THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Board Report

Engineering Services Group

- **Seismic Resilience Report 2025**

Summary

This report summarizes Metropolitan's seismic resilience activities over the last five years and outlines goals for the coming years.

Purpose

This report complies with a board directive to provide an annual verbal update and a five-year written report on Metropolitan's efforts to improve seismic resilience. The annual verbal update was presented to the Board in April 2025.

Attachments

2025 Update of Seismic Resilience Report

Detailed Report

The 2025 Seismic Resilience Report summarizes Metropolitan activities undertaken within the last five years to assess and mitigate seismic risk. Metropolitan's objectives for its seismic resilience strategy are to (1) provide a diversified water supply portfolio, system flexibility, and emergency storage; (2) prevent damage to water delivery infrastructure in probable seismic events and limit damage in extreme events; (3) minimize water delivery interruptions through a dedicated emergency response and recovery organization; and (4) prepare for restoration by implementing resilient measures such as stockpiling materials, pre-event design, and emergency contractor retention.

Recent seismic-related improvements include the installation of earthquake-resistant ductile iron pipe on Colorado River Aqueduct Casa Loma Siphon No. 1, and completion of seismic upgrades to the Diemer West Filter Building, Union Station Headquarters building, and the Weymouth West Wash Water Tank.

Other activities include the initiation of a comprehensive risk assessment program for Metropolitan's dams, a program to modernize Metropolitan's dam monitoring systems, and a study, in collaboration with the University of California, Berkeley Center for Smart Infrastructure, to assess the risk to Metropolitan's pipeline system against earthquake hazards. Metropolitan also continues to work with member agencies and regional partners when conducting emergency response exercises.

The 2025 Seismic Resilience Report includes a chapter on the California Department of Water Resources (DWR) seismic program, including recent studies, design and construction activities, and emergency preparedness/ emergency response planning. Key accomplishments for DWR include completing the Perris Dam Seismic Remediation Project in 2022, the Castaic Dam Tower Bridge Seismic Retrofit in 2023, and updating its Emergency Response Plan outlining post-earthquake response protocols and procedures.

The report proposes primary goals in different areas to continue advancing the seismic resilience objectives for the next 5-year period. Examples of these goals include completion of the Pipeline Seismic Vulnerability Study and System Flexibility Study, completion of design or construction for facility seismic upgrades, such as the Weymouth Administration Building and the La Verne Water Quality Laboratory, and continuation of the dam

monitoring improvements and the dam safety assessments. It is also crucial to continue conducting emergency response exercises in coordination with member agencies and enhancing regional seismic resilience by reinforcing the mutual-aid framework with regional partners. Staff will continue to ensure accountability by providing annual updates and issuing five-year reports to the Board for guidance and feedback.

REPORT

SEISMIC RESILIENCE REPORT
2025 UPDATE

The Metropolitan Water District of Southern California

700 N. Alameda Street, Los Angeles, California 90012

Report No.
2025 MWD08 01S1
August 2025

Seismic Resilience Report 2025 Update

Prepared By:

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

Report Number 2025 MWD08 01S1
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Prepared under the direction of:

Mai Hattar	Interim Chief Engineer; Group Manager-Engineering Services

Prepared by:

Albert Rodriguez	Engineering Services
Bei Su	Engineering Services
Bashar Sudah	Engineering Services
Kingsley Ozegbe	Engineering Services
Andrew Brainard	Engineering Services
Rosa Lau	Engineering Services
Demetri Polyzos	Water Resources Management
Ian Whyte	Water Systems Operations
David Sarkisian	California Department of Water Resources

Reviewed by:

John Bednarski	Assistant General Manager-Water and Technical Resources
Keith Nobriga	Group Manager-Water System Operations
Catherine Stites	Office of the General Counsel
John Shamma	Engineering Services
Winston Chai	Engineering Services
Ernie Ariza	Engineering Services
Brandon Goshi	Group Manager-Water Resources Management

Additional copies: The Seismic Resilience Report is located on the Seismic Resilience SharePoint site. To obtain a copy of this document, please contact the Engineering Services Group.

Disclaimer

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PUBLICATION HISTORY:

First Biennial Report (Report No. 1551/ 2020 MWD02 01S1)	*February 2018*
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Cover Photo: Installation of 104-inch diameter earthquake-resistant ductile-iron pipe on Metropolitan's Casa Loma Siphon

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1 Executive Summary

The 2025 Seismic Resilience Report provides an overview of Metropolitan's current seismic resilience strategy and the infrastructure improvements made to mitigate potential impacts to facilities and systems from earthquake hazards. The report maintains continuity with the 2020 Seismic Resilience Report, which listed goals for the purpose of enhancing seismic resilience for the 5-year planning period. Metropolitan's seismic resilience strategy is comprised of four main components – Planning, Engineering, Operations, and Reporting.

Under the Planning component, water supply diversification and improved system flexibility continue to be the primary goals for increased resilience. The Diamond Valley Lake to Rialto Pipeline Project and Sepulveda Feeder Pump Project will improve Metropolitan's ability to move Colorado River or stored water within Diamond Valley Lake to member agency service areas that are highly dependent on State Water project supplies improving both drought and seismic resilience for these areas. Additionally, the proposed Pure Water Southern California will provide a new reliable water source for the region in case of a seismic event impacting the region's imported water supplies.

Under the Engineering component, staff continues to implement the Seismic Upgrade Program, which aims to improve the performance of existing facilities against seismic events. Dam safety continues to be a priority with the initiation of a new Dam Safety Risk Assessment program and an initiative to modernize Metropolitan's existing dam monitoring systems, both initiated in 2023. Additionally, staff continues to conduct systemwide seismic assessments utilizing the latest technologies and updated methodologies for evaluating the risk of the infrastructure system.

Under the Operations component, Metropolitan continues to conduct emergency exercises in coordination with member agencies and regional partners. An example is the planning exercise with the California Department of Water Resources (DWR) and Los Angeles Department of Water and Power (LADWP) as part of the Seismic Resilient Water Supply Task Force to identify areas of improvement for strengthening the region's imported water network against future seismic events. Building up in-house fabrication and construction capacity allows Metropolitan to react to potential seismic damage quickly and effectively minimize interruptions to system operations. Upgrade of the La Verne fabrication shops and investment in heavy construction equipment have significantly improved Metropolitan's capability to restore its infrastructure system and assist in the region's recovery after a major seismic event.

Under the Reporting component, staff continues to provide annual seismic resilience updates to the Board as part of the infrastructure resilience updates to report progress and receive

feedback. Meanwhile, the 2025 Seismic Resilience Report summarizes achievements in the last five years and lays out the plan and focused areas for the next five years to continuously enhance infrastructure seismic resilience. Included in the report is a section on DWR's seismic program highlighting seismic preparedness accomplishments of the last five years related to the State Water Project, including the completion of the Perris Dam Seismic Remediation Project in 2022 and the Castaic Dam Tower Bridge Seismic Retrofit Project in 2023. Current activities include the design of modifications to the Castaic Dam Intake Tower and Outlet Works and emergency response planning.

The availability of water following a large seismic event will be vital for fire suppression, the general welfare of the public, and the region's economic stability. As documented in this report, Metropolitan has established a robust strategy for preparing and responding to seismic hazards. Since 2000, Metropolitan has invested more than $700 million toward seismic resilience, including pre-event risk mitigations and post-event restoration capacity, and will continue to incorporate seismic resilience in its planning and design activities.

2 Introduction

2.1 Purpose

The Metropolitan Water District of Southern California (Metropolitan) owns and operates a complex conveyance, treatment, and distribution system that serves a 5,200-square-mile service area within an active seismic region. Over its 95-year history, Metropolitan has been proactive in mitigating seismic risks posed to this expansive infrastructure, as well as improving its ability to maintain (or quickly restore) water deliveries following a major seismic event. This ability to mitigate seismic risks and maintain (or quickly restore) water deliveries following a seismic event is referred to as "seismic resilience." Metropolitan's strategy for seismic resilience follows a multi-layered approach for managing risk: providing a diversified water resource portfolio, system flexibility, emergency water storage, robust emergency response capabilities, and performing cyclical assessments of facilities and addressing identified vulnerabilities.

In February 2018, Metropolitan published *Report No. 1551 (2020 MWD02 01S1), Seismic Resilience First Biennial Report*, which provided an in-depth review of seismic events affecting Metropolitan and summarized Metropolitan's historical approach to mitigating seismic risk. The document also defined Metropolitan's current Seismic Resilience Strategy, the core components of that strategy, and identified performance objectives and near-term goals. An update was published in 2020 highlighting organizational achievements toward improved seismic resilience.

The *2025 Seismic Resilience Report* documents revisions to Metropolitan's Seismic Resilience Strategy, summarizes seismic-resilience-related studies completed since the publication of the last report; lists milestones related to structural upgrades, dam seismic safety enhancement, and emergency response planning; and highlights achievements in meeting seismic performance objectives and near-term goals. The report also identifies new performance objectives and goals that will further increase the seismic resilience of Metropolitan's infrastructure system.

2.2 Seismic Risk

Southern California is crossed by several faults of varying levels of activity that can generate large earthquakes and cause widespread damage. The region's imported water conveyance facilities – Metropolitan's Colorado River Aqueduct, the State Water Project California Aqueduct (California Department of Water Resources), and the Los Angeles Aqueduct (Los Angeles Department of Water and Power) are all crossed by the San Andreas Fault. Other faults cross different pipelines within Metropolitan's conveyance and distribution system, potentially impacting different sections of Metropolitan's service area. Ruptures of one of these faults can result in intense shaking and permanent ground displacements, causing damage to pipelines,

tunnels, building structures, and other treatment and distribution components. Figure 2-1 shows the major fault lines that cross Metropolitan's service area.

