Attachment B

Water Supply Allocation Plan

December 2014 Revision

Metropolitan Water District of Southern California

Inside cover: Photo courtesy of Cora Edmonds/ArtXchange for the Healing Planet

Water Supply Allocation Plan

Table of Contents

List of Tables and Figures

Figure 1: Base Period Retail Demand Calculation 28
Figure 2: Allocation Year Retail Demand Calculation 29
Figure 3: Allocation Year Wholesale Demand Calculation 30
Figure 4: WSAP Allocation Regional Shortage Level 4 33

List of Acronyms

AF – Acre-feet
CUP – Groundwater Conjunctive Use Program
CWD – County Water District
DWP – Drought Management Plan
IAWP – Interim Agricultural Water Program Reductions and Rates
IICP – Incremental Interruption and Conservation Plan
IRP – Integrated Resources Plan
GPCD – Gallons per Capita per Day
M&I – Municipal and Industrial
MWD – Municipal Water District
RUWMP – Regional Urban Water Management Plan
SWP – State Water Project
WSAP – Water Supply Allocation Plan
WSDM – Water Surplus and Drought Management

Definitions

Extraordinary Supplies- Deliberate actions taken by member agencies to augment the total regional water supply only when Metropolitan is allocating supplies through the WSAP.

Groundwater Recovery- The extraction and treatment of groundwater making it usable for a variety of applications by removing high levels of chemicals and/or salts.

In-lieu deliveries- Metropolitan-supplied water bought to replace water that would otherwise be pumped from the groundwater basins.

Seawater Barrier- The injection of fresh water into wells along the coast to protect coastal groundwater basins from seawater intrusion. The injected fresh water acts like a wall, blocking seawater that would otherwise seep into groundwater basins as a result of pumping.

Section 1: Introduction

Calendar Year 2007 introduced a number of water supply challenges for the Metropolitan Water District of Southern California (Metropolitan) and its service area. Critically dry conditions affected all of Metropolitan's main supply sources. In addition, a ruling in the Federal Courts in August 2007 provided protective measures for the Delta Smelt in the Sacramento-San Joaquin River Delta which brought uncertainty about future pumping operations from the State Water Project. This uncertainty, along with the impacts of dry conditions, raised the possibility that Metropolitan would not have access to the supplies necessary to meet total firm demands[1] and would have to allocate shortages in supplies to the member agencies.[2]

In preparing for this possibility, Metropolitan staff worked jointly with the member agency managers and staff to develop a Water Supply Allocation Plan (WSAP). The WSAP includes the specific formulas for calculating member agency supply allocations and the key implementation elements needed for administering an allocation should a shortage be declared. The WSAP became the foundation for the urban water shortage contingency analysis required under Water Code Section 10632 and was incorporated into Metropolitan's 2010 Regional Urban Water Management Plan (RUWMP).

Section 2: Development Process

Member Agency Input

Between July 2007 and February 2008, Metropolitan staff worked cooperatively with the member agencies through a series of member agency manager meetings and workgroups to develop a formula and implementation plan to allocate supplies in case of shortage. These workgroups provided an arena for in-depth discussion of the objectives, mechanics, and policy aspects of the different parts of the WSAP. Metropolitan staff also met individually with fifteen member agencies for detailed discussions of the elements of the recommended proposal. Metropolitan introduced the elements of the proposal to many nonmember retail agencies in its service area by providing presentations and feedback to a number of member agency caucuses, working groups, and governing boards. The discussions, suggestions, and comments expressed by the member agencies during this process contributed significantly to the development of this WSAP.

Board of Directors Input

Throughout the development process Metropolitan's Board of Directors was provided with regular progress reports on the status of this WSAP, with oral reports in September, October, and December 2007, an Information Board of Directors Letter with a draft of the WSAP in November 2007, and a Board of Directors Report with staff recommendations in January 2008. Based on Water Planning and Stewardship Committee discussion of the staff recommendations and further review of the report by

[1] Firm demands are also referred to as uninterruptable demands; likewise non-firm demands are also called interruptible demands.

[2] See Appendix A: Metropolitan Member Agencies.

the member agencies, refinements were incorporated into the WSAP for final consideration and action in February 2008. The WSAP was adopted at the February 12, 2008 Board of Directors meeting.[3]

The 12-Month Review Process

When the Board adopted the WSAP in February 2008, the decision specified a formal revisit of the WSAP commencing in February 2010. The scheduled revisit was meant to ensure the opportunity for Metropolitan staff and the member agencies to re-evaluate the WSAP and recommend appropriate changes to the Board of Directors.

In April 2009, the Board voted to implement the WSAP for the first time. The WSAP was implemented at a Level 2 allocation level, and was in effect for the period of July 1, 2009, through June 30, 2010. Since implementation of the 2009/10 WSAP began in July 2009, a number of practical issues relating to the WSAP were identified by staff and the member agencies for further consideration during the 12-Month Review Process. Metropolitan staff engaged with the member agencies in a formal review of the WSAP from January through May 2010. During the review process the member agency managers participated in a series of six workshops. The focus of these workshops was to facilitate in-depth discussion on WSAP-related issues and lessons learned since the WSAP was implemented in July 2009. The proposed adjustments to the WSAP developed during the review process were adopted at the August 17, 2010 Board of Directors meeting[4].

The Three-Year Review Process

The Board action to adopt of the WSAP in February 2008 also directed staff to review the WSAP formula three years after the February 2008 adoption. February 2011 marked the three-year anniversary since the adoption of the WSAP. Similar to the 12-Month Review Process, the purpose of the Three-Year Review Process was to provide an opportunity for Metropolitan staff and the member agencies to re-evaluate the plan and recommend appropriate changes for board consideration.

Metropolitan staff met with the member agencies in a formal review of the WSAP from February through August 2011. Staff and member agency managers participated in a series of eleven workshops. Proposed adjustments to the WSAP developed during the process were adopted at the September 13, 2011 Board of Directors meeting.[5]

---

[3] A complete listing of member agency meetings and Board of Directors reporting activities is contained in Appendix B: Water Supply Allocation Plan Process Timeline.

[4] A complete listing of member agency meetings and Board of Directors reporting activities is contained in Appendix C: 12-Month Review Process and Results.

[5] A complete listing of member agency meetings and Board of Directors reporting activities is contained in Appendix D: Three-Year Review Process and Results.

2014 Review Process

In 2014, California was challenged with a third year of severe drought.[6] Metropolitan managed its operations through significant use of regional storage reserves. It was anticipated that end of year total dry storage reserves would approach levels similar to those when the WSAP was last implemented in 2009.

Following discussion at the June 2014 Water Planning and Stewardship Committee, Metropolitan staff convened a member agency working group to revisit the WSAP. The purpose of the working group was to collaborate with member agencies to identify potential revisions to the WSAP in preparation for mandatory supply allocations in 2015. There were eight working group meetings and three discussions at the monthly Member Agency Managers' Meetings.

The process focused on three areas of the WSAP: the Base Period, the Allocation Formula, and the Allocation enforcement mechanism. Proposed adjustments to the WSAP developed during the process were adopted at the December 9, 2014 Board of Directors meeting. [7]

[6] The Governor of California proclaimed a State of Emergency due to drought conditions on January 17, 2014 and, on April 24, 2014 issued an Executive Order proclaiming a continued State of Emergency noting drought conditions have persisted for the last three years and authorizing adoption and implementation of emergency regulations.

[7] A complete listing of member agency meetings and Board of Directors reporting activities is contained in Appendix E: 2014 Review Process and Results.

Section 3: Review of Historical Shortage Plans[8]

The WSAP incorporates key features and principles from the following historical shortage allocation plans but will supersede them as the primary and overarching decision tool for water shortage allocation.

Interruptible Water Service Program

As part of the new rate structure implemented in 1981, Metropolitan's Board of Directors adopted the Interruptible Water Service Program (Interruptible Program) which was designed to address short-term shortages of imported supplies. Under the Interruptible Program, Metropolitan delivered water for particular types of use to its member agencies at a discounted rate. In return for this discounted rate, Metropolitan reserved the right to interrupt delivery of this Interruptible Program water so that available supplies could be used to meet municipal and industrial demands.

Incremental Interruption and Conservation Plan

The ability to interrupt specific deliveries was an important element of Metropolitan's strategy for addressing shortage conditions when it adopted the Incremental Interruption and Conservation Plan (IICP) in December 1990. Reductions in IICP deliveries were used in concert with specific objectives for conservation savings to meet needs during shortages. The IICP reduced Interruptible Service deliveries in stages and provided a pricing incentive program to insure that reasonable conservation measures were implemented.

1995 Drought Management Plan

The 1995 Drought Management Plan (DMP) was a water management and allocation strategy designed to match supply and demand in the event that available imported water supplies were less than projected demands. Adopted by the Metropolitan Board of Directors in November 1994, the 1995 DMP was a short-term plan designed to provide for the 1995 calendar year only. The primary objective of the 1995 DMP was to identify methods to avoid implementation of mandatory reductions. The 1995 DMP included various phases and a step-by-step strategy for evaluating supply and demand conditions and utilizing Metropolitan's available options, with the final phase being implementation of the revised IICP.

1999 Water Surplus and Drought Management Plan

Metropolitan staff began work on the Water Surplus and Drought Management (WSDM) Plan in March 1997 as part of the Integrated Water Resources Plan (IRP), which was adopted by Metropolitan's Board of Directors in January 1996. The IRP established regional water resource targets, identifying the need for developing resource management policy to guide annual operations. The WSDM Plan defined Metropolitan's resource management policy by establishing priorities for the use of regional resources to achieve the region's reliability goal identified in the IRP. In April 1999, Metropolitan's Board of Directors adopted the WSDM Plan.

[8] A summary of the key elements in the following allocation plan is found in Appendix F: Summary of Historical Shortage Plans.

The WSDM Plan also included a set of principles and considerations for staff to address when developing specific allocation methods. The WSDM Plan stated the following guiding principle to be followed in developing any future allocation scheme:

> *"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."*[9]

This principle reflects a central desire for allocation methods that are both equitable and minimize regional hardship to retail water consumers. The specific considerations postulated by the WSDM Plan to accomplish this principle include the following:[10]

- The impact on retail customers and the economy
- Allowance for population and growth
- Change and/or loss of local supply
- Reclamation/Recycling
- Conservation
- Investment in local resources
- Participation in Metropolitan's interruptible programs
- Investment in Metropolitan's facilities.

Section 4: Water Supply Allocation Formula

Based on the guiding principle and considerations described in the WSDM Plan, Metropolitan staff and the member agencies developed a specific formula for allocating water supplies in times of shortage. The formula seeks to balance the impacts of a shortage at the retail level while maintaining equity on the wholesale level, and takes into account growth, local investments, changes in supply conditions and the demand hardening[11] aspects of non-potable recycled water use and the implementation of conservation savings programs. The formula, described below, is calculated in three steps: base period calculations, allocation year calculations, and supply allocation calculations.[12] The first two steps involve standard computations, while the third section contains specific methodology developed for this WSAP.

Base Period Calculations

The first step in calculating a water supply allocation is to estimate water supply and demand using a historical base period with established water supply and delivery data. The base period for each of the different categories of demand and supply is calculated using data from the fiscal years (July through June) ending 2013 and 2014.[13]

[9] WSDM Plan, p. 1. Emphasis added.
[10] WSDM Plan, p. 2.
[11] Demand hardening is the effect that occurs when all low-cost methods of decreasing overall water demand have been applied (e.g., low-flow toilets, water recycling) and the remaining options to further decrease demand become increasingly expensive and difficult to implement.
[12] Detailed operational elements of these objectives and a numerical example are discussed in Appendix G: Water Supply Allocation Formula Example.
[13] Exceptions to this methodology are noted in the descriptions of base period calculations.

Base Period Local Supplies: Local supplies for the base period are calculated using a two-year average of groundwater production, groundwater recovery, Los Angeles Aqueduct supply, surface water production, and other imported supplies. Non-potable recycling production is not included in this calculation due to its demand hardening effect.

Base Period Wholesale Demands: Demands on Metropolitan for the base period are calculated using a two-year average of firm purchases and in-lieu deliveries to long-term groundwater replenishment, conjunctive use, cyclic, and supplemental storage programs.

Base Period Retail Demands: Total retail-level municipal and industrial (M&I) demands for the base period are calculated by adding the Base Period Wholesale Demands and the Base Period Local Supplies. This estimates an average total demand for water from each agency.

Base Period Mandatory Conservation Credit: Metropolitan allows a consultation process that enables member agencies to describe mandatory water use restrictions and/or rationing restrictions that were in place within their service areas during the Base Period. Restrictions may vary among agencies but include restricted water uses, fines, and water budget or penalty based rate structures that are enacted by the governing body of the member agency or retail agency. Following the consultation process, Metropolitan staff will recommend adjustments based on evidence of reduced GPCD. To qualify for an adjustment, GPCD reductions would have to be observed that are beyond those expected from the agency's ongoing conservation efforts and trends.

Allocation Year Calculations

The next step in calculating the water supply allocation is estimating water needs in the allocation year. This is done by adjusting the base period estimates of retail demand for population or economic growth and changes in local supplies.

Allocation Year Retail Demands: Total retail M&I demands for the allocation year are calculated by adjusting the Base Period Retail Demands for baseline inflation and growth.

Baseline Inflation Adjustment: Baseline inflation occurs when non-potable recycling or conservation is developed after the Base Period. The development of these supplies reduces actual demands for water in the Allocation Year. Because non-potable-recycling and conservation are excluded from the WSAP formula, the actual need for water in the Allocation year is overestimated. The Baseline Inflation Adjustment removes increases in non-potable recycling and conservation annually from the Base Period forward to better reflect the true need for water in the Allocation Year.

Growth Adjustment: The growth adjustment is calculated using the estimated actual annual rate of population growth at the county level, as generated by the California Department of Finance, whenever possible. For years without complete data, the growth rate is calculated using an average of the three most recent years available. Growth will be allocated based on historical per capita water use during the Base Period, with a cap equal to Metropolitan's IRP Target for Water Use Efficiency. For allocation years up to and including 2014, the cap will be 163 GPCD, and for allocation years 2015-2020 the cap will reduce linearly from 163 to 145 GPCD. On an appeals basis, member agencies may request that their adjustment be calculated using member agency level population growth. A weighted combination of actual population and actual employment growth rates may also be requested.

Allocation Year Local Supplies: Allocation Year Local Supplies include groundwater production, groundwater recovery, Los Angeles Aqueduct supply, surface water production, seawater desalination, and other imported supplies. Estimates of Allocation Year Local Supplies are provided by the member agencies upon implementation of a WSAP. If estimates are not provided, Metropolitan will use the sum of the Base Period Local Supplies and Base Period In-Lieu Deliveries as a default. Agencies may provide updated estimates at any time during the Allocation Year to more accurately reflect their demand for Metropolitan supplies.

Extraordinary Supplies: Under the WSAP formula, local supply production in the Allocation Year can either be designated as a "planned" supply, or as an "extraordinary" supply.[14] This is an important designation for a member agency because the two types of supplies are accounted for differently in the WSAP formula. Local supplies classified at Extraordinary Supply are only partially included (scaled depending on the WSAP Level) as local supplies. This has the effect of providing significantly more benefit to the member agency in terms of total water supply that is available to the retail customer.[15]

Allocation Year Wholesale Demands: Demands on Metropolitan for the allocation year are calculated by subtracting the Allocation Year Local Supplies from the Allocation Year Retail Demands.

Water Supply Allocation Calculations

The final step is calculating the water supply allocation for each member agency based on the allocation year water needs identified in Step 2. The following table displays the elements that form the basis for calculating the supply allocation. Each element and its application in the allocation formula are discussed below.

Table 1: Shortage Allocation Index

(a) Regional Shortage Level	(b) Wholesale Minimum Percentage	(c) Maximum Retail Impact Adjustment Percentage
1	92.5%	2.5%
2	85.0%	5.0%
3	77.5%	7.5%
4	70.0%	10.0%

[14] Appendix H: Board Policy Principles on Determining the Status of Extraordinary Supply lists the key Board principles used in determining if a supply qualifies as an Extraordinary Supply.

[15] See Appendix G: Water Supply Allocation Formula Example for specific allocation formulae.

5	62.5%	12.5%
6	55.0%	15.0%
7	47.5%	17.5%
8	40.0%	20.0%
9	32.5%	22.5%
10	25.0%	25.0%

Regional Shortage Level: The WSAP formula allocates shortages of Metropolitan supplies over ten levels.

Wholesale Minimum Allocation: The Wholesale Minimum Allocation ensures a minimum level of Metropolitan supplied wholesale water service to each member agency.

Maximum Retail Impact Adjustment: The purpose of this adjustment is to ensure that agencies with a high level of dependence on Metropolitan do not experience disparate shortages at the retail level compared to other agencies when faced with a reduction in wholesale water supplies. The Maximum Retail Impact Percentage is prorated on a linear scale based on each member agency's dependence on Metropolitan at the retail level. This percentage is then multiplied by the agency's Allocation Year Wholesale Demand to determine an additional allocation.

Conservation Demand Hardening Credit: The Conservation Demand Hardening Credit addresses the increased difficulty in achieving additional water savings at the retail level that comes as a result of successful implementation of water conserving devices and conservation savings programs. To estimate conservation savings, each member agency will establish a historical baseline Gallons Per Person Per Day (GPCD) calculated in a manner consistent with California Senate Bill SBx7-7.[16] Reductions from the baseline GPCD to the Allocation Year are used to calculate the equivalent conservation savings in acre-feet. The Conservation Demand Hardening Credit is based on an initial 10 percent of the GPCD-based Conservation savings plus an additional 5 percent for each level of Regional Shortage set by the Board during implementation of the WSAP. The credit will also be adjusted for:

- The overall percentage reduction in retail water demand
- The member agency's dependence on Metropolitan

The credit is calculated using the following formula:

Conservation Demand Harding Credit = Conservation Savings x (10% + Regional Shortage Level Percentage) x (1 +((Baseline GPCD – Allocation Year GPCD)/Baseline GCPD)) x Dependence on MWD Percentage

[16] California Department of Water Resources, February 2011, "Methodologies for Calculating Baseline and Compliance Urban Per Capita Water Use. Available at: http://www.water.ca.gov/wateruseefficiency/sb7/docs/MethodologiesCalculatingBaseline_Final_03_01_2011.pdf

This provides a base demand hardening credit equal to 10 percent of conservation savings and increases the credit as deeper shortages occur, which is when conservation demand hardening has a bigger impact on the retail consumer. The credit also increases based on the percentage of an agency's demand that was reduced through conservation. This accounts for increased hardening that occurs as increasing amounts of conservation are implemented. Lastly, the credit is scaled to the member agency's dependence on Metropolitan to ensure that credits are being applied to the proportion of water demand that is being affected by reductions in Metropolitan supply.

Minimum Per-Capita Water Use Credit: This adjustment creates a minimum per capita water use threshold. Member agencies' retail-level water use is compared to two different thresholds. The proposed minimum thresholds are based upon compliance guidelines established under Senate Bill X7-7.

- 100 GPCD total water use
- 55 GPCD residential water use

Agencies that fall below either threshold under the WSAP will receive additional allocation from Metropolitan to bring them up to the minimum GPCD water use level. If an agency qualifies under both thresholds, the one resulting in the maximum allocation adjustment will be given.[17] To qualify for this credit, member agencies must provide documentation of the total agency level population and the percent of retail level demands that are residential; no appeal is necessary.

Total WSAP Allocation: The allocation to an agency for its M&I retail demand is the sum of the Wholesale Minimum Allocation, the Retail Impact Adjustment, the Conservation Demand Hardening Credit, and the Minimum Per-Capita Water Use Credit.[18]

Total Metropolitan Supply Allocations: In addition to the WSAP Allocation described above, agencies may also receive separate allocations of supplies for and seawater barrier and groundwater replenishment demands. Allocations of supplies to meet seawater barrier demands are to be determined by the Board of Directors independently but in conjunction with the WSAP. Separating the seawater barrier allocation from the WSAP allocation allows the Board to consider actual barrier requirements in the Allocation Year and address the demand hardening issues associated with cutting seawater barrier deliveries. According to the principles outlined for allocating seawater barrier demands, allocations should be no deeper than the WSAP Wholesale Minimum Percentage implemented at that time.

The WSAP also provides a limited allocation for drought-impacted groundwater basins based on the following framework:[19]

[17] See Appendix J: Per Capita Water Use Minimum Example for specific minimum per-capita water use credit formulae and example.
[18] See Appendix G: Water Supply Allocation Formula Example for specific allocation formulae.
[19] See Appendix L: Groundwater Replenishment Allocation for more information.

1. Metropolitan staff will hold a consultation with the requesting member agency and the appropriate groundwater basin manager to document whether the basin is in one of the following conditions:
    a. Groundwater basin overdraft conditions that will result in water levels being outside normal operating ranges during the WSAP allocation period; or
    b. Violations of groundwater basin water quality and/or regulatory parameters that would occur without imported deliveries
2. An allocation is provided based on the verified need for groundwater replenishment. The allocation would start with a member agency's ten-year average purchases of imported groundwater replenishment supplies (excluding years in which deliveries were curtailed). The amount would then be reduced by the declared WSAP Regional Shortage Level.

Section 5: WSAP Implementation

The WSAP will take effect if a regional shortage is declared by the Board of Directors. The following implementation elements are necessary for administering the WSAP during a time of shortage. These elements cover the processes needed to declare a regional shortage level as well as provide information pertaining to the allocation surcharge.

Allocation Period

The allocation period covers twelve consecutive months, from July of a given year through the following June. This period was selected to minimize the impacts of varying State Water Project (SWP) allocations and to provide member agencies with sufficient time to implement their outreach strategies and rate modifications.

Setting the Regional Shortage Level

Metropolitan staff is responsible for recommending a Regional Shortage Level for the Board of Directors' consideration. The recommendation shall be based on water supply availability, and the implementation of Metropolitan's water management actions as outlined in the WSDM Plan. Metropolitan staff will keep the Board of Directors apprised to the status of water supply conditions and management actions through monthly reports to the Water Planning and Stewardship Committee. To further facilitate staff in the development of a recommended regional shortage level, member agency requests for local supply adjustments shall be submitted by April 1st.

Metropolitan's Board of Directors, through the Water Planning and Stewardship Committee, is responsible for approving the final Regional Shortage Level at its April meeting. By the April meeting, the majority of the winter snowfall accumulation period will have passed and will allow staff to make an allocation based on more stable water supply estimates. Barring unforeseen large-scale circumstances, the Regional Shortage Level will be set for the entire allocation period, which will provide the member agencies an established water supply level for their planning.

Exit Strategy

While the Board ultimately has discretion to implement or lift and allocation at any point of time during the year; the WSAP includes a two-part exit strategy that is meant to streamline the WSAP implementation decision making process.

- If the Board decides to implement the WSAP, then any current WSAP allocation would remain in place until the end of the Allocation Year.
- If the Board decides not to implement the WSAP, then any current WSAP allocation would be terminated concurrent with the Board decision.

Allocation Appeals Process

An appeals process is necessary for the administration of any changes or corrections to an agency's allocation. Metropolitan's General Manager will designate, subsequent to a declaration of an allocation by the Board of Directors, an Appeals Liaison as the official point of contact for all information and inquiries regarding appeals. All member agency General Managers will be notified in writing of the name and contact information of the Appeals Liaison. Only appeals that are made through the Appeals Liaison and in accordance with the provisions outlined in Appendix N: Allocation Appeals Process will be evaluated. Basis for appeals claims can include but are not limited to:

- Adjusting erroneous historical data used in base period calculations
- Adjusting for population growth rates
- Determining if a local supply qualifies as Extraordinary Supply

Additional details and a checklist for the appeals process are available in Appendix N: Allocation Appeals Process and Appendix O: Appeals Submittal Checklist.

Allocation Surcharge

Member agency allocations are supported by an Allocation Surcharge. The Allocation Surcharge is charged to water use above the Member Agency allocation and is charged in addition to Metropolitan's standard rates for water service. Allocation Surcharges will only be assessed to the extent that an agency's total annual usage exceeds its total annual allocation. Any revenues collected through the Allocation Surcharge will be applied towards Metropolitan's Water Management Fund, which is used to in part to fund expenditures in dry-year conservation. No billing or assessment of allocation surcharges rates will take place until the end of the twelve-month allocation period.

> **Allocation Surcharge:** The application of the Allocation Surcharge structure is a two tier structure that provides a lower level of Allocation Surcharge for minor overuse of allocations and a higher level of Allocation Surcharge for major overuse of allocations. The structure and applicable Allocation Surcharges are listed in Table 2.

Table 2: Allocation Surcharge			
Water Use	**Base Water Rate**[20]	**Allocation Surcharge**[21]	**Total Rate**
100% of Allocation	Tier 1	0	Tier 1
Between 100% and 115%	Tier 1	$1,480	Tier 1 + ($1,480)
Greater than 115%	Tier 1	$2,960	Tier 1 + ($2,960)

Qualifying Income-Based Rate Allocation Surcharge Adjustment:[22] Any Allocation Surcharges incurred by a member agency under the WSAP will be adjusted to reflect the extent to which retail customers within a member agency's service area are served under a "lifeline" or similar qualified discounted rate program based on income or ability to pay ("Income-Based Rate").

Any member agency who is assessed Allocation Surcharges under the WSAP may submit an acre-foot equivalent of water used by retail customers served under a qualifying Income-Based Rate.[23] This amount of water use would be multiplied by the percentage of retail-level reduction in allocation year demand necessary for that member agency to avoid exceeding its WSAP allocation. The monetary amounts resulting from these acre feet are subtracted from the total monetary amounts incurred by an agency for exceeding its allocation. In the case that the monetary amounts associated with the Income-Based Rate are greater than the total Allocation Surcharges an agency incurs, no Allocation Surcharges will be incurred. The end result of this adjustment is that the member agency will not be subject to Allocation Surcharges for the use of water by their retail customers served under a qualifying Income-Based Rate.

Growth Rate Allocation Surcharge Adjustment": In recognition of member agency differences in geography and climate, a Growth Rate Allocation Surcharge Adjustment will be given to any agency that exceeds its WSAP Allocation. The Allocation Surcharge reduction will be based on the difference in acre-feet between the Growth Adjustment applied at Metropolitan's IRP planning goal rate, and the greater of the following:

- The IRP planning goal rate adjusted for the member agency's ETo, or
- The member agency's certified and documented 20x2020 targeted GPCD

If both of these alternatives result in a lower growth adjustment than the IRP planning goal, no Allocation Surcharge reduction will be made.

---

[20] The base water rate shall be the applicable water rate for the water being purchased. In most cases, it will be the Tier 1 rate (plus Treatment Surcharge for treated water deliveries). However, it is possible that the water being purchased would be in the amount that would put an agency beyond its Tier 1 limit. In that case, the base water rate will be the Tier 2 rate (plus Treatment Surcharge for treated water deliveries).

[21] Allocation Surcharge is applied to water use in excess of an agency's WSAP allocation.

[22] See Appendix K: Qualifying Income-Based Rate Allocation Surcharge Adjustment Example for specific penalty adjustment formulae and example.

[23] Appropriate documentation and certification will be required.

Tracking and Reporting

Subsequent to a declared regional shortage by the Board of Directors, Metropolitan staff will produce monthly reports of each member agency's water use compared to its allocations based on monthly delivery patterns to be submitted by the member agency. In order to produce these reports, member agencies are requested to submit their local supply use on a monthly basis and certify end of allocation year local supply use. These reports and comparisons are to be used for the purposes of tracking and communicating potential underage/overage of an agency's annual allocations.

Key Dates for Water Supply Allocation Implementation

The timeline for implementation of an allocation is shown in Table 3. A brief description of this timeline follows:

January to March: Water Surplus and Drought Management reporting occurs at Metropolitan's Water Planning and Stewardship Committee meetings. These reports will provide updated information on storage reserve levels and projected supply and demand conditions.

April: Member agencies report their projected local supplies for the coming allocation year. This information is incorporated in staff analysis of storage reserves and projected supply and demand conditions in order to provide an allocation recommendation to the Board. Metropolitan's Board will consider whether an allocation is needed. A declaration of an allocation will include the level of allocation to be in effect for the allocation year. Likewise, member agencies will report their projected demands and local supplies needed to meet seawater barrier and groundwater replenishment requirements for the allocation year. Metropolitan's Board will consider whether allocations for seawater barrier demands and groundwater replenishment demands are needed independently from the WSAP allocation decision.**July 1st**: If the Board declared an allocation in April, then it will be effective starting July 1st. The allocation level will be held through June 30th, barring unforeseen circumstances. Member agencies will now be requested to submit their local supply use on a monthly basis and certify end of allocation year local supply use. Local production data must be reported to Metropolitan by the end of the month following the month of use (use in July must be reported by the end of August). This information will be combined with Metropolitan sales information in order to track retail water use throughout Metropolitan's service area. Each month Metropolitan will report on member agency water sales compared to their allocation amounts.

June 30th: The allocation year is complete.

July: Member agency local supplies must be certified for the month of June, the last month of the previous allocation year.

August: Metropolitan will calculate each member agency's total potable water use based on local supply certifications and actual sales data for the allocation year of July through June. Allocation surcharges will be assessed for usage above a given member agency's final adjusted allocation (reflecting the actual local supply and imported water use that occurred in the allocation year).

Table 3: Board Adopted Allocation Timeline					
Year	**Month**	**Year 1 Board Decision**	**Year 1 Allocation Year**	**Year 2 Board Decision**	**Year 2 Allocation Year**
Year 1	January				
	February				
	March				
	April	Declaration *			
	May				
	June				
	July		**Effective Period** Continuous Tracking of Member Agency Local Supply and Imported Water Use		
	August				
	September				
	October				
	November				
	December				
Year 2	January				
	February				
	March				
	April			Declaration *	
	May				
	June				
	July				**Effective Period** Continuous Tracking of Member Agency Local Supply and Imported Water Use
	August		Assess		
	September				
	October				
	November				
	December				
Year 3	January				
	February				
	March				
	April				
	May				
	June				

*Member agency projections of local supplies are due on April 1st to assist Metropolitan staff in determining the need for an allocation in the coming allocation year.

Appendix A: Metropolitan Member Agencies

Table 4: Member Agencies		
City of Anaheim	City of Glendale	City of San Marino
City of Beverly Hills	Inland Empire Utilities Agency	City of Santa Ana
City of Burbank	Las Virgenes MWD	City of Santa Monica
Calleguas MWD	City of Long Beach	Three Valleys MWD
Central Basin MWD	City of Los Angeles	City of Torrance
City of Compton	MWD of Orange County	Upper San Gabriel MWD
Eastern MWD	City of Pasadena	West Basin MWD
Foothill MWD	San Diego CWA	Western MWD
City of Fullerton	City of San Fernando	

Source: http://mwdh2o.com/WhoWeAre/Member-Agencies/

Appendix B: Water Supply Allocation Plan Process Timeline

July 2007

- City of Long Beach Water Department staff briefing
- Member Agency Managers/Member Agency Workgroup meeting
- Northern Managers Group meeting
  - Foothill MWD, City of Pasadena, City of Long Beach, Calleguas MWD, City of Los Angeles, West Basin MWD, City of Burbank, Three Valleys MWD, City of Glendale, Upper San Gabriel MWD

August 2007

- Central Basin MWD staff briefing
- Eastern MWD staff briefing
- San Diego CWA staff briefing
- Member Agency Managers/Member Agency Workgroup meeting
- Western MWD staff briefing
- City of Beverly Hills staff briefing

September 2007

- Member Agency Subgroup meetings
  - MWD of Orange County, San Diego CWA, West Basin MWD, Central Basin MWD
- MWD of Orange County staff briefing
- Member Agency Workgroup meeting
- Member Agency Workgroup meeting
- MWD Board of Directors Oral Report

October 2007

- Inland Empire Utilities Agency staff briefing
- Central Basin MWD Caucus Meeting (included sub-agencies)
- Three Valleys MWD staff briefing
- MWD of Orange County staff briefing
- West Basin MWD staff briefing
- MWD Board of Directors Oral Report

November 2007

- West Basin MWD Caucus Meeting (included sub-agencies)
- West Basin Water Users Association presentation
- Walnut Valley MWD staff briefing (sub-agency of Three Valleys MWD)
- Foothill MWD Managers Meeting (included sub-agencies)
- Central Basin MWD staff briefing
- City of Claremont City Council (sub-agency of Three Valleys MWD)
- MWD Board of Directors Information Letter with Draft Proposal

December 2007

- Northern Managers Group Meeting
- California Department of Public Health staff briefing
- City of Long Beach Water Department staff briefing
- Santa Ana River Watershed Project Authority presentation
- Foothill MWD Managers Meeting (included sub-agencies)
- MWD Board of Directors Oral Report

January 2008

- Northern Managers Group Meeting
- Water Replenishment District Board of Directors presentation
- Three Valleys MWD staff briefing
- Member Agency Conservation Coordinator's Group presentation
- Member Agency Managers/Member Agency Workgroup meeting
- City of Chino Hills presentation (sub-agency of IEUA)
- Member Agency Workgroup meeting
- Hemet/San Jacinto Exchange Club presentation
- MWD Board of Directors Report with Staff Recommended Water Supply Allocation Plan

February 2008

- MWD of Orange County and Irvine Ranch WD staff briefing
- MWD Board of Directors Action Item
- San Gabriel Valley Water Association Meeting
- Orange County Water Policy Meeting
- SCAG Water Policy Task Force Meeting

Appendix C: 12-Month Review Process and Results

January 2010

- WSAP 12-Month Review Process workshop #1
    - Focused discussion of WSAP issues identified by Metropolitan staff and by member agencies since the July 2009 implementation began.

February 2010

- WSAP 12-Month Review Process workshop #2
    - Continuation of focused discussion
- WSAP 12-Month Review Process workshop #3
    - Continuation of focused discussion

March 2010

- WSAP 12-Month Review Process workshop #4
    - Continuation of focused discussion
- MWD Board of Directors information item
    - Review of potential modifications to the WSAP definition of Extraordinary Supply

April 2010

- WSAP 12-Month Review Process workshop #5
    - Recap of identified issues and discussion of Metropolitan staff proposals for adjustments to the WSAP
- Member Agency Managers Meeting
    - Update on the 12-Month Review Process
- WSAP 12-Month Review Process workshop #6
    - Discussion of WSAP issues related to groundwater replenishment
- Member Agency Managers conference call
    - Clarification of WSAP definition for Extraordinary Supply

May 2010

- Member Agency Managers Meeting
    - Discussion of proposed Extraordinary Supply policy principles and WSAP Local Supply certification process.
- Member Agency Managers conference call
    - Discussion of proposed Extraordinary Supply policy principles

June 2010

- MWD Board of Directors action item

July 2010

- MWD Board of Directors information item
    - Review of proposed adjustments to the WSAP developed in the 12-Month Review Process

August 2010

- MWD Board of Directors action item

Resulting Changes

- Removed references to Gains and Losses of Local Supply
  - Removed references in the WSAP to "gains and losses of local supplies" in order to better facilitate the accounting of historical base year and allocation year local supplies. This change did not affect the WSAP formula or allocations.
- Removed references to the Regional Shortage Percentage
  - Removed references to the "Regional Shortage Percentage" in the WSAP to reduce unintended confusion between calculation factors and shortage amounts. This change did not affect the WSAP formula or allocations.
- Included the Retail Impact Adjustment in all shortage levels
  - Included the Retail Impact Adjustment for Regional Shortage Levels 1 and 2. This change results in additional allocations to Metropolitan-dependent agencies under Level 1 and Level 2 regional shortages.
- Revised the accounting of Extraordinary Supplies
  - Revised the methodology for accounting of Extraordinary Supply in the WSAP formula by:
    - Removing the Base Period Local Supply threshold provision,
    - Removing the sliding-scale sharing mechanism from the formula, and
    - Including the full amount of the Extraordinary Supply in the calculation of the Retail Impact Adjustment.
- Included a Minimum Per Capita Water Use Threshold
  - Developed a minimum water use credit based on two GPCD water use thresholds. Member agencies would receive additional Metropolitan allocation for an acre-foot equivalent of GPCD below the minimum threshold. Member agency water use, on a gallon per capita per day (GPCD) basis, is compared to the following minimum thresholds established under Senate Bill X7-7 (Water Conservation Act of 2009)
    - 100 GPCD total use or
    - 55 GPCD residential indoor use
- Excluded Seawater Barrier from the WSAP Formula
  - Excluded seawater barrier supplies from the WSAP Base Period and Allocation Year local supply calculations. This allows the Board to determine allocations for seawater barrier demands separately from the WSAP.

Appendix D: Three-Year Review Process and Results

February 2011

- WSAP 3-Year Review Process workshop #1
    - Review of the existing WSAP policy formula; review of the process timeline; and focused discussion of WSAP issues identified by Metropolitan staff and by member agencies since the WSAP's adoption in February 2008

March 2011

- WSAP 3-Year Review Process workshop #2
    - Discussion of issues related to local supplies and baseline inflation due to adjustments for recycling in the WSAP formula
- WSAP 3-Year Review Process workshop #3
    - Continuation of prior workshop

April 2011

- WSAP 3-Year Review Process workshop #4
    - Discussion of issues and alternatives related to base period selection and baseline inflation in the WSAP formula
- WSAP 3-Year Review Process workshop #5
    - Discussion of recommendations to address baseline inflation in the WSAP formula

May 2011

- WSAP 3-Year Review Process workshop