuse into to the project should be investigated. My understanding is that DPR is only providing about 25 of the 115 MGD of the Project. However, DPR related costs add substantial costs to the project. Indirect Potable Reuse, which will provide water to recharge basins, is a much more economical approach and would probably reduce the length of the pipelines, which is a substantial part of the costs.*
5. *You are pursuing grants, and contributions from agencies such as LA County Sanitations Districts and Southern Nevada Water Authority. I would highly encourage pursuing these vigorously.*

Detailed Response to Comment #1: Comparison to GWRS Program Costs

Metropolitan appreciates these comments and the insights that may help us lower the overall program costs.

Orange County Water District's (OCWD) Groundwater Replenishment System (GWRS) has a capacity of 130 mgd and takes secondary treated wastewater from the Orange County Sanitation District (OC San) and purifies it using a three-step advanced treatment process consisting of microfiltration (MF), RO, and UV/AOP disinfection. GWRS water is recharged into the local groundwater basin where it supports increased groundwater basin pumping by local cities and retail water districts. Thus, GWRS is an IPR program only, with no DPR facilities. Approximately 30 MGD of GWRS water can be pumped into injection wells to create a seawater intrusion barrier. Another 100 MGD is conveyed approximately 13 miles to OCWD's percolation basins in Anaheim where the GWRS water naturally filters through sand and gravel to the deep aquifers of the groundwater basin to increase the local drinking water supply. OCWD can also inject up to 10 MGD into wells located in the City of Santa Ana.

GWRS came online in 2008, producing 70 MGD for $481 million. It was expanded in 2015, producing an additional 30 MGD for $142 million. The final expansion, completed in 2023, increased production capacity by another 30 MGD for $284 million, bringing the total plant capacity to 130 MGD. Total capital costs are therefore approximately $900 million over a span of 15 years. This includes construction, engineering/legal/admin (ELA), and program management for all program facilities including the treatment, conveyance and recharge infrastructure summarized above.

To adequately compare Pure Water costs to those of GWRS, the PMC used the capital and O&M estimates for the Pure Water 75 MGD and GWRS 70 MGD capacities in 2025 dollars, without adjustments for grants or contributions. As GWRS does not have a DPR component and the conveyance system is very different in the overall configuration, the cost comparison between the two programs was focused on the IPR process components (AWT only, without the Sanitation Districts' MBR or pretreatment facilities) excluding the conveyance system. The Pure Water estimate for 75 MGD would be the closest capacity option for comparison purposes.

The cost comparison is detailed in **Attachment A** and summarized below:

1. Capital costs for the two programs are not directly comparable because of the difference in time and capacity at which GWRS was implemented. However, the PMC performed a high-level comparison of the GWRS 70 MGD facility (in 2025 dollars) and the Pure Water 75 MGD capacity scenario (for AWT facilities only) and found that the cost difference falls within the expected range for a Class 5 estimate (i.e. expected accuracy range between -50% and +100%). Pure Water's projected capital cost is approximately 34% higher than that of GWRS on a $/MGD basis. This is primarily due to early design maturity necessitating higher construction contingency costs, and the inclusion of allowances for a program management consultant (given the program size and complexity), BABAA requirements, and tariffs.

2. O&M costs for the GWRS 70 MGD facility (in 2025 dollars) and the Pure Water 75 MGD capacity scenario (for AWT facilities only) are within a reasonable cost range. Pure Water's projected O&M cost is approximately 78% higher than that of GWRS on an annual $/MGD basis. This is primarily due to the early design maturity necessitating higher O&M contingency costs, as well as higher projected plant maintenance costs due to the additional facilities needed for Pure Water in comparison to GWRS (such as process buildings, ancillary facilities, public outreach facilities, and a workforce training center).

Detailed Response to Comment #2: Laboratory Staffing

Metropolitan estimates approximately 55 laboratory staff would be required at full buildout of 150 MGD, which includes 40 laboratory staff for IPR- and 15 laboratory staff for DPR-focused work. The staffing level is based on Metropolitan's experience in operating large water treatment facilities, as well as scaling comparable large-scale operating water reuse projects like GWRS. GWRS's current operating staff of 66 FTE (for 130 MGD capacity) includes 33 IPR-focused laboratory staff. As a result, Pure Water's laboratory staffing level is comparable to GWRS, given Pure Water's higher capacity (150 MGD vs. 130 MGD) and additional DPR analytical requirements for regulatory compliance.

Detailed Response to Comment #3: Outside Funding for Workforce Training Center

The Workforce Training Center is essential in developing local workforce skills and creating employment opportunities locally within our communities. Costs are anticipated to be shared between the Sanitation Districts and Metropolitan. Metropolitan is also monitoring state and federal grant opportunities and will pursue available grants to supplement funding for this facility.

Detailed Response to Comment #4: DPR Implementation

Metropolitan will consider various staging options, including both IPR and DPR. IPR is essential to replenish diminishing groundwater supplies in several basins and requires the construction of an approximately 39-mile large-diameter backbone conveyance system to reach the areas with the greatest replenishment demand in the Main San Gabriel Basin. An additional approximately 10 miles of smaller diameter pipeline would be needed to convey a portion of the water eastward to Metropolitan's Weymouth plan in the City of La Verne for DPR by augmenting Metropolitan's regional raw water supplies. In Phase 1 (115 MGD), approximately 25 MGD would be temporarily conveyed through the existing Azusa Pipeline owned by the San Gabriel Valley Municipal Water District. In Phase 2 (150 MGD), a new DPR pipeline would be constructed to convey approximately 60 MGD. However, Metropolitan may consider reducing the size of the DPR pipeline to convey only 35 MGD if the Azusa Pipeline is able to be used on a more permanent basis. In addition, Metropolitan is evaluating opportunities to incorporate DPR via treated water augmentation with direct connections along the backbone pipeline to one or more existing feeders, which would eliminate the need for the additional 10 miles of DPR pipeline to the Weymouth plant, resulting in potential cost savings.

Metropolitan is currently assessing DPR implementation for its conceptual feasibility, infrastructure requirements, planning-level costs, and implementation strategies via raw water augmentation and/or treated water augmentation. Current known DPR demands and considerations for potential constraints and benefits will be included in the study. This assessment will be refined and investigated through targeted research studies, pilot/demonstration testing, additional engineering, costing, and design inputs. The preliminary findings will be presented to Metropolitan's Board this spring.

Detailed Response to Comment #5: Grants and Partnership Contributions

Pure Water has secured both state ($80 million) and federal ($130.5 million) grant funding. Metropolitan is also seeking other grant opportunities and partnership contributions. Most notably, the Sanitation Districts is committed to partner with Metropolitan to build and operate the AWPF facilities for Pure Water. In addition, the Southern Nevada Water Authority is actively engaged with Metropolitan in a potential partnership, and Metropolitan is also working with other State Water Project and Colorado River partners for their potential contributions to Pure Water.

Attachment A

Cost Comparison of Pure Water Southern California and OCWD Groundwater Replenishment System

Capital Cost Comparison

Pure Water is envisioned to be implemented in two phases - Phase 1 at 115 MGD and Phase 2 (ultimate buildout) at 150 MGD. Phase 1 will build 90 MGD IPR and 25 MGD DPR capacities, and Phase 2 adds another 35 MGD DPR capacity. Additional staging options of 45, 75, and 115 MGD, as a subset of Phase 1, are also considered. The capital and O&M costs for both phases, as well as the staging options, were presented to Metropolitan's Board on September 23, 2025, and are summarized in the 2025 Pure Water Southern California Cost Estimate Memorandum prepared by Metropolitan's Pure Water program management consultant (PMC).

As GWRS does not have a DPR component and the conveyance system is very different in the overall configuration, the cost comparison between the two programs is focused on the IPR process components (AWT only, without the Sanitation Districts' pretreatment and MBR facilities) excluding the conveyance system. Conveyance system capital costs for the two programs are not comparable because of the significant difference in pipe sizes, materials, construction methods, subsurface conditions, and length (13 miles for GWRS versus approximately 50 miles for Pure Water), as well as the need for appurtenant facilities including five pump stations with adequate clearwell capacity, nine service connections, isolation valves, electrical substation, etc.

All Pure Water estimates are at Class 5 level (AACE Cost Estimating Classification System) based on the current maturity level of project definition deliverables, with a corresponding expected accuracy range between -50% and +100%.

Pure Water's estimate for 75 MGD would be the closest capacity option for comparison. GWRS (70 MGD) started design in 1995, started construction in 1999 and was commissioned in 2008. As these events occurred many years ago, a large escalation factor of 94 percent needs to be applied to adjust the GWRS cost from the 2008 to the 2025 dollars using the City Cost Index for Los Angeles (CCI-LA) for cost comparison. CCI-LA and CCI-Orange County are assumed to be similar for this period. The long escalation period to bring the GWRS costs to 2025 dollars adds complexity to the comparison of similar equipment, supplies, labor pools, site preparations, compliance requirements, and building construction.

Table 1 is a high-level capital cost comparison between the GWRS 70 MGD IPR facility and the Pure Water 75 MGD IPR-only AWT facility. The resulting cost difference falls within the expected accuracy range for a Class 5 estimate, with the expected accuracy range between -50% and +100%. The analysis indicates that the 75 MGD Pure Water IPR facility is approximately 43% higher than the 70 MGD GWRS facility in cost (2025 dollars), or 34% higher on a $/MGD basis to adjust for the slight difference in capacities. This is primarily due to early design maturity necessitating higher construction contingency costs, and the inclusion of allowances for a program management consultant (given the program size and complexity), BABAA requirements, and tariffs. These are based on conservative assumptions given the early design maturity, and actual capital costs may be less. Table 1 provides a detailed breakdown of this comparison.

Table 1 – PWSC (75 MGD) and GWRS (70 MGD) AWT Capital Cost Comparison

Description	GWRS 70 MGD *Actuals* in 2008$ (2)	GWRS 70 MGD *Actuals* in 2025$ (1), (2)	PWSC 75 MGD in 2025$ (3)	Variance ($M)	Variance (%)
Pre-selection Services (MF and UV Engineering)	$ 861,526	$ 1,671,360	$ -		
Program Management(4)	$ 807,221	$ 1,566,009	$ 41,310,119		
Construction Cost	$ 409,858,792	$ 795,126,056	$ 826,202,370		
Engineering, Legal and Administrative	$ 69,372,461	$ 134,582,574	$ 206,550,593		
Tariff Allowance (3.5%)	$ -	$ -	$ 7,229,271		
BABAA Allowance (1%)	$ -	$ -	$ 8,262,024		
Contingency (30%)	$ -	$ -	$ 247,860,711		
Total Project Cost	**$ 480,900,000**	**$ 932,946,000**	**$ 1,337,415,087**	**$ 404,469,087**	**43%**
Cost by MGD		**$ 13,327,800**	**$ 17,832,201**	**$ 4,504,401**	**34%**

(1) Inflation Factor based on ENR CCI-LA (1.94)
(2) GWRS includes all program facilities including the treatment, conveyance and recharge infrastructure
(3) PWSC includes AWT only, excluding the Sanitation Districts' MBR and the conveyance system.
(4) GWRS includes Construction Management Trailers

O&M Cost Comparison

Similar to the capital cost comparison, the O&M costs for PWSC AWT at 75 MGD and GWRS at 70 MGD were used for the O&M cost comparison. As the conveyance systems of the two programs are quite different in complexity, size, length, facilities, staffing needs, labor costs for qualified delivery staff, and end-users' needs, a direct conveyance system O&M cost comparison was not completed between the two programs.

Assumptions for the PWSC AWT O&M costs include:

- Electricity rate: $0.15/kWh
- Labor rate: $150/hour; 2,080 hours annually
- Maintenance: 3% of equipment cost
- Sales tax on replacement components: 9.5%
- Contingency: 15%
- Major equipment replacement: 1% of construction cost

O&M costs for the GWRS 70 MGD facility (in 2025 dollars) and the Pure Water 75 MGD capacity scenario (for AWT facilities only) are within a reasonable cost range. Pure Water's projected O&M cost is approximately 91% higher than the GWRS O&M costs (in 2025 dollars), or 78% higher on an annual $/MGD basis to adjust for the slight difference in capacities. This is primarily due to the early design maturity necessitating higher O&M contingency costs, as well as higher projected plant maintenance costs due to the additional facilities needed for Pure Water in comparison to GWRS (such as process buildings, ancillary facilities, public outreach facilities, and a workforce training center). These are based on conservative assumptions given the early design maturity, and actual maintenance costs may be less. Table 2 provides a detailed breakdown of this comparison.

Table 2 – PWSC (75 MGD) and GWRS (70 MGD) AWT O&M Cost Comparison

Description	GWRS 70 MGD *Actuals* in 2015/2016$ (2)	GWRS 70 MGD *Actuals* in 2025$ (1), (2)	PWSC 75 MGD in 2025$ (3)	Variance ($M)	Variance (%)
Electricity	$ 8,784,000	$ 15,196,320	$ 12,970,000		
Chemicals	$ 5,559,252	$ 9,617,506	$ 9,860,000		
Labor	$ 9,678,633	$ 16,744,035	$ 18,310,000		
Plant Maintenance	$ 3,586,290	$ 6,204,282	$ 38,260,000		
Contingency (15%)	$ -	$ -	$ 11,910,000		
Total Project Cost	**$ 27,608,175**	**$ 47,762,143**	**$ 91,310,000**	**$ 43,547,857**	**91%**
Cost by MGD		**$ 682,316**	**$ 1,217,467**	**$ 535,150**	**78%**

(1) Inflation Factor based on ENR CCI-LA (1.94)
(2) GWRS excluding R&R Funding Contribution and Debt Service
(3) PWSC includes AWT only, excluding the Sanitation Districts' MBR and the conveyance system.

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Board Report

Engineering Services Group

- **Engineering Services Group Monthly Activities Report for March 2026**

Summary

This monthly report provides highlights and a summary of Engineering Services Group activities for March 2026 in the following key areas:

- Colorado River Aqueduct (CRA) Program
- Dams & Reservoirs Program
- Distribution System Program
- Additional Facilities and Systems Program
- Prestressed Concrete Cylinder Pipe (PCCP) Program
- Water Treatment Plants Program
- Pure Water Southern California
- Drought Mitigation – State Water Project Dependent Areas
- Value Engineering Program
- Engineering Services Career Launch Program Tour – F.E. Weymouth Water Treatment Plant
- California State University Long Beach Student Outreach Tour at the Weymouth Plant

Purpose

Informational

Attachments

Detailed Report – Engineering Services Group's Monthly Activities for March 2026

Date of Report: April 13, 2026

Engineering Services' Monthly Activities for March 2026

Highlights

In support of the General Manager's Business Plan goal of providing organizational stability and delivering operational excellence, Engineering Services manages and executes projects within the adopted Capital Investment Plan (CIP) to maintain infrastructure resiliency, ensure regulatory compliance, enhance sustainability, and provide flexibility in system operations to address uncertain water supply conditions. In addition, Engineering Services provides technical services to enhance reliable system operation and real property planning, valuation, acquisition, and disposition services to protect Metropolitan's assets. Engineering Services empowers our staff and partners with our business partners and the communities we serve to accomplish Metropolitan's mission.

Recent key activities on CIP programs and other key engineering functions are described below.

Protect public health, the regional economy, and Metropolitan's assets

Colorado River Aqueduct (CRA) Program

The CRA program includes CIP projects to replace or refurbish facilities and components of the CRA system to reliably convey water from the Colorado River to Southern California.

- CRA Domestic Water Treatment System — This project upgrades the domestic water treatment systems at all five CRA pumping plants, including the replacement of the water treatment units. The contractor has installed the temporary treatment skid system at the Intake Pumping Plant. The temporary skid will remain in operation until installation, testing, and commissioning of the new system are complete. Installation of the electrical and mechanical systems to support the new equipment is underway at the Intake Pump Plant. Installation of the temporary skid at Gene Pumping Plant is nearing completion, and a 14-day water quality test will be conducted. Construction is 55 percent complete and is scheduled to be completed by April 2027.
- Intake Main Motor Protection Relay Panels 1R and 3R — This project replaces the existing main transformer bank protection relay panels 1R and 3R and associated annunciator panels that protect the transformer from electrical fault events at the Intake Pumping Plant. Construction was performed during the 2026 annual CRA shutdown. Installation and functional testing of the new equipment is complete.

- Gene Transformer Bank Protection Annunciator Panels — This project replaced the existing main transformer bank annunciator panels inside the Gene Pumping Plant Control Room. Construction was performed during the 2026 annual CRA shutdown. Installation and functional testing of the new equipment is complete.
- CRA Pump Plant Sumps Rehabilitation — This project rehabilitates the sump and circulating water systems at all five CRA pumping plants. The scope of work also includes replacement of the structural support systems, piping, valves, motors, and electrical equipment. Final design is complete, and the project will be advertised in April 2026. A board action to award a construction contract is planned for July 2026.



CRA Domestic Water Treatment System — New Sample Lab at Intake

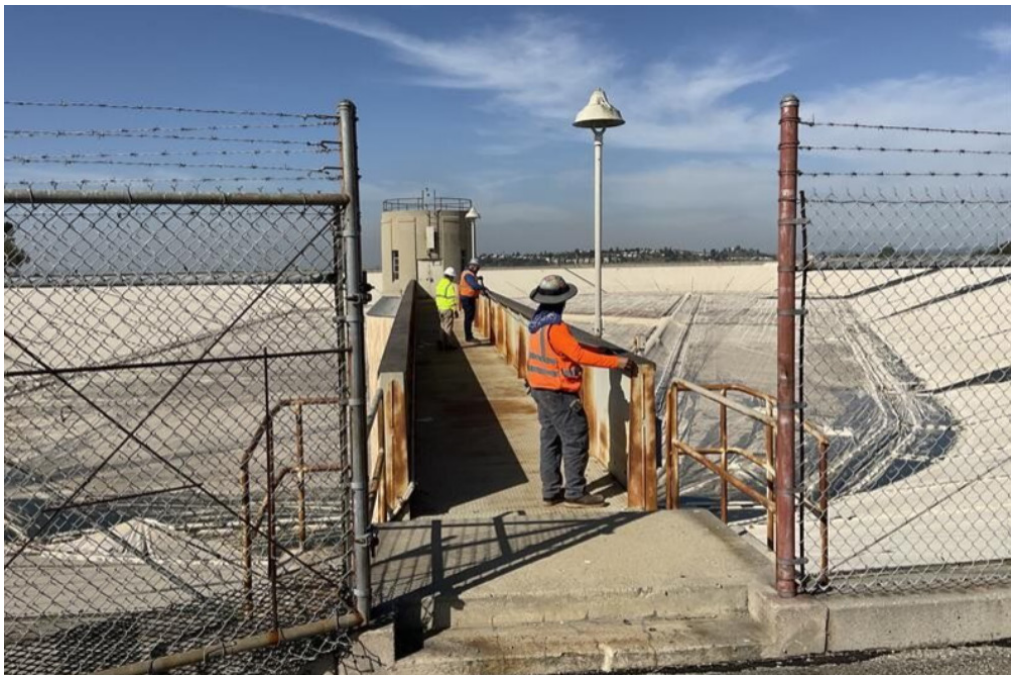


CRA Domestic Water Treatment System — Gene Temporary Skid Commissioning

Dams & Reservoirs Program

The Dams & Reservoirs Program includes CIP projects to upgrade or refurbish Metropolitan's dams, reservoirs, and appurtenant facilities to reliably meet water storage needs and regulatory compliance.

- Garvey Reservoir Rehabilitation — This project will replace the aging reservoir floating cover and liner; strengthen the structure of the reservoir outlet tower to reduce the risk of damage following a major seismic event; and upgrade the reservoir's rainwater collection, pumping, and subdrain systems. The Board awarded a construction contract in December 2025, and the Notice to Proceed was issued to the contractor in January 2026. The contractor continued preparing submittals and has begun mobilization. Construction is planned to be completed by June 2028.
- Copper Basin Discharge Valve — This project installs a new 54-inch fixed cone valve and actuator at the base of the dam, refurbishes a slide gate and the existing valve house, and upgrades all associated electrical systems and access ladders at the Copper Basin Reservoir. This project will also include the replacement of access ladders at the Gene Wash Dam. Final design and acquisition of environmental permits are complete. A board action to award a construction contract is planned for August 2026.
- Lake Mathews Pressure Control Structure (PCS) and Electrical System Upgrades — This project will replace the aging Lake Mathews discharge facility and electrical system. The project includes the construction of a new PCS with a bypass pipeline alongside the existing forebay, a new chlorination facility, and upgrading the electrical system to accommodate future power needs. This project utilizes a progressive design-build (PDB) project delivery method. The procurement process for the design-build entity is underway. A board action to authorize the Phase 1 agreement is planned for August 2026. The project is anticipated to be completed by 2032.



Garvey Reservoir Rehabilitation — Performing Layout for the Existing Access Bridge Demolition, Looking West

Distribution System Program

The Distribution System Program includes CIP projects to replace, upgrade, or refurbish existing facilities within Metropolitan's distribution system, including PCSs, hydroelectric power plants, and pipelines, to reliably meet water demands.

- Wadsworth Sleeve Valve Refurbishment — This project refurbishes seven sleeve valves at the Wadsworth Pumping Plant. All seven valves have been refurbished, tested, and commissioned with the last valve completed on 12/18/2025. The project is complete.
- San Jacinto Diversion Structure Gate Replacement — This project will replace three cast-iron slide gates at the San Jacinto Diversion Structure with stainless steel slide gates designed for throttling. Construction was recently completed as part of the annual 2026 CRA shutdown. The new slide gates and actuators were successfully installed and are now operational as of February 2026.
- Service Connection LA-17 Meter Procurement — The project will replace two flow meters, adjoining thimble pieces, coupling assemblies, gaskets and studs and bolts that are in the same vault at the Eagle Rock Operations Control Center. A procurement contract was awarded in December 2025, and the flow meters are scheduled to be delivered by September 2, 2026. The meter fabricator is currently preparing submittals for Metropolitan staff review.
- Hollywood Tunnel North Portal Rehabilitation — The project will replace the existing worn valves with two new 24-inch sleeve valves operated by electro-hydraulic actuators for pressure control and two 24-inch bonneted knife gate valves for flow isolation at the Hollywood Tunnel North Portal along the Santa Monica Feeder. The valve procurement contract was awarded in March 2025. The valves are in fabrication and are 70 percent complete with delivery expected in summer 2026. Final design for the

valve installation is complete and the construction contract is scheduled for board award in June 2026.



San Jacinto Diversion Structure Gate Replacement — Slide Gate V-02 Installation

Additional Facilities and Systems Program

The Additional Facilities and Systems Program includes CIP projects to refurbish, replace, upgrade, or provide new facilities and systems that support Metropolitan's business and district-wide operations.

- Diamond Valley Lake (DVL) Wave Attenuator Replacement — This project adds a second attenuator to the existing wave attenuating system at the East Marina in Diamond Valley Lake. As part of the improvements, the existing floating wave attenuator (FWA) will be relocated to a new location, and the new attenuator will be installed in its place. The contractor completed fabrication and installation of the new north FWA modules and completed relocation of the existing FWA to the new south location. Construction is complete.
- Colorado River Aqueduct District Housing Improvements — This project will replace aging housing after decades of use in the harsh desert environment with new townhomes, implement village enhancements and amenities, and replace kitchens and lodges at the CRA pumping plants. The District Housing Improvements will be completed in four stages. Conceptual design of an alternative housing model layout is complete at four pumping plants (Hinds, Eagle Mountain, Iron Mountain, and Gene). Stage 1 improvements will be implemented in three sub-stages with Eagle Mountain Pumping Plant as the pilot to evaluate the success of the alternative housing. Based on the success of the pilot, design for the remaining three plants will then be implemented. Final design for Eagle Mountain Pumping Plant is 5 percent complete and is scheduled to be completed by spring 2027.



Diamond Valley Lake Wave Attenuator Replacement — New Floating Wave Attenuator and Relocated Existing Floating Wave Attenuator

Prestressed Concrete Cylinder Pipe (PCCP) Program

The PCCP Program includes CIP projects to refurbish or upgrade Metropolitan's PCCP feeders to maintain water deliveries without unplanned shutdowns.

- Sepulveda Feeder PCCP Rehabilitation Reach 1 — This project rehabilitates PCCP segments of the Sepulveda Feeder. Reach 1 of the Sepulveda Feeder spans 4.7 miles through several cities, including the cities of Hawthorne, Inglewood, and Los Angeles. Final design is approximately 75 percent complete and is scheduled to be completed in August 2027.
- Electromagnetic Inspection — Regular inspections of the PCCP feeders are a critical step in evaluating the condition of each pipeline and assist staff in prioritizing the relining work on each feeder. This project conducts the fifth cycle of electromagnetic and visual inspections of Metropolitan's approximately 146.4 miles of PCCP pipelines. Inspections of the Jensen Washwater Return and Balboa Bypass were completed in February 2026, and inspections of the AMP/Diemer Bypass and South Coast Feeder were completed in March 2026.

Water Treatment Plants Program

The Water Treatment Plants Program includes CIP projects to replace or refurbish facilities and components at Metropolitan's five water treatment plants to continue to reliably meet treated water demands.

- Weymouth Administration Building Upgrades — This project upgrades the Weymouth Administration Building to withstand a significant earthquake. The planned upgrades include structural strengthening consistent with current seismic standards for essential facilities, accessibility, and fire/life safety improvements, architectural modifications near the areas of structural upgrades, and improvements associated with the preservation of historic architectural features. Final design is complete, and the project was advertised for bids. Board award of a construction contract is planned for May 2026.
- Diemer Chemical Feed Facility Improvements — This project rehabilitates the Diemer plant's chemical feed facility to maintain operational reliability, meet Metropolitan's current chemical safety standards, and enhance worker safety. The Board awarded a construction contract in October 2025. The

contractor has begun mobilization and underground utility verification. Construction is 10 percent complete and is scheduled to be completed in October 2027.

- Water Quality Lab Building Upgrades — This project upgrades the Michael J. McGuire Water Quality Laboratory in La Verne to increase its seismic resiliency and to efficiently address new and evolving water quality issues and regulations. Planned improvements include strengthening of the existing structure to meet current seismic criteria for essential facilities; building expansion and functional layout improvements; replacement of specialized laboratory equipment; and implementation of technology upgrades to support current and future water quality regulations. Final design is approximately 14 percent complete and is scheduled to be completed in spring 2028.
- Mills Finished Water Reservoir Rehabilitation — This project will replace the aging floating covers and liners at the Mills Plant's finished water reservoirs; upgrade the rain removal system, piping, and valving to enhance reservoir operational flexibility and mixing improvements; refurbish the reservoir slide gates; and install a new drop gate. Final design is approximately 25 percent complete and is scheduled to be completed in spring 2027.
- Jensen Mechanical Dewatering Facility —This project will construct a new mechanical dewatering facility at the Jensen plant, including associated solids conveyance piping, chemical feed, and electrical and control systems, to improve the plant's residual solids processing and address the plant's long-term solids handling needs. Final design is approximately 8 percent complete and is scheduled to be completed in spring 2027.



Adapt to changing climate and water resources

Pure Water Southern California

Pure Water Southern California (Pure Water) is a large regional recycled water program that will provide a new local source of safe and reliable water for Southern California. Pure Water currently focuses on five areas: program management, environmental planning, advanced water purification facility (AWPF) planning, demonstration testing, and preliminary design of initial pipeline reaches. Pure Water will produce up to 150 million gallons per day of purified water from the AWPF in Carson for indirect potable reuse (IPR) and direct potable reuse (DPR) applications.

- Program Management — Program management activities include project controls, scheduling, budget development, risk management, coordination with program partners and stakeholders, grants and funding, and preparation of various plans and studies. The Pure Water program management team was engaged in the following activities during this reporting period:
    - Continued coordination and grant reporting efforts with the United States Bureau of Reclamation for the $125,472,855 Large-Scale Water Recycling Program grant and the $5 million WaterSmart Title XVI Planning Grant. Metropolitan has received a total of approximately $25.5 million to date.

  - The $80 million state grant is also used to support the current phase of program work; approximately $56 million is spent as of end of February. Continued to coordinate with the Climate Adaptation Master Plan for Water (CAMP4W) assessments.

- Environmental Planning — In February 2026, Metropolitan's Board certified the program's final Environmental Impact Report and approved Pure Water Southern California (PWSC) for California Environmental Quality Act purposes. The notice of determination was also filed with the State's Office of Planning and Research and the County Clerk to initiate a 30-day statute of limitations for legal challenges.
- Advanced Water Purification Facility —The AWPF will purify treated wastewater from the Los Angeles Sanitation Districts' (Sanitation Districts) A.K. Warren Water Resource Facility using membrane bioreactors (MBR), reverse osmosis, and ultraviolet/advanced oxidation. With its expertise in biological wastewater treatment, the Sanitation Districts will be responsible for implementing the AWPF pretreatment, including the MBR facilities. A final draft of the Conceptual Facilities Report has been prepared. This document records key assumptions of AWPF components and would be used for the upcoming Request for Qualifications for the PDB contracts to design and construct the full-scale AWPF.
- Demonstration Testing — Staff continued testing the IPR processes. Five equipment procurement packages were advertised for DPR testing, including membrane filtration/reverse osmosis, UV/AOP, ozone with granular and biological activated carbon, lime stabilization system, and carbon dioxide system. Staff is evaluating the bids received and plans to return to the Board this summer to award one or more of these procurement contracts. Construction and installation are anticipated to commence in 2027. Information from this DPR testing will allow Metropolitan to assess both treated-water augmentation and raw-water augmentation alternatives.
- Conveyance System — The PWSC Conveyance Facilities Conceptual Design Report for the entire conveyance system has been completed and is available on Metropolitan's public website: https://www.mwdh2o.com/building-local-supplies/pure-water-southern-california/technical-resources/. In addition, preliminary design of Reaches 1 and 2 through the cities of Carson, Long Beach, and Lakewood is underway. Preparation of bid documents for one or more Construction Manager/ General Contractor (CM/GC) projects for the first two reaches is also underway. Staff would be ready to advertise these packages after the CAMP4W assessments have been completed, and if the Board decides to proceed with the design of the initial stage of PWSC.

Drought Mitigation — State Water Project Dependent Areas

The Drought Mitigation—State Water Project Dependent Areas Program includes CIP projects to replace, refurbish, upgrade, or construct new facilities, which are identified to mitigate the vulnerability experienced by specific member agencies that are affected during shortages of State Water Project supplies.

- Wadsworth Bypass Pipeline — This project installs a bypass pipeline and an isolation valve to interconnect the Wadsworth Pumping Plant with the Eastside Pipeline. This project is one of the four Rialto Pipeline service area supply reliability improvement projects. The contractor is currently installing electrical and Supervisory Control and Data Acquisition) (SCADA) control components. Construction is 99 percent complete and is scheduled to be completed in June 2026.

- Inland Feeder Rialto Pipeline Intertie — This project installs an interconnection pipeline and isolation valve structure between the Inland Feeder and Rialto Pipeline so that water can be delivered from DVL to the Rialto Pipeline. This project is one of the four Rialto Pipeline service area supply reliability improvement projects. The contractor has completed the SCADA and power duct bank and is currently performing electrical work in preparation for the Motor Control Center electrical equipment delivery in April 2026. Construction is 99 percent complete and scheduled to be completed in July 2026.
- Sepulveda Feeder Pump Stations — This project installs new pump stations at the existing Venice and Sepulveda Canyon pressure control facilities, providing the ability to reverse flow in the Sepulveda Feeder and deliver 30 cubic feet per second from the Central Pool to portions of the western State Water Project exclusive area. This project will utilize the PDB project delivery method. Construction of the Venice Pump Station is approximately 15 percent complete. The concrete foundation for the electrical building has been placed, and the contractor is currently drilling piles for the suction piping shoring. Negotiations for construction of the Sepulveda Canyon Pump Station work have begun, and a final negotiated value is anticipated in the middle of April.



Inland Feeder Rialto Pipeline Intertie
Valve Vault and Insulating Joint Test Station – Looking West



Sepulveda Feeder Pump Stations — J.F. Shea Installing Rebar for Basement Wall at Venice Pump Station

Sustain Metropolitan's mission with a strengthened business model

Value Engineering Program

Engineering Services conducts a Value Engineering (VE) program to review capital projects and identify opportunities and alternatives to enhance project performance, optimize funding for CIP projects, and demonstrate responsible use of public funds. The objective of the VE Program is to improve the overall value of CIP projects by applying an industry-accepted assessment methodology to examine a project's function, design, equipment, material selections, and contracting approach. This comprehensive assessment is conducted at strategic stages in a project's life cycle.

State Water Project (SWP) Invasive Mussel Mitigation and Control

Engineering Services, through its VE Program, delivered a scoping workshop to examine Metropolitan's SWP Invasive Mussel Mitigation and Control Initiative. This initiative was recently developed to coordinate Metropolitan's response to the discovery of golden mussels in California's waterways, and to bolster its monitoring and control program initiated in 2007 upon the discovery of invasive quagga mussels in Lake Mead.

The four-day workshop was held at Metropolitan's Water Quality Lab in La Verne, and was executed to achieve several objectives, including an assessment of control and mitigation measures; confirmation of planned CIP efforts including development of planning-level cost estimates for facilities believed to be impacted by golden mussels; and development of prioritized near- and long-term Operations & Maintenance activities.

Workshop participants included staff from Water Quality, Engineering, and Operations; external subject matter experts in the fields of invasive mussel eradication and the selection, design, and installation of control technology; US Bureau of Reclamation staff experienced in this topic; and CA DWR staff reporting strategies undertaken and planned to implement control and mitigation of mussels within the SWP.



Empower the workforce

Engineering Services Career Launch Program Tour – F.E. Weymouth Water Treatment Plant

On February 14, 2026, participants in the Fiscal Year 2025/26 Engineering Services Career Launch Program toured the F.E. Weymouth Water Treatment Plant at La Verne. This workforce development initiative is designed to support new staff during onboarding and provide a deeper understanding of Engineering Services. Fourteen participants visited the Water Quality Laboratory, where they observed the evaluation processes used to assess taste, odor, and regulatory compliance, and then toured the treatment plant to see water entering the facility, the pumping systems, flocculation tanks, and other key infrastructure involved in delivering clean, reliable drinking water.

The cohort also toured the Machine and Fabrication Shops to learn about production planning and coatings and viewed demonstrations from the Soils and Corrosion Laboratories and the Field Survey Team. The 2025/26 Career Launch Program is nearing completion of its six-module curriculum, with an Engineering Services manager's session scheduled for April and a final celebration planned for May. This program helps connect new staff to the mission, operations, and teams that support Engineering Services.



Participants Touring the Machine and Fabrications Lab



Field Survey Team Demo on Use of Drone Technology

Partner with interested parties and the communities we serve

California State University Long Beach Student Outreach Tour of the Weymouth Plant

Engineering recently provided an opportunity for students from California State University, Long Beach (CSULB) to tour the Weymouth plant. This followed two events at CSULB in November 2025, with Unit Manager Jorge Alvarado sharing valuable insights into water infrastructure and career opportunities within the water industry, as well as Team Manager Javier Garcia's participation as a keynote speaker for his current intern's civil engineering club. This Weymouth plant tour was led by Weymouth Operations Team Manager Jonathan Brown, with special coordination by Plant Engineer Charles Chen. According to student intern Jayson Serrano, the educational tour at the Weymouth plant provided a highly informative experience for the CSULB students, with the overall objectives of gaining practical knowledge and interacting with industry professionals. The students expressed how beneficial these tours are for the future generation of engineers and encourage Engineering staff to continue offering these tours during the year to support student academic and professional development.



CSULB Students Touring the F.E. Weymouth Water Treatment Plant