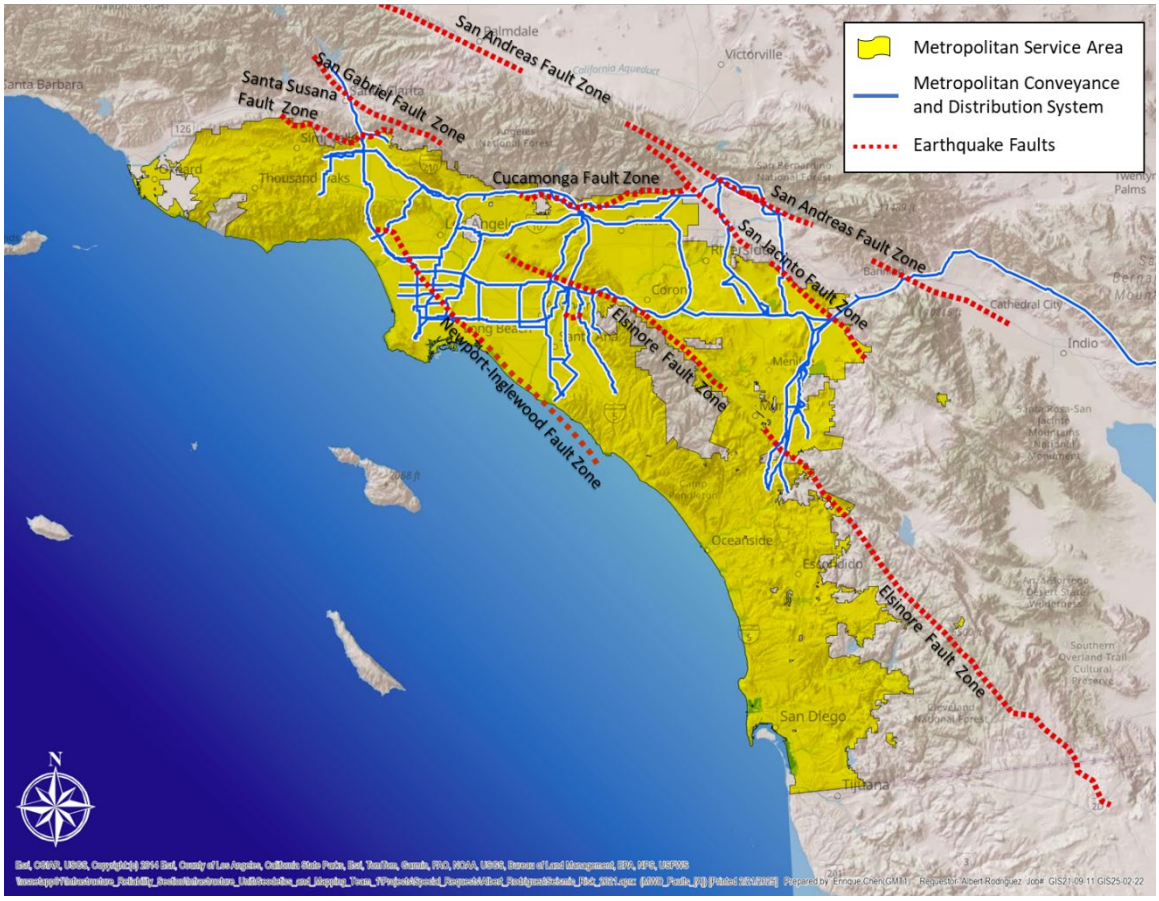

Figure 2-1: Major Southern California Faults in Metropolitan Service Area

2.3 Seismic Resilience Strategy

The Seismic Resilience Strategy has the following objectives which are applicable to Metropolitan's infrastructure and the region's resilience:

- 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 a dedicated emergency response and recovery organization
- Prepare for restoration by implementing resilient measures such as stockpiling materials, pre-event design, and emergency contractor retention

Metropolitan's Seismic Resilience Strategy was described in detail in the 2018 Report, and the overall structure of the strategy remains intact with refinements to reflect the maturity of the overall program and the emphasis on implementation. A detailed breakdown of the current Seismic Resilience Strategy is provided in Figure 2-2. The figure provides an overview of the comprehensive efforts taken to mitigate impacts from large earthquakes, to quickly respond following an earthquake event, and to provide transparency regarding seismic risk mitigation measures and receive feedback to facilitate improvements.

As shown in Figure 2-2, in addition to the activities conducted under the Planning, Engineering, Operations, and Reporting components of the Seismic Resilience Strategy, Metropolitan has continued its involvement with the Seismic Resilient Water Supply Task Force. The Seismic Resilient Water Supply Task Force is a collaboration between Metropolitan, the California Department of Water Resources (DWR), and the Los Angeles Department of Water and Power (LADWP) to improve the seismic resilience of the imported water supplies.

Investments in seismic mitigation must be balanced with other Metropolitan priorities to ensure effective and efficient risk mitigation. Since 2000, Metropolitan has invested more than $700 million toward seismic resilience. Investments include upgrade of facilities and pipelines to meet seismic performance goals and improving emergency response capabilities.

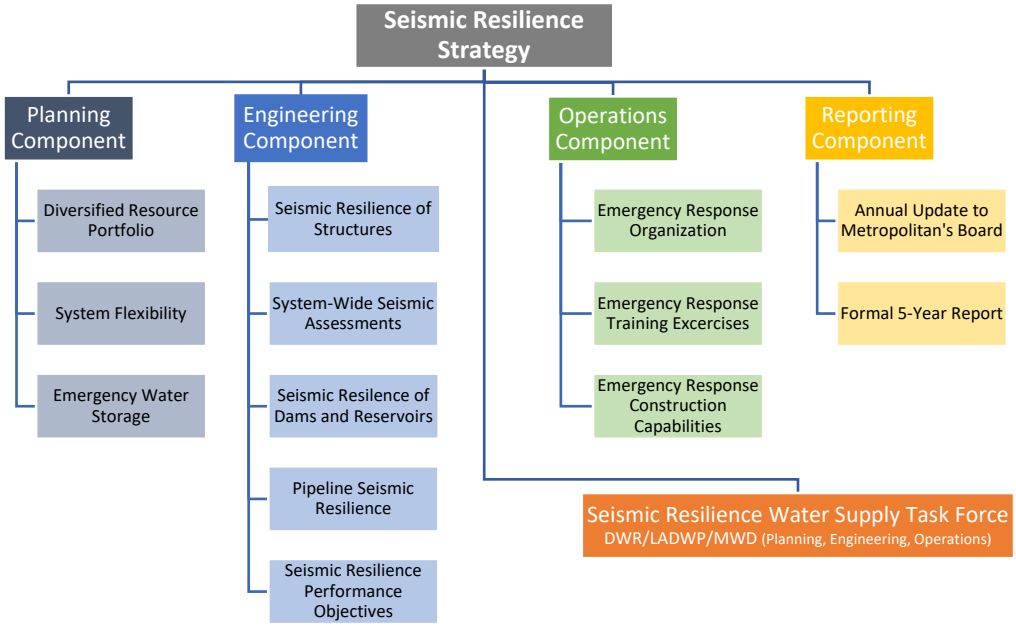

Figure 2-2: Seismic Resilience Strategy and Focus Areas

3 Planning Component

As a primary supplier to the Southern California water community, Metropolitan faces many challenges in meeting the region's needs for water supply reliability and quality. One of the challenges is the ability to maintain water deliveries within the region following a major seismic event. In general, Metropolitan's planning efforts focus on meeting peak demands during normal operations. However, during the original planning for Diamond Valley Lake (DVL), Metropolitan considered a scenario and planned to meet regional demands if imported supplies were interrupted due to a seismic event, leading to the development of a significant increase in storage dedicated to meeting demands during emergencies.

Since 2000, Metropolitan has provided about 49 percent (ranging annually between 38 and 56 percent) of the total water used in its service area from the Colorado River (via the Colorado River Aqueduct) and from the Sacramento-San Joaquin River Watershed (via the State Water Project). In addition to relying on imported supplies, Metropolitan and its member agencies have developed other sources, including groundwater, surface water, recycled water, desalination of seawater, and an aggressive water conservation and water use efficiency program. These investments, and Metropolitan's ongoing efforts in several different areas, coalesce toward the goal of long-term regional water supply reliability.

Metropolitan's Integrated Water Resources Plan (IRP) is the foundation for planning and developing a diverse water supply and emergency storage. The fundamental goal of the IRP is for Southern California to develop a water supply portfolio that will be able to maintain a reliable water supply. Maintaining this reliability includes making investments prior to major seismic events when there could be extended outages of imported water conveyance systems. To meet this fundamental IRP goal of a diversified water portfolio, Metropolitan believes in investing in the reliability of imported supplies, incentivizing its member agencies to develop increased water conservation, recycling, storage, and other resource-management programs. A significant part of imported water supply reliability is preparing for recovery periods following seismic events. With the commencement of the IRP process in 1993, Metropolitan formalized this process as a long-term strategy and official policy.

Metropolitan's success in improving water supply reliability by diversifying its water resource portfolio and by the application of adaptive resource management approaches has also increased seismic resilience. At a system level, the Planning component of seismic resilience has several facets:

- Diversified water supply portfolio
- System flexibility
- Emergency storage

3.1 Diversified Water Portfolio

Metropolitan has undertaken several planning initiatives over the years to maintain a diversified water portfolio. These initiatives include the IRP, periodic IRP updates, the Water Surplus and Drought Management (WSDM) Plan, and the Water Supply Allocation Plan (WSAP). Collectively, these initiatives provide policy framework guidelines and resource targets for Metropolitan to ensure regional water supply reliability, along with additional resilience for seismic events. In addition to Metropolitan's efforts to coordinate regional supply planning through its inclusive IRP process, Metropolitan's member agencies also conduct their own planning analyses and may develop projects independently of Metropolitan.

3.1.1 2020 IRP Regional Needs Assessment

The 2020 IRP Regional Needs Assessments strengthens the adaptive management approaches employed in prior updates through the incorporation of an explicit scenario planning step. With knowledge gained from the completion of the full "planning cycle" from the original 1996 IRP, Metropolitan was able to use the lessons learned from the previous 25 years to conduct the 2020 IRP Regional Needs Assessment. The key lesson is that the future is not predictable; rather, future outcomes are a function of many diverse drivers that are out of the control of the water community. The purpose of scenario planning is to broaden the understanding of plausible, but uncertain, future conditions affecting both supplies and demands. On the demand side, uncertainties surrounding future economic conditions, the extent to which local supplies are developed, and water use behavior will guide member agency dependence on Metropolitan in meeting their retail demands. On the supply side, factors such as climate change and regulatory uncertainty are expected to affect future supply availability in unpredictable ways.

The Regional Needs Assessment outcomes can be summarized through a set of findings grounded in the scenario reliability analysis. The findings fall within five key focus areas:

- SWP Dependent Areas – addressing identified vulnerabilities in the portion of Metropolitan's service area dependent upon State Water Project deliveries (the "SWP Dependent Areas");
- Storage – storage capacity, put/take capabilities, and accessibility as critical considerations in reliability and reducing the need for new core supply development;
- Retail Demand/Demand Management – managing variability in demand through appropriate regional measures and efficient water use;
- Metropolitan Imported Supplies – maintaining existing imported supply reliability and addressing risks to existing imported supplies from various drivers of uncertainty; and
- Local Supply – maintaining existing and developing new local supplies as a critical element of managing demands on Metropolitan.

The Regional Needs Assessment presents key technical findings and examines the effectiveness of generalized portfolio categories. It frames and guides the establishment of more specific targets to maintain reliability over the planning period and informs the Board on resource investment decisions as well as the establishment of a plan to fund them. Considering future uncertainties inherent in long-term resource planning, including uncertainties about climate change and regulatory requirements, as well as Southern California's population and economy, this scenario planning approach better prepares the region for a wider range of potential outcomes by identifying solutions and policies across a variety of possible future conditions. This strategy is designed to enable Metropolitan and its member agencies to manage future challenges and changes in California's water conditions and to balance investments with water reliability benefits.

3.1.2 Water Surplus and Drought Management (WSDM) Plan

Diversifying the region's water supplies and developing adequate and healthy water storage reserves have proven to be the backstop for water supply reliability. These actions have also contributed to improved seismic resilience for the region. Stored water reserves provide certainty for meeting the needs of the region when traditional sources of supply are challenged by drought, climate change, seismic events, and other risks. It is critical that these storage resources be developed, managed, maintained, and enhanced.

Metropolitan's WSDM Plan, which defines a regional water management strategy for Metropolitan and its member agencies, has focused on using storage to manage water supplies and enhance reliability since 1999. The WSDM Plan includes the following guiding principle: Metropolitan will encourage storage of water during periods of surplus and work jointly with its member agencies to minimize the impacts of water shortages on the region's retail consumers and economy during periods of shortage.

3.1.3 Water Supply Allocation Plan

When continued drought, earthquakes, or other natural disasters lead to shortages of supplies, Metropolitan distributes a limited amount of water through its Water Supply Allocation Plan (WSAP). First developed in 2008, Metropolitan's WSAP takes a basic premise —to fairly distribute a limited amount of water supply—and applies it through a detailed methodology to reflect a range of local conditions and needs of the region's retail water consumers. In particular, under severe drought conditions or a potential seismic event that impacts imported conveyance systems, it may be necessary and prudent to call for greater reductions in the use of limited water supplies and to reduce reliance on storage reserves. The WSAP has 10 levels of water supply allocations, each corresponding to a five percent reduction of supply. A Level 2 allocation, for example, represents a reduction of approximately 10 percent in the overall water supply

available to each member agency. The level of WSAP reduction implemented would correlate to the severity of interruption caused by the seismic event.

3.2 System Flexibility

Metropolitan develops its facilities to meet demands; however, in the course of developing a reliable system to meet demands, some flexibility has been incorporated into the system. This flexibility helps Metropolitan accommodate changes in water supply, demands, and water quality. System flexibility also helps mitigate the impacts of scheduled and unscheduled outages. Metropolitan's system flexibility has two key components:

- Operational flexibility: the ability to respond to changes in regional supply, water quality, or member agency demands
- Delivery flexibility: the ability to maintain partial to full deliveries during scheduled and unscheduled facility outages

Metropolitan has found that for scheduled and unscheduled outages of Metropolitan facilities, system flexibility at the regional and local levels is key to minimizing the effects of these outages. Water supply reliability and water demand-driven projects increase Metropolitan's system flexibility, which in turn can also increase seismic resilience. For example, the Diemer and Jensen water treatment plants (and associated feeders) were constructed as water demand-driven projects that also significantly improved delivery flexibility and seismic resilience within Metropolitan's distribution system. The service areas for these water treatment plants and the Weymouth Water Treatment Plant overlap creating the Common Pool service area (Figure 3-1), which can be supplied by the other two plants if one is removed due to a planned or unplanned outage. More recent examples include the Inland Feeder-Lakeview Pipeline interconnection, which improved the supply reliability of the Mills Water Treatment Plant by enabling the delivery of water from Diamond Valley Lake, and upgrades to the Greg Avenue Pump Station, which can deliver water from Weymouth into areas normally supplied by the Jensen Water Treatment Plant. These projects were initiated in response to drought, and also provide additional reliability against seismic events.

More recently, drought conditions between 2020 and 2022 in Northern California resulted in historic low allocations from the SWP with consecutive 5 percent allocations. The drought highlighted needed improvements in the system to move alternative supplies into those areas highly dependent on SWP supplies. As a result, Metropolitan has implemented two projects that will enable delivery of Colorado River or stored SWP supplies within DVL to the SWP dependent areas. The first project, DVL Storage to Rialto Pipeline Delivery, will enable pumping of up to 120 cfs of stored water within DVL to the Rialto Pipeline service area. The second project, the Sepulveda Feeder Pump Project (SFPP) Stage 1, will provide up to 30 cfs of additional supply to member agencies in Metropolitan's western SWP dependent area.

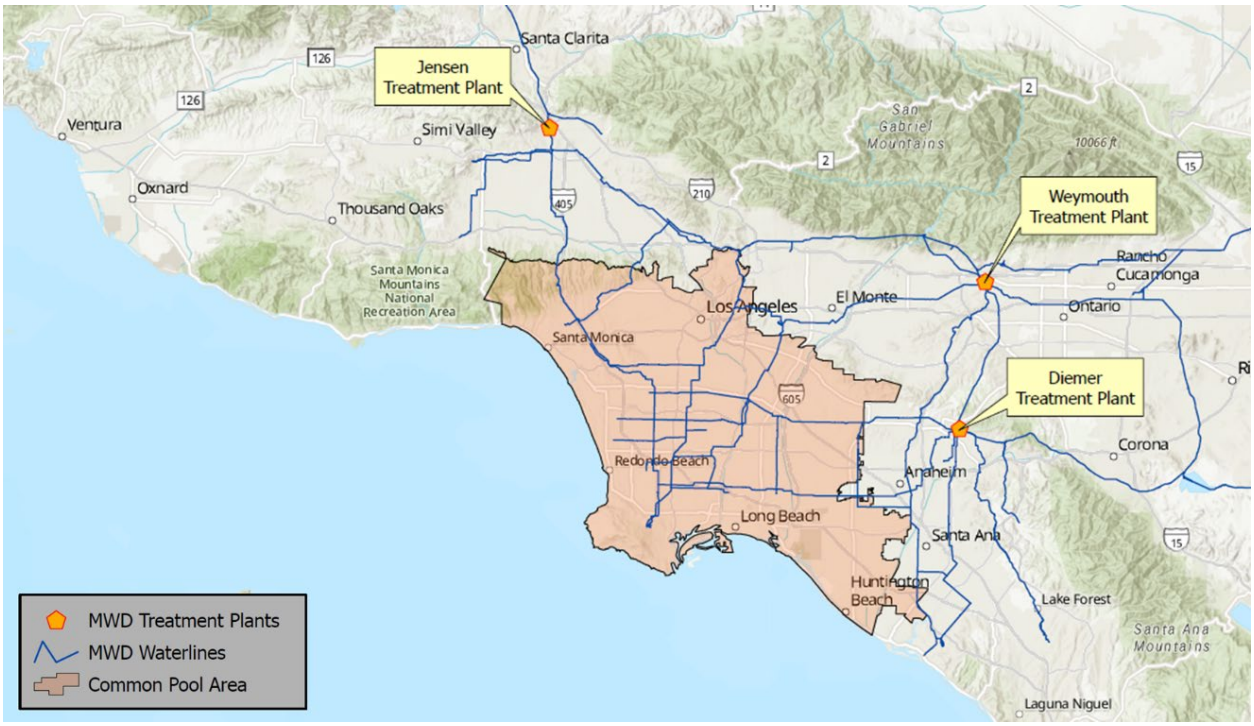

Figure 3-1: The Common Pool Service Area can be supplied by the Weymouth, Diemer, and Jensen Water Treatment Plants

While these projects are intended to improve the drought resilience of the SWP dependent areas, they will also provide benefits in case of a seismic event impacting deliveries of imported supplies to these areas.

3.3 Emergency Storage

Emergency storage requirements are based on the potential for a major earthquake that would damage all supply aqueducts, isolating Southern California from its imported water sources. Metropolitan maintains emergency storage throughout multiple reservoirs located on the coastal side of the San Andreas Fault.

In 2019, Metropolitan and its member agencies completed a collaborative process to update the regional planning estimate of Metropolitan's Emergency Storage Objective. This emergency storage represents the amount of water that Metropolitan would store for the region in preparation for a catastrophic earthquake that would damage the aqueducts that transport imported water supplies to Southern California, including the Colorado River Aqueduct, both the East and West branches of the California Aqueduct, and the Los Angeles Aqueduct.

The emergency storage allows Metropolitan to deliver reserve supplies to its member agencies to supplement local production. This helps avoid severe water shortages during periods when the imported water aqueducts may be out of service. The Emergency Storage Objective

incorporates three main considerations: 1) a six- and twelve-month outage period for the imported supply aqueducts based on the latest assessment[1] and operational flexibility of Metropolitan's system; 2) a retail water demand cutback ranging from 25 to 35 percent given the level of conservation that the region achieved during recent droughts; and 3) an aggregated loss of 10 to 20 percent of local supplies accounting for factors that could affect local production during emergency conditions. The methodology and recommendation of the workgroup were described in detail in a draft white paper, "2018 Evaluation of Regional Storage Portfolio: Draft Evaluation of Metropolitan's Emergency Storage Objective," and presented to Metropolitan's Board in May 2019[2].

Under this update, Metropolitan's Emergency Storage Objective was set to 750 TAF, as this level of storage would prevent severe water shortages in the region given the latest estimate on expected recovery durations. The emergency storage volume represents a planning estimate for the amount of water that Metropolitan would store for the region in preparation for a catastrophic earthquake or other disasters. It is not intended to set a basis or a policy for allocating or apportioning storage for any individual member agency.

Figure 3-2: Emergency Storage is allocated throughout multiple reservoirs such as Diamond Valley Lake (shown)

3.4 Other Actions

Metropolitan is evaluating the implementation of a large-scale recycled water project, Pure Water Southern California (PWSC). PWCS is a collaboration with the Los Angeles County Sanitation Districts (LACSD) that will purify up to 150 million gallons per day of treated wastewater from the LACSD's A.K. Warren Water Resource Facility in Carson for groundwater augmentation and potential incorporation at Metropolitan's treatment facilities, which can then be treated and delivered through Metropolitan's distribution system. PWSC's location within the Los Angeles basin will improve the region's seismic resilience by providing another water source for Metropolitan's member agencies in case of a seismic event that impacts the region's imported water supplies for an extended period.

3.5 Summary

Through its IRP, Metropolitan has established a fundamental goal that Southern California will have a reliable water supply system for present and future generations, even if imported water supplies are disrupted due to a major seismic event. This reliability is achieved through Metropolitan's collaborative efforts with its member agencies in developing local water supplies, emphasis on water conservation, and establishment of emergency storage on the coastal side of major earthquake faults that are crossed by the SWP, CRA, and LAA. These reliability actions enable Metropolitan to continue water deliveries during the period when imported supply aqueducts are out of service due to damage from a major seismic event. Metropolitan also continues to coordinate with state and regional entities to develop robust plans to bring back the imported supply aqueducts in service to minimize the outage period and disruption. In addition, Metropolitan's planning efforts to diversify the water supply and increase overall system flexibility over time have also contributed to providing resilience against potential in-basin earthquakes.

Metropolitan will continue to evaluate its water resource planning programs in terms of how they may further enhance seismic resilience and coordinate these efforts with the Engineering and Operations functions that are described in Sections 4 and 5 of this report.

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1 The latest assessment of potential outage durations for the region's imported water supply aqueducts (Colorado River Aqueduct, the Los Angeles Aqueduct, and the State Water Project East and West branches) following a seismic event developed as part of the 2015 Seismic Resilience Water Supply Task Force between Metropolitan, LADWP, and DWR.

2 https://bda.mwdh2o.com/Board%20Archives/2019/05-May/Letters/064883968.pdf

4 Engineering Component

Metropolitan develops strategies that assess systemwide risks and identify facilities' deficiencies against earthquake hazards. Component-specific mitigation measures are developed and implemented based on established priority. These strategies include evaluating the seismic resilience of structures; systemwide seismic assessments that address multiple facilities and infrastructure components; other specialized efforts that address the seismic resilience of dams and reservoirs and linear components such as tunnels and pipelines; and developing component-specific seismic design criteria.

4.1 Seismic Resilience of Structures

The purpose of evaluating the seismic resilience of structures is to prevent seismic damage to water delivery infrastructure from probable events and to limit damage due to extreme events to minimize water delivery interruptions. For occupied structures, the goal is to protect life safety and critical functions. Metropolitan applies a systematic approach to evaluate existing structures that were constructed in accordance with earlier codes, and where necessary, to upgrade structures with identified seismic deficiencies. The criteria applied to the seismic evaluations incorporate current code provisions and up-to-date industry standards. In general, structures are upgraded to maintain seismic performance levels that are comparable to the levels of a new facility.

A seismic risk-reduction program identifies seismic deficiencies of structures and quantifies the associated risks through an effective evaluation process, enabling limited resources to be allocated strategically to projects that address key vulnerabilities and maximize improvements in the seismic resilience of the water delivery system. A 5-step process aims to achieve the above objectives were developed: 1) a preliminary high-level evaluation to quickly assess structures for potential seismic deficiencies; 2) prioritization of seismically deficient structures; 3) detailed evaluations and development of retrofit options, 4) seismic retrofit implementation, and 5) periodic reevaluation of structures.

Over the past two decades, the prioritization (step 2) was primarily aimed at improving the seismic resilience of above-ground facilities and structures constructed prior to 1990 with emphasis on water delivery facilities and facilities with potential life-safety risks. For example, the Weymouth Water Treatment Plant was placed into service in 1941 and expanded twice to meet growing demand. Weymouth basins 5 through 8 were constructed in 1962 as part of the plant's second expansion. In 2022, Metropolitan's Board authorized rehabilitation of the basins including seismic improvement of the concrete basin inlet channel. These improvements increase

seismic performance of the basin structure (Figure 4-1) and other water treatment equipment such as the baffle walls.

Figure 4-1: Seismic Reinforcement of Weymouth Basin 7

4.1.1 Progress to date

A comprehensive inventory list of Metropolitan's above-ground structures is used to track the progress of the evaluation and seismic upgrades of structures. To date, Metropolitan has completed preliminary evaluations of all 311 pre-1990 above-ground structures (Figure 4-2). Upgrades of many critical structures have also been completed, including the five pumping plants along the Colorado River Aqueduct, the Jensen Administration Building, the Diemer Administration Building, and the Lake Mathews Outlet Tower.

As shown in Figure 4-2, of the 116 structures identified as potentially deficient, 74 have been upgraded and 16 are authorized for study, design, or construction. The remaining 26 structures will proceed through Metropolitan's Capital Investment Plan (CIP) evaluation process to obtain authorization for the detailed evaluations.

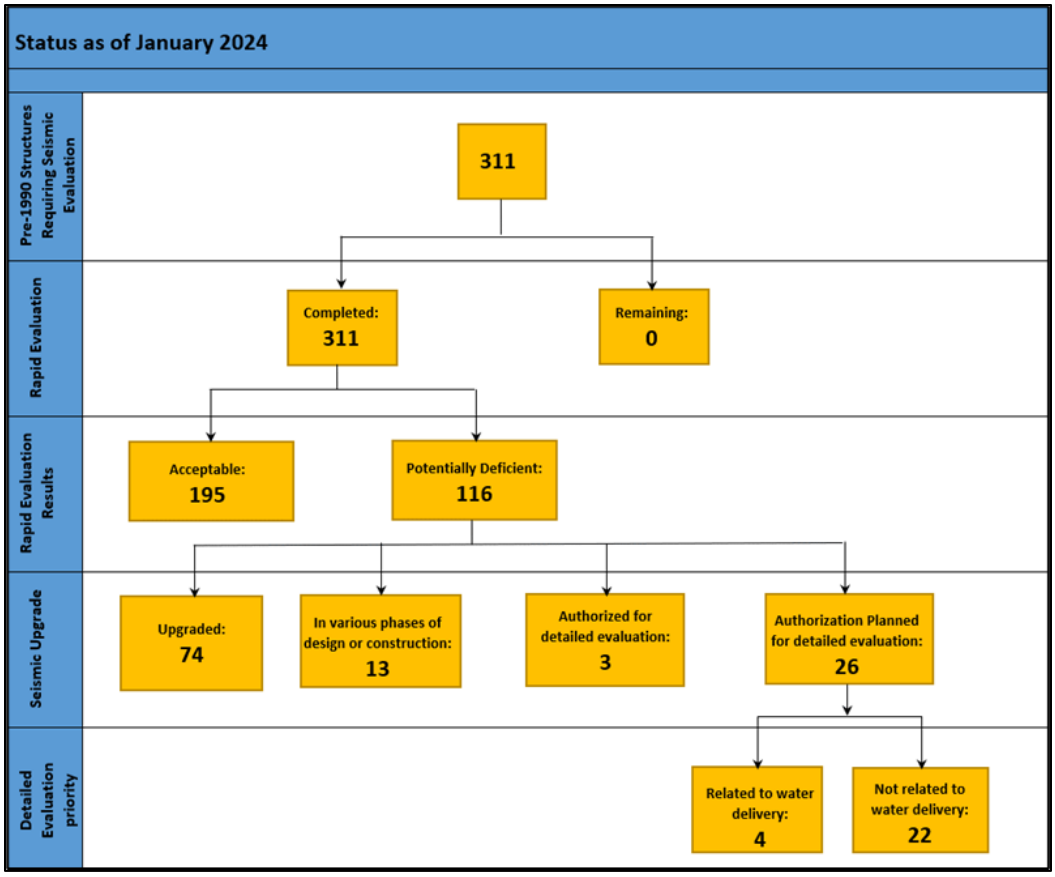


Figure 4-2: Status of Seismic Assessments and Upgrades for Pre-1990 Structures

In 2017, the strategy for achieving the seismic resilience of structures was modified to further enhance the seismic resilience of the delivery system. The refined strategy moved beyond assessing only pre-1990 above-ground structures to include the following:

- Fully and partially buried structures
- Seismic anchorage and bracing of non-structural components such as equipment, pipes, and ducts.
- Structures constructed between 1990 and 2000 (prior to the adoption of UBC 1997)

For the first two items, it was recognized that fully and partially buried structures, while less vulnerable to seismic hazards than above-ground structures, are nevertheless important to maintaining system reliability. Similarly, the seismic resilience of non-structural components, such as equipment and piping, is also important for minimizing operational downtime after a seismic event. To this end, Metropolitan initiated a pilot study to identify potential deficiencies of non-structural components at several facilities across multiple treatment plants. Upon completion of the pilot study, the information gathered will be used to start a comprehensive assessment of non-structural components at all Metropolitan facilities.

The third item, relating to UBC 1997, is included in the expanded effort since seismic design codes have been modified such that some structures designed and constructed after 1990 also warrant an assessment. Recorded ground motions in the 1994 Northridge Earthquake, for example, revealed that the design seismic force specified in building codes at the time was underestimated for sites located close to faults. This near-fault effect was incorporated into the subsequent code (UBC 1997). As a result, certain structures designed between 1990-2000 prior to the adoption of UBC 1997 may be vulnerable to a major earthquake.

Metropolitan has begun the preliminary evaluations of the post-1990 above ground structures (Figure 4-3). As shown in the figure, of the 6 structures identified as potentially deficient, 1 has been upgraded and 1 is authorized for preliminary design. The remaining 4 structures will proceed through Metropolitan's CIP evaluation process to obtain authorization for the detailed evaluations.

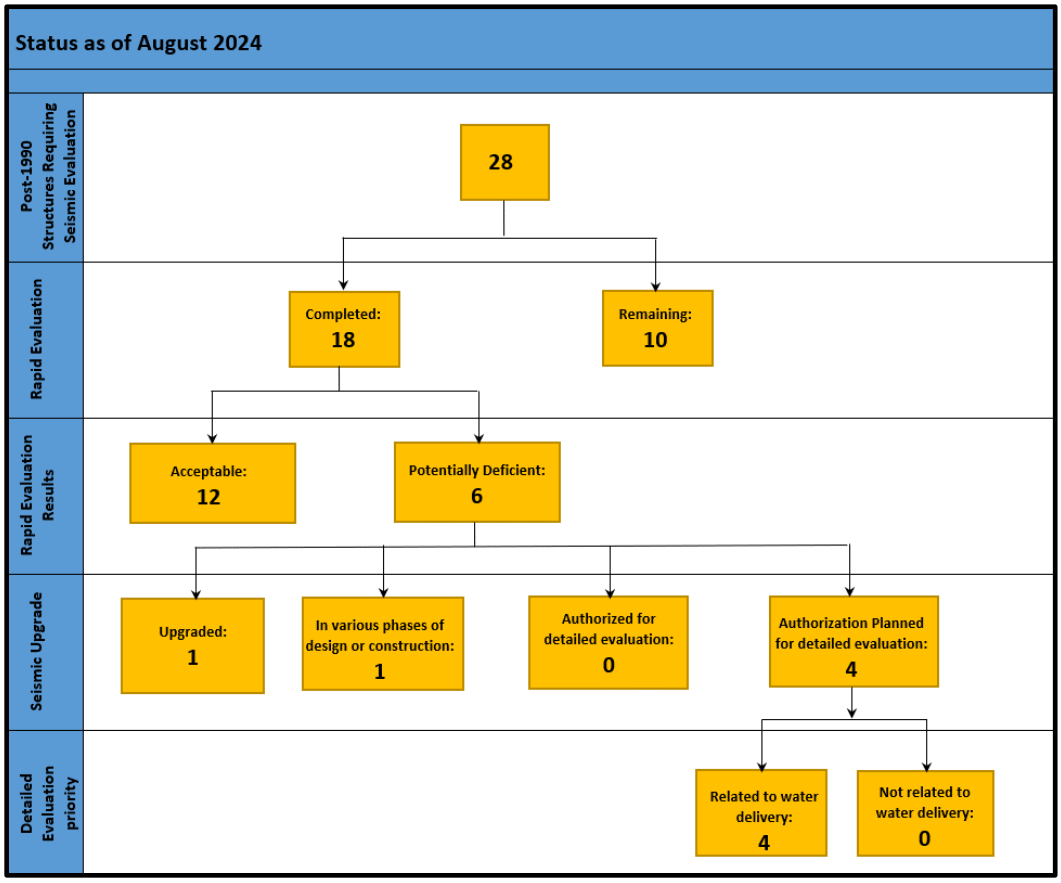


Figure 4-3: Status of Seismic Assessments and Upgrades for Post-1990 Above Ground Structures

Moving forward, the near-term focus is to complete the detailed evaluations and seismic retrofit projects that have been authorized to date. Long-term goals include:

- Continue assessment of seismic design criteria to incorporate updated seismic resilience strategy
- Develop a systematic approach to improve the seismic resilience of non-structural components
- Conduct preliminary evaluations for critical fully or partially buried structures
- Complete the preliminary evaluation of post-1990 above ground structures

4.2 Systemwide Seismic Assessments

Metropolitan conducts studies to further the organization's understanding of the vulnerability of its infrastructure system to seismic hazards. The studies support emergency response training and planning for future earthquake events by estimating the magnitude of damage that may occur from various seismic events. Current studies are described below.

Local Hazard Mitigation Plan – The Local Hazard Mitigation Plan will assess Metropolitan's exposure to natural hazards, including earthquakes, wildfires, landslides, floods, droughts, extreme weather events, and climate change. The plan sets goals for hazard mitigation and identifies studies and projects that will move the organization toward those goals. The plan will require approval by the Federal Emergency Management Agency (FEMA) and adoption by Metropolitan's Board of Directors. Completion of the Local Hazard Mitigation Plan would qualify Metropolitan for federal grant funding programs to offset the costs of hazard mitigation studies and projects.

Pipeline Seismic Vulnerability Assessment – A collaboration with the University of California, Berkeley Center for Smart Infrastructure (CSI), the Pipeline Seismic Vulnerability Assessment evaluates the risk to Metropolitan's pipeline system against the seismic hazard. Whereas previous studies have looked at damage under specific earthquake scenarios, this study will utilize a probabilistic approach to evaluate the impacts on Metropolitan's conveyance and distribution system, considering earthquakes with varying ranges of magnitudes at different faults. This approach provides a more comprehensive understanding of the relative risk, considering uncertainties in estimating hazard level and damage extent, for different pipelines. The findings will inform the prioritization process and result in a more effective mitigation effort. Figure 4-4 shows four potential repair realizations based on a hindcast of the 1994 Northridge Earthquake (M 6.7), as part of the model calibration process. The multiple realizations are a result of modeling the damage probability at each pipe segment using a Poisson distribution. The

parameters of the Poisson distributions are estimated based on pipeline fragility curves and the estimated ground shaking and ground failure intensities from the 1994 Northridge earthquake.

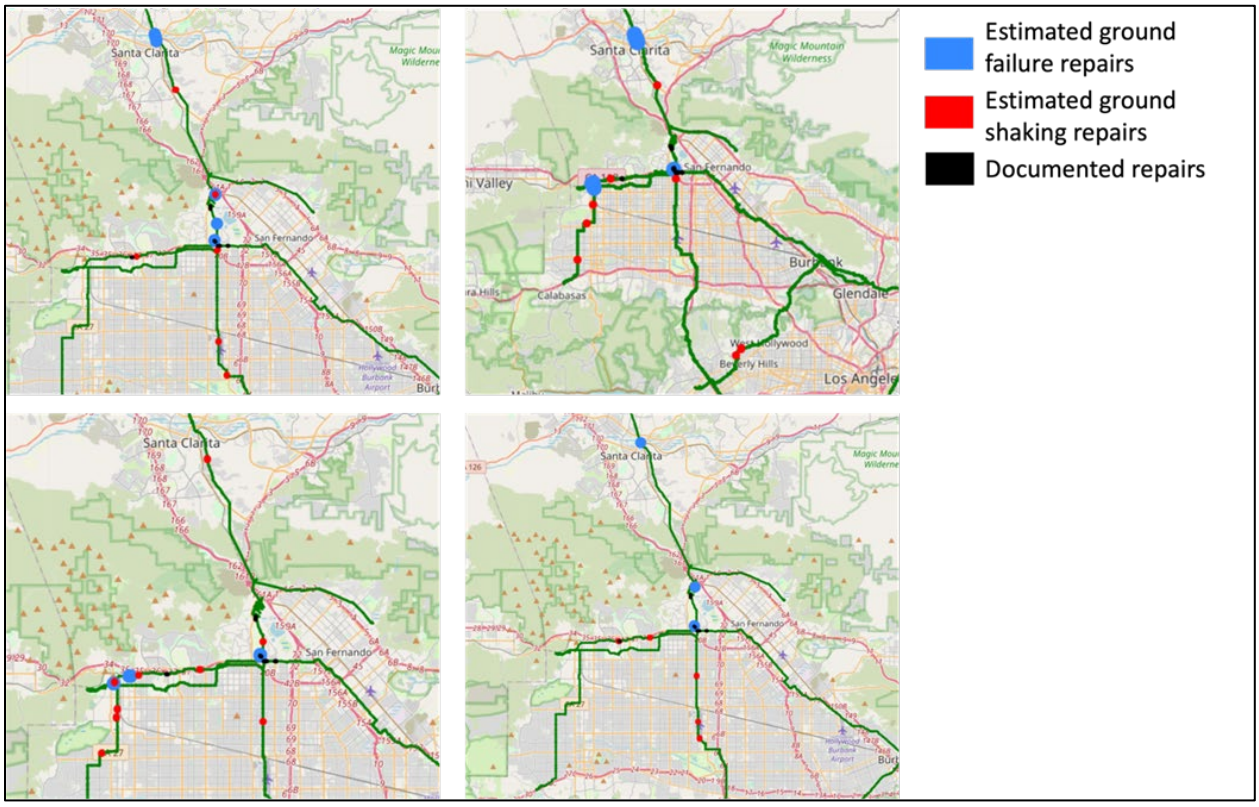


Figure 4-4: Examples of Pipeline Repair Location Realizations from Northridge Hindcast for Pipeline Seismic Vulnerability Assessment

4.3 Dams and Reservoirs Seismic Resilience

The seismic resilience of Metropolitan's dams and reservoirs is safeguarded by a robust and proactive comprehensive dam safety program managed by the Engineering Services Group (ESG). ESG's Safety of Dams and Geotechnical Team performs inspections, interprets, and analyzes collected surveillance and monitoring data, evaluates dam structures and appurtenant works, reports the findings, and serves as Metropolitan's liaison with the California Department of Water Resources, Division of Safety of Dams (DSOD).

Metropolitan owns and operates 20 facilities that are under the jurisdiction of DSOD, and there are a total of 24 individual dams, as some of these facilities have multiple dams. Metropolitan's portfolio of dams includes concrete arch dams, embankment dams, and rectangular reinforced concrete reservoirs or basins.

Several new programs were recently initiated that aim to bolster the seismic resilience of Metropolitan's dams by evaluating seismic risk and identifying risk reduction measures, better monitoring of the dams' performance during and after earthquakes and preparing for emergencies that could result from earthquakes.

4.3.1 Dam Safety Risk Assessments

A program was initiated in 2023 to perform comprehensive risk assessments of Metropolitan's dams which aim to identify potential failure modes (PFM) for the dam systems, and to estimate the risk associated with the PFMs. These comprehensive evaluations are done in accordance with current industry standards and best practices and include all the dam/reservoir system components such as spillways, outlet towers, and other appurtenant structures. The risk of failure as a result of a seismic event is estimated semi-quantitively considering a range of site-specific earthquake scenarios including the more frequent smaller events as well as the less frequent much larger events, and any necessary risk reduction measures are identified. In addition to identifying risk reduction measures, the understanding of seismic risk will inform the periodic updates to the inspection and monitoring procedures for the dams and provide the basis for prioritizing CIP projects.

The first risk assessment was completed for Lake Mathews dams and appurtenant structures in 2024, and the risk assessment for Lake Skinner was completed in 2025. The risk assessments concluded that the risk associated with seismic PFMs at both Lake Mathews and Lake Skinner dams are relatively low, below the action level identified in the federal risk guidelines. No immediate risk reduction measures were deemed necessary. However, further studies including detailed three-dimensional numerical analyses and enhanced post-seismic monitoring and surveillance were recommended.

These assessments are prioritized based on perceived risk at sites, with additional assessments scheduled to be completed by 2028.

4.3.2 Automated Dam Monitoring Systems

Another new initiative to modernize Metropolitan's existing dam monitoring systems began in 2023. The existing monitoring systems at several dams will be upgraded with state-of-the-art automated data acquisition systems (ADAS) that provide the ability to collect, view, and evaluate data on a near real-time basis from many instruments located in and around the dams and appurtenant structures. Data collected from different types of instruments that monitor pore pressures, groundwater levels, seepage flows, ground shaking, and deformation can be reviewed immediately after an earthquake to assess the performance of the dam and appurtenant structures. The upgraded systems also provide easy-access dashboards for data, and notification capabilities when preset thresholds are exceeded.

The monitoring system at Garvey Reservoir was upgraded in 2024. Monitoring system upgrade at Diamond Valley Lake is underway with a planned completion date of June 2025. Additional monitoring system upgrades planned for Lake Mathews and Lake Skinner will utilize the same approach as Garvey Reservoir and Diamond Valley Lake.

Figure 4-5 shows the instrumentation layout at Garvey Reservoir and the earthquake record from the recent 4.4 magnitude Highland Park earthquake, which occurred on August 12, 2024, with an epicenter located approximately 4 miles northwest of the reservoir. The new seismic accelerograph installed on the Garvey Reservoir North Embankment provided useful data immediately after the earthquake, which enabled staff to quickly evaluate the impact of the earthquake on the dam.

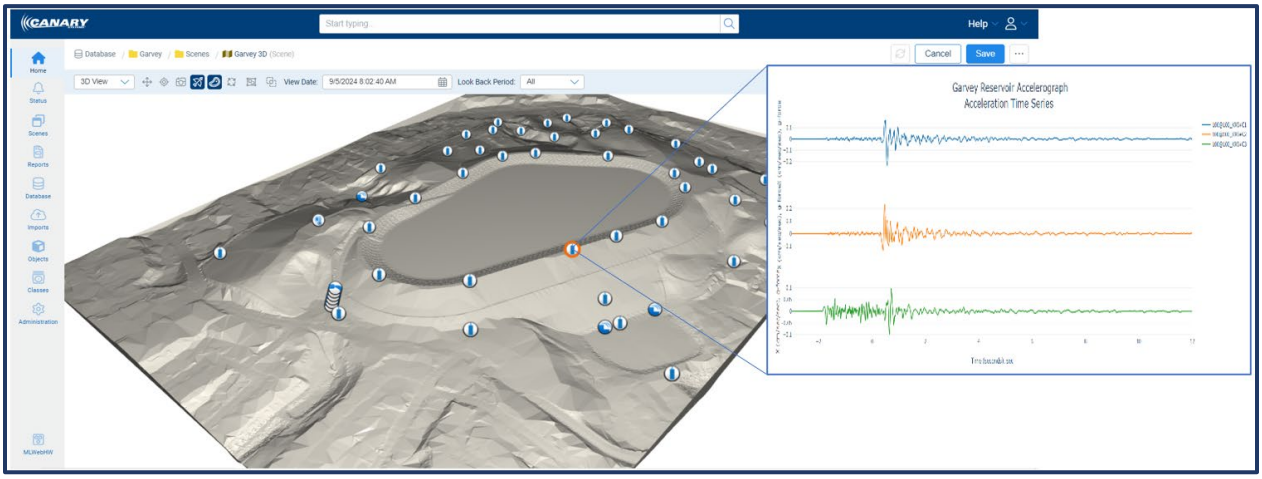


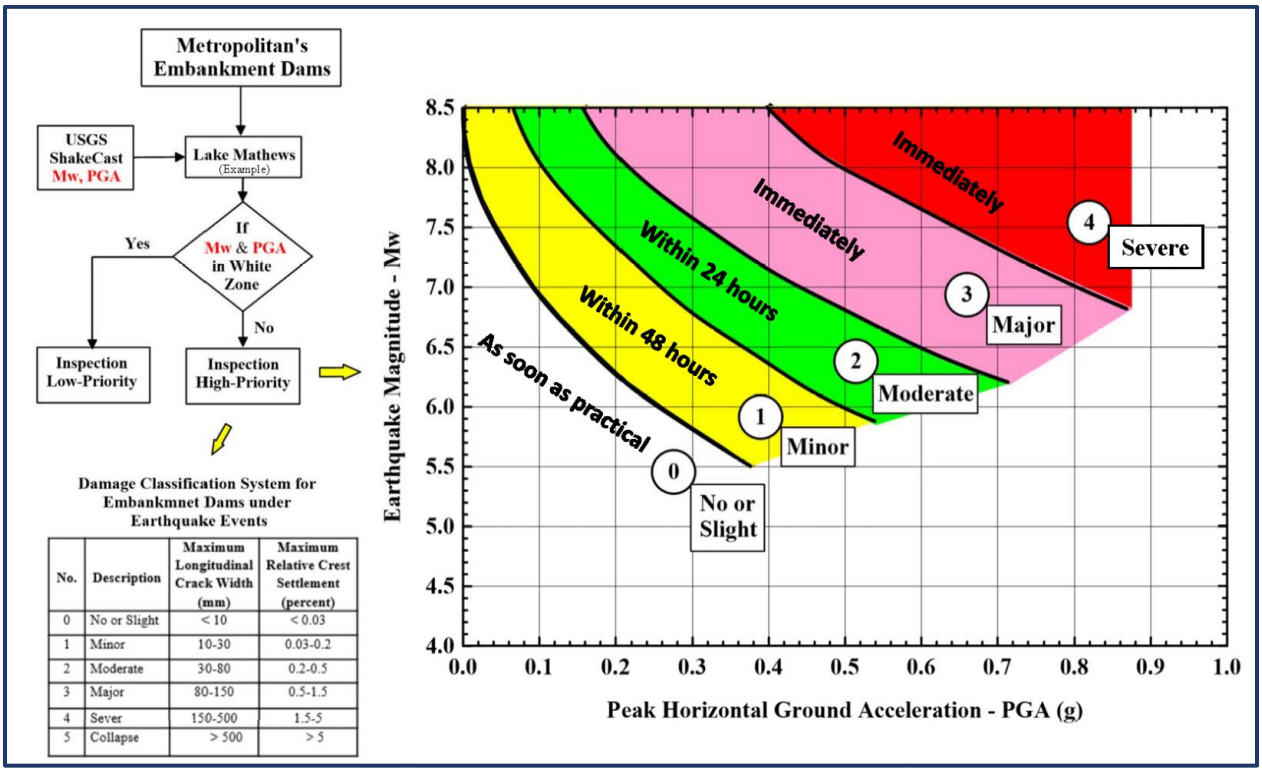
Figure 4-5: Garvey Reservoir Dam Monitoring System Dashboard and Recent Earthquake Data

4.3.3 Emergency Preparedness and Response

State-mandated Dam Emergency Action Plans (EAP) were completed and approved by the California Governor's Office of Emergency Services (Cal OES). A total of 13 EAPs were completed and approved, and several EAP exercises have been conducted with Metropolitan staff. The EAPs identify potential emergency conditions resulting from significant ground shaking during an earthquake and specify actions to be taken during and after the emergency.

In addition to the Dam EAPs, a new procedure was developed to allow the Dam Safety Assessment Team (DSAT), which is part of Metropolitan's Emergency Operations Center (EOC) organization, to prioritize post-earthquake inspections based on the earthquake magnitude and the recorded Peak Ground Acceleration (PGA) at or near the dam location. The purpose of this

procedure is to prioritize post-event inspections on the dam(s) that are likely impacted by the event. The new guideline is shown in Figure 4-6.



No.	Description	Maximum Longitudinal Crack Width (mm)	Maximum Relative Crest Settlement (percent)
0	No or Slight	< 10	< 0.03
1	Minor	10-30	0.03-0.2
2	Moderate	30-80	0.2-0.5
3	Major	80-150	0.5-1.5
4	Sever	150-500	1.5-5
5	Collapse	> 500	> 5

Figure 4-6: Dam Safety Assessment Team – Emergency Response Time Chart

4.4 Pipeline Seismic Resilience

Metropolitan's pipelines have been constructed in conformance with standards and practice at the time of design. Historically, there have been very few prescriptive code requirements for seismic design of pipelines. More recently, there have been developments in evaluation guidelines and mitigation measures for large-diameter pipelines, including improved techniques to analyze the interaction between pipelines and surrounding soil during shaking, increased post-earthquake reconnaissance on water systems, and demonstrated performance of earthquake-resistant pipeline products.

Two types of seismic hazards, ground shaking and permanent ground displacement (PGD), can potentially cause damage to pipelines. PGD could occur at fault crossings, liquefiable zones, and unstable slopes. Metropolitan has conducted and will continue to update seismic vulnerability assessment of its distribution system, which consists of mainly large-diameter pipelines. From historical data and records of Metropolitan's pipeline performance in past earthquakes, large-diameter pipelines are less vulnerable to ground shaking. Damage resulting in severe pipeline leaking was mainly caused by PGD. Therefore, the current focus of Metropolitan's pipeline

seismic resilience strategy is to mitigate vulnerabilities caused by PGD to effectively reduce overall risks with limited resources. In the meantime, Metropolitan will opportunistically address other seismic vulnerabilities when an aging pipeline is slated for rehabilitation.

Metropolitan has adopted seismic design criteria for pipelines to resist various hazards. For new design or rehabilitation of pipelines at fault crossings, Metropolitan will attempt to characterize the fault rupture location, direction, and ground displacement which can be used as the input to simulate the interaction between pipeline structure and surrounding soil. Slope instability hazards are analyzed similarly applying nonlinear finite element models of subgrade structures and soil materials to capture the soil-structure interaction. Mitigation measures could include strengthening pipelines and joints, soil improvements, and application of earthquake-resistant pipelines. Since the extent of liquefaction areas is difficult to define for the purpose of calculating pipeline strain and stress, the approach to address liquefaction hazards is avoidance and restoration. New pipeline installation will avoid potential liquefaction zones. For existing pipes, the resilient strategy, such as isolation, pre-event design, and stockpiling described in a later section, will be most prudent. Pipe joints and thrust are evaluated to resist the shaking hazards.

Examples of some of Metropolitan's ongoing and recently completed pipeline-related seismic projects are provided below.

Casa Loma Siphon No. 1 - The Casa Loma Siphon No. 1 seismic upgrade project was completed in 2024 and put into active service. The project utilized Earthquake Resistant Ductile Iron Pipe (Figure 4-7) to replace approximately 700 feet of the existing siphon with a 104-inch-diameter-double barrel system able to accommodate long-term subsidence and potential rupture of the San Jacinto Fault at the crossing.

Figure 4-7: Earthquake Resistant Ductile Iron Pipe Joint Assembly for Casa Loma Siphon

Prestressed Concrete Cylinder Pipe Rehabilitation - Metropolitan's rehabilitation program of its prestressed concrete cylinder pipelines (PCCP) is progressing as planned. The program will install welded steel liners within the existing PCCP pipeline sections of Metropolitan's conveyance and distribution system. Approximately 18 miles of a planned approximate 29 miles have been relined on Metropolitan's Second Lower Feeder. Reach 9 of the Second Lower Feeder PCCP Rehabilitation crosses the Los Angeles River and the Newport-Inglewood Fault. The feeder is being evaluated for improvements to the proposed steel liner rehabilitation of the PCCP, which will increase the feeder's seismic capacity against potential fault ruptures. Possible improvements include improved joint construction to match the yield strength of the steel liner and modifications of the grout material between the liner to the PCCP to achieve higher performance during a seismic event. Metropolitan is also progressing with the design for the PCCP Rehabilitation Project for the Sepulveda Feeder, which will line approximately 19 miles of pipe.

Sepulveda Canyon Slope Stability - The Sepulveda Canyon Control Facility (SCCF) is an important system and central in controlling the flow and hydraulic operating pressure of the Sepulveda Feeder system. The SCCF is situated in a large tributary canyon, located near the Getty Center and west of the junction of Interstate 405 and Sepulveda Boulevard in Los Angeles.

The facility was originally constructed on level pads created by placing and compacting fill in Sepulveda Canyon. Site work, including placement of this compacted fill, was carried out between 1969 and 1970. Grading for the original site development and canyon-area fill was performed with only partial removal of alluvial soils present in the bottom of a V-shaped canyon. These soils were reportedly removed to just above the groundwater level. The pads were established at elevations designed to maintain sufficient head to control the distribution of water from the facility. Site grading involved constructing an east-facing fill slope in the narrow canyon area that ranges from about 90 to 130 feet in height and is inclined at approximately 1.5:1 to 2:1 (horizontal to vertical).

Major infrastructure at the SCCF consists of large circular tanks, a pressure control structure, hydroelectric power generation, overflow structures, and the Sepulveda Feeder pipeline. Recent field investigations indicated that the facility may suffer liquefaction-induced slope failure in the existing alluvial soils under the most recently updated seismic code. The planned Sepulveda Feeder Pump Stations Project has developed effective measures to stabilize the slope that include soil remediation and a soil retaining system (Figure 4-8). The pipe approaching and leaving the facility will be evaluated to remain in service following a seismic event and slope movement.

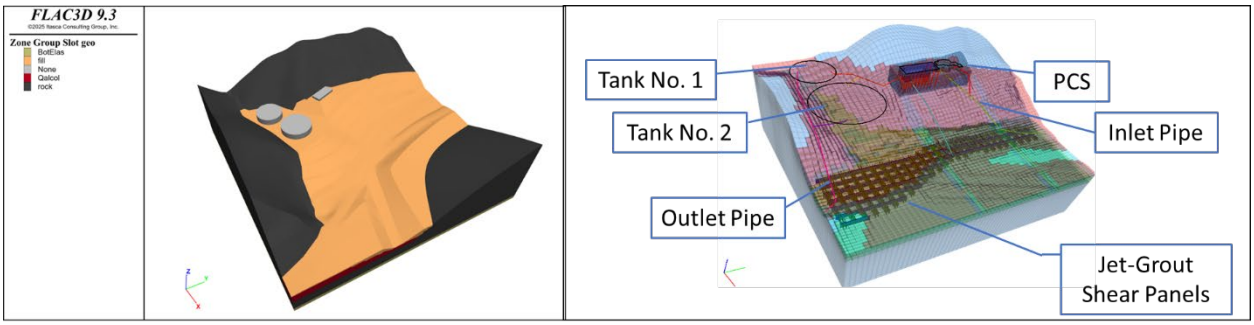


Figure 4-8: FLAC 3D Models of Sepulveda Canyon Site, with left model showing fill area (yellow) and right model showing 3-D mesh of proposed mitigation to stabilize the slope

4.5 Tunnel Seismic Resilience

Metropolitan's main conveyance line, the CRA, and its distribution system traverse through complex topographies that required tunnel construction in some areas. The CRA features approximately 92 miles of tunnels, accounting for 38 percent of the 242-mile aqueduct. The western portion of the CRA is in a seismically active area and crosses several known active faults. The distribution system includes 41 tunnels with a combined total length of 68.9 miles, representing 8.3 percent of the entire system. Similarly, many known active faults in the region also present a significant seismic risk to this part of the system.

The primary hazards associated with seismic events for tunnels include ground shaking, fault rupture, and other ground failures related to the site characteristics such as liquefaction, landslides, and rockfalls. The performance of tunnels during a seismic event also depends on the different tunnel attributes, including construction method, geological conditions, type of liner, and depth of cover. Recent projects for tunnel-related seismic improvements include the Whitewater Tunnel No. 2 and the Iron Mountain Tunnel.

Whitewater Tunnel No. 2 – Whitewater Tunnel No. 2 is part of the Colorado River Aqueduct, which conveys water from the Colorado River into the Metropolitan's service area. The tunnel is located near the Garnet Hills segment of the San Andreas Fault Zone and is crossed by a strand of the Garnett Hills fault. A project to improve the seismic resilience of the tunnel is currently in preliminary design. The project will strengthen the portal sections of the tunnel and improve access to the western portal including road improvements and construction of a new access structure. Since the precise location of the fault crossing is difficult to define, the design of a bypass tunnel is part of the resilient measures to plan for the potential restoration of the damaged tunnel segment regardless of its location. The project is currently nearing completion of preliminary design.

Iron Mountain Tunnel – The Iron Mountain Tunnel is part of the Colorado River Aqueduct, which conveys water from the Colorado River into the Metropolitan's service area. The western end of the tunnel was constructed through old alluvial fan deposits predominantly consisting of slightly to moderately consolidated, boulder, cobble, gravel, sand, and silt deposits. Approximately 2,500 feet of the Iron Mountain Tunnel concrete lining is distressed with a continuous longitudinal crack running near the centerline of the crown. The width of the crack ranges from 1/8-inch up to approximately 2 inches but is more consistently about a ½ inch to 1-inch wide. Metropolitan has performed focused tunnel inspections and has concluded that although the observed tunnel lining distress does not present an immediate threat to structural integrity, it could have the potential to adversely impact the long-term reliability of the CRA system. Iron Mountain Tunnel seismic improvements are focused on strengthening the distressed portion of the tunnel to prevent potential damage from earthquake-induced shaking. The project is currently in the study phase, which will consider different strengthening options.

5 Operations (Emergency Response)

5.1 Emergency Response Training

In addition to training emergency response staff on National Incident Management System procedures, Metropolitan regularly conducts emergency response training exercises which are often based upon a postulated seismic event (Figure 5-1). Exercises can be in the form of table-top exercise, a high-level review of policies and procedures, or a functional exercise, a simulated emergency event.

Recent seismic related exercise examples include:

- "ShakeOut 2024" – Functional exercise located at Metropolitan's Emergency Operations Center with participation from member agencies including the Foothill Municipal Water District, Calleguas Municipal Water District, City of Long Beach Water Department, and Southern California Edison
- "ShakeOut 2022"- Functional exercise located at Metropolitan's EOC with participation from member agencies including the Three Valleys Municipal Water District, Foothill Municipal Water District, Upper San Gabriel Valley Municipal Water District, City of Pasadena, and City of San Marino
- "ShakeOut 2020" – Functional exercise located at Metropolitan's Emergency Operations Center with participation from member agencies including the City of Anaheim, City of Burbank, Eastern Municipal Water District, City of Fullerton, City of Glendale, and Las Virgenes Municipal Water District

Figure 5-1: Metropolitan staff conducting emergency response exercise at the Emergency Operations Center

The Metropolitan EOC also conducts monthly communication tests, which include Metropolitan's emergency two-way radio system, on-line WebEOC system, Met-Alert mass notification system, and satellite phones. These monthly tests reach out to the member agencies, treatment plant control centers, ICPs, Metropolitan management, and the Department of Water Resources. These regular exercises help prepare Metropolitan and its member agencies to respond to future emergencies.

5.2 Emergency Response Capabilities

Metropolitan continues to maintain the necessary staffing, materials, and equipment to respond to two simultaneous pipeline breaks. The Machine Shop and Coating Shop at La Verne are available to fabricate pipe sizes up to 12 feet in diameter, and Metropolitan's construction forces have the necessary equipment and expertise to make the repairs in-house. In May 2022, Metropolitan's Board approved Stage 5 of the La Verne Shops upgrades which included building and utility upgrades, refurbishment of existing equipment, and installation of new equipment (Figure 5-2). This project is expected to be completed in 2025.

Figure 5-2: Installation of new equipment at the La Verne Shops

6 Reporting

The reporting component of Metropolitan's seismic resilience strategy focuses on the following areas:

1. Record Keeping: Tracking progress and maintaining a record of expenditures
2. Annual Updates: Providing annual updates to Metropolitan's Board of Directors
3. Formal Reporting: Preparing a formal Seismic Resilience Report every five years

6.1 Record Keeping

The component involves tracking progress on key seismic activities. Key seismic resilience activities include the planning, engineering, operations, and near-term goals identified in Section 8. Specific activities include:

- Systemwide planning studies related to seismic resilience
- Seismic evaluations of structures, facilities, and components
- Designs for seismically upgrading structures/systems and related construction activities
- Emergency response training exercises
- Update component-specific seismic design criteria and performance objectives
- Joint efforts with external agencies through the Task Force

For each of these activities, progress is tracked and reported at regular intervals.

6.2 Annual Updates

Staff provides updates to Metropolitan's Board of Directors on an annual basis. The annual update focuses on refinements in seismic resilience strategies due to new information on regional seismicity, new technologies, industry standards, and recent seismic events. It also highlights recent accomplishments and recaps progress toward near-term goals.

6.3 Formal Reporting

The report summarizes seismic resilience objectives, goals, and accomplishments; consolidates key reference materials; and provides a high-level summary of the various activities related to seismic resilience throughout Metropolitan. Specific areas of emphasis can include:

- Knowledge Transfer: The formal report will provide a convenient, comprehensive source for seismic resilience information. The report will contain key information for all seismic resilience efforts throughout Metropolitan and will include a list of all formal Metropolitan reports on seismic issues. Individuals can use this information to familiarize

themselves with Metropolitan's seismic resilience history, issues, and goals, which will make them more effective in supporting seismic resilience efforts.

- Accountability: Through annual reporting to the Board, seismic resilience programs will maintain a higher degree of visibility, focus, and momentum on projects and studies that will help Metropolitan meet target goals.
- Transparency: The sharing of seismic resilience studies, projects, and performance objectives will benefit the facility planning efforts of member agencies. Seismic risk, mitigation, and projected duration of outages are complex issues that deserve adequate discussions between Metropolitan and member agencies to facilitate decisions and investments that best serve the public.

This summary report is updated every five years.

7 Seismic Resilient Water Supply Task Force

The Seismic Resilient Water Supply Task Force is a joint effort between Metropolitan, the California Department of Water Resources, and the Los Angeles Department of Water and Power. The task force was formed in 2016 to mitigate impacts and promote a coordinated response in the event of a large-scale earthquake impacting the region's major imported water conveyance systems. The task force meets annually and as needed to review and update goals and objectives (Figure 7-1). Additionally, the task force conducts joint emergency response exercises.

7.1 Joint Emergency Response Plan and Exercises

A Joint Agency Emergency Response Plan was developed, which describes a strategy for responding to emergencies caused by natural disasters or other unavoidable circumstances that would significantly damage the three largest aqueducts that bring water to the Southern California. The three aqueducts are the State Water Project's California Aqueduct (CA), which is owned and operated by the State of California's Department of Water Resources (DWR); the Los Angeles Aqueduct (LAA), which is owned and operated by the City of Los Angeles Department of Water and Power (LADWP); and the Colorado River Aqueduct (CRA), which is owned and operated by The Metropolitan Water District of Southern California (Metropolitan). DWR, LADWP and Metropolitan are the focus of this plan because the overlap of service area of the three agencies allows for a unique opportunity to coordinate emergency repairs following a catastrophic event that disrupts the imported water supply to the region. As such, the focus of the plan is the response to emergencies on the imported conveyance systems.

Figure 7-1: Seismic Resilient Water Supply Task Force Emergency Planning Exercise in March 2025

The plan will be updated every three years by representatives from each agency's emergency management departments. The updated plan will be reviewed and approved by System Operations or a higher-level manager.

The plan is exercised every two years, at a minimum, and follows the exercise processes set forth by the United States Department of Homeland Security. An Exercise After-Action Report and Improvement Plan will be created after each exercise and presented to the managers of each agency for review.

8 State Water Project Seismic Resilience

DWR continues to enhance the seismic resilience of the State Water Project (SWP) through a multi-pronged approach of re-evaluating SWP infrastructure with current seismic loading parameters, design and construction of seismic improvements, emergency preparedness, and research. Within the last three years, DWR's Division of Engineering Geotechnical Services Branch has fully implemented the SWP Seismic Program (SWP-SP). The objective of the SWP-SP is to identify and evaluate the overall seismic risk to the SWP and to establish priorities for seismic studies, risk reduction, and mitigation. Multiple projects are currently underway.

Re-Evaluations

- Between 2019 and 2024, DWR conducted advanced non-linear finite element analyses of the Oroville Dam Flood Control Outlet Monoliths 25 and 26 (the gated monoliths). The radial gates and the roadway bridge were also reanalyzed. Retrofit projects have been included in future planning as DWR awaits technical feedback from regulatory agencies.
- DWR completed screening-level structural analyses of "hard structures" at Pyramid and Cedar Springs Dams. More advanced analyses were also conducted for the Pyramid Dam outlet tower, which was identified as the most "seismically vulnerable" of the structures.
- DWR completed re-analysis of the left abutment of Castaic Dam considering current seismic loading conditions and potential future groundwater conditions.
- DWR completed the *Hyatt Powerplant Seismic Walkdown*. Phase 1 of the effort included a high-level assessment of plant equipment and systems for criticality and vulnerability to seismic shaking. Phase 2, completed in 2023, consisted of structural calculations of key equipment to determine the need for seismic retrofits. The on-going Phase 3 consists of design and construction of retrofits which largely consist of adding anchor bolts, strapping, or other means of preventing overturning or sliding failure during the design level seismic event.
- Phase 1 seismic walkdowns were also performed for Pearblossom Pumping Plant and Devil Canyon Powerplant.

Design and Construction

- In 2022, DWR completed the *Perris Dam Seismic Remediation* project which included deep soil-cement mixing to improve the dam's foundation and construction of a large berm to improve its stability and reduce deformations in association with extreme seismic events.

- In 2023, DWR completed the *Castaic Dam Tower Bridge Seismic Retrofit* which required a temporary drawdown of the lake to allow for installation of carbon-fiber reinforced polymer wrap on the bridge's piers (Figure 8-1).
- DWR continued to engage with the US Bureau of Reclamation on the BF Sisk Dam *(San Luis Reservoir) Safety of Dams* project that will address seismic deficiencies for multiple segments of the dam. The first construction contract was issued in April of 2022 and anticipated to complete in late 2025.
- DWR is currently evaluating 42 seismically vulnerable bridges on the California Aqueduct in the San Joaquin Field Division and designing retrofit measures to be implemented by late 2027.
- DWR is currently designing modifications to the Castaic Dam Intake Tower and Outlet Works to prevent damage to critical components and allow drawdown of the reservoir following a major earthquake. Construction is scheduled to be complete in late 2027.
- DWR is currently evaluating alternatives to minimize the risk of failure and improve post-seismic operation of the existing headworks and radial gate on the main spillway at Pyramid Dam. Construction is anticipated in the 2028 – 2030 timeframe.

Figure 8-1: Castaic Dam High Tower and Access Bridge, with scaffolding installed for installation of carbon-fiber reinforced polymer wrap on piers

Emergency Preparedness

- DWR prepared or updated inundation maps for nearly all its dams for inclusion in Emergency Actions Plans (EAPs) for SWP dams. DWR also updated and submitted all its dam EAPs, with DSOD-approved inundation maps, to CalOES.

- In 2022, DWR established the Emergency Preparedness Program (EPP) to drive continuous improvement of the SWP's response and recovery capabilities.
- In 2022, the SWP EPP modernized post-earthquake response plans and procedures that provide for a scaled response commensurate with the magnitude and geographic expanse of damage that might be experienced.
- On an annual basis, DWR conducts annual Emergency Action Plan seminars and conducts communication drills for its dams.
- The creation of the SWP Emergency Preparedness Program (EPP) has led to increase in exercises. Prior to the SWP EPP, typically just one tabletop or functional exercise occurred each year. DWR is now averaging three tabletop and two functional EAP exercises per year.
- Field Divisions instituted duty monitoring and/or implemented their EAPs for the following events:
    - 2022 – North Complex Fire near Oroville Dam
    - 2022 – Tropical Storm "Kay" for Southern FD
    - 2022 – Route Fire near Castaic Dam
    - 2021 and 2023 – High Flow Operations at Del Valle Dam, DFD
    - 2023 – Devils Den Pumping Plant Fire, San Luis FD
    - 2023 – January Winter Storms
    - 2024 – Post Fire, near Pyramid and Castaic Dams, SFD
    - 2024 – Thompson Fire, near Oroville Dam (Figure 8-2)

Figure 8-2: 2024 Thompson Fire burning along the rim of Lake Oroville (photo courtesy of CalFire)

Seismic Hazard Characterization

DWR commonly partners with leading consultants and researchers to ensure the best available information is utilized to design and re-evaluate SWP assets. DWR's efforts in the fields of faulting and seismicity, in particular, have been significant in advancing the state of practice and characterization of seismic hazards in California. Examples of the efforts undertaken over the past five years include:

- Investigation of the Grizzly Valley fault near Grizzly Valley Dam, including fault trench excavation
- Investigation of the Indian Creek fault near Antelope Dam, including detailed field mapping in preparation of fault trench excavation
- Investigation of the West Tracy fault at Clifton Court Forebay, including seismic reflection imaging
- Investigation of the Midway fault near Bethany Dam, including detailed field mapping in preparation of fault trench excavation
- Investigation of the Right Abutment faults at Del Valle Dam, including subsurface investigation and fault trench excavation
- Evaluation of most recent fault slip on the "Palomas Segment" of the San Gabriel fault in proximity to Pyramid Dam and Castaic Dam (Figure 8-3)
- Investigation of the Waterman Canyon fault at the Devil Canyon Power Development, including detailed field mapping in preparation of fault trench excavation
- Down-hole and surface shear wave velocity data collection at several dams to support development of current earthquake ground motion estimates
- Site-specific seismic hazard analyses, including deterministic and probabilistic analyses, utilizing the latest fault parameters and attenuation relationships, to better characterize and understand the likelihood of strong ground motions at SWP dams

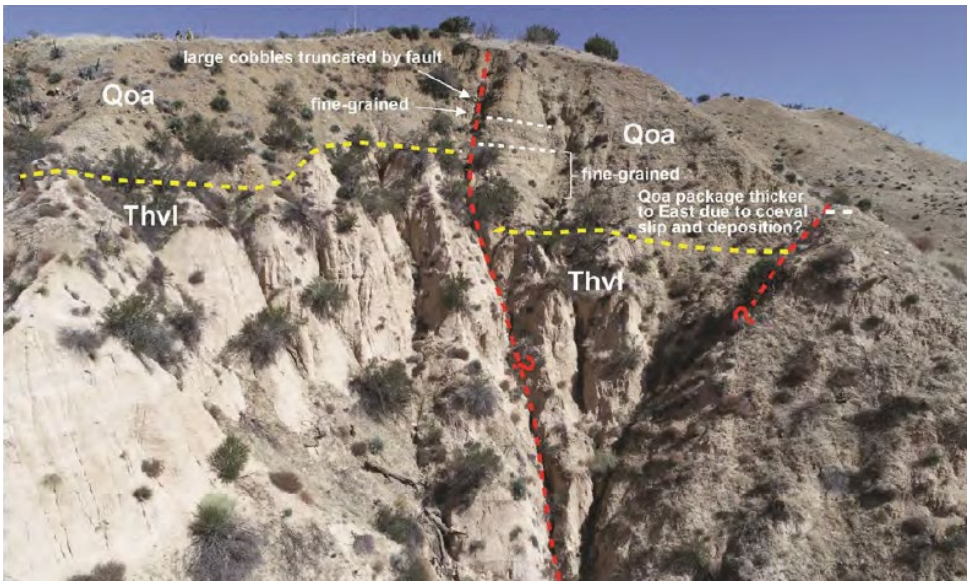


Figure 8-3*:* Drone Image of San Gabriel Fault (Palomas Segment) fault strand displacing base of Older Alluvium (Qoa) deposit (yellow dashed line)

9 Proposed Seismic Resilience Goals

9.1 Status of 2020 Listed Goals

The 2020 Seismic Resilience Report identified near-term goals to further Metropolitan's seismic resilience objectives. The near-term goals are listed below along with an update of the work done to date.

9.1.1 System Level Goals

Goal	**Conduct Special Seismic Studies**
• Update 2006 System Reliability Study, which analyzed the impacts of various single outage scenarios on Metropolitan's ability to meet member agency demand	
Outcome: An update of the study is planned to begin in 2025. The study update will assess the flexibility of the system to withstand a 7-day outage and an extended outage. Flexibility analysis will consider member agency ability to move water from different service connections within their systems, availability of local supplies, and member agency interconnections.	

Goal	**Conduct Planning Studies**
• Complete the 2020 IRP and comprehensive distribution system study under collaborative regional process. Update the emergency storage objective based on new IRP goals and forecasts.	
Outcome: 2020 IRP was finalized and approved by the Board in 2022.	

9.1.2 Facility Level Goals

Goal	**Complete Construction of Approved Projects**
• Weymouth West Wash Water Tank Seismic Upgrade • Union Station Headquarters Building Seismic Upgrade • Diemer West Filter Seismic Upgrade • CRA Casa Loma Siphon Barrel No. 1 Replacement	
Outcome: All four projects have been completed	

Goal	Complete Design of Approved Seismic Upgrade Projects
• Weymouth Administration Building Seismic Upgrade and Building Improvements (Administration and Control Buildings): the final design of both facilities is ongoing • La Verne Water Quality Lab and Field Engineering Building Seismic Upgrades and Building Improvements: preliminary design of the WQ Lab is ongoing while the preliminary design of a new Field Engineering Building has been scheduled • Lake Mathews Disaster Recovery Facility Seismic Upgrades: construction of the seismic upgrade has been completed • Upper Feeder San Gabriel Tower Seismic Upgrade: a detailed seismic assessment revealed that the tower can withstand the design earthquake • Weymouth Inlet Channel Structural Upgrades: construction of the seismic upgrade is ongoing along with the upgrade of Weymouth Basins 5-8. • Foothill HEP Seismic Upgrade: construction of seismic upgrade has been completed • Diemer WWRP No. 2 Seismic Upgrade and Slope Stability Mitigation: preliminary design is ongoing • Sepulveda Canyon Control Facility: final design for the seismic mitigation of the existing tanks and slope stabilization is ongoing	
Outcome: The current status for each project is provided in the box above	

Goal	Seismic Upgrade of Below-Ground Structures
• Initiate evaluation of below-ground structures. Identify and list all structures. Develop a prioritization system for evaluation.	
Outcome: Completed inventory of structures. Visual assessments of structures within Orange, Riverside, San Bernardino, and Los Angeles Counties have been completed. Staff has developed a program for linking the inspection findings to Metropolitan's GIS database for future reference. The results of the visual inspections will be used to identify and prioritize needed repairs.	

9.1.3 Task Force Goals

Goal	Emergency Response Plan and Exercises
• Conduct annual exercises to ensure familiarity with Joint Agency Emergency Response Plan • Semi-annual verification of emergency contact list for DWR, Metropolitan, and LADWP	
Outcome: Partners have held multiple exercises and continue to update the contact list during regular Task Force meetings.	

9.2 Proposed 2025 Seismic Goals

9.2.1 System Level Goals

Goal	Conduct Special Seismic Studies
• Complete Pipeline Seismic Vulnerability Study in partnership with CSI	

Goal	Conduct Planning Studies
• Conduct System Flexibility Study • Review Emergency Storage Criteria	

9.2.2 Facility Level Goals

Goal	Seismic Upgrade of Facilities
• Complete construction of Weymouth Administration Building Seismic Upgrade and Building Improvements (Administration and Control Buildings) • Complete construction of Weymouth Basin 5-8 Seismic Upgrade • Complete seismic upgrade design of La Verne Water Quality Lab • Complete seismic upgrade design of La Verne Storage Building • Complete seismic upgrade design of La Verne Engineering Building • Continue with seismic evaluation of non-structural components • Complete the rapid seismic evaluation of Post-1990 Structure Assessment	

Goal	Pipeline and Tunnel
• Complete design of Whitewater Tunnel No. 2 Seismic Upgrades • Complete studies for seismic mitigation of the Iron Mountain Tunnel • Evaluate seismic risk of the Eagle Mountain siphons • Evaluate seismic mitigation of the Newport Inglewood fault crossing for the Second Lower Feeder Reach 9	

Goal	Dams and Reservoirs
• Complete Garvey Reservoir Outlet Tower seismic rehabilitation • Complete seismic evaluation of Lake Skinner Outlet Tower • Continue with dam monitoring system upgrades • Continue with periodic dam safety assessments	

Goal	Seismic Upgrade of Below-Ground Structures
• Perform initial seismic risk screening and prioritize the list of below-ground structures for seismic evaluation	

9.2.3 Task Force Goals

Goal	Emergency Response Plan and Exercises
• Conduct annual exercises to ensure familiarity with the Joint Agency Emergency Response Plan • Semi-annual verification of emergency contact list for DWR, Metropolitan, and LADWP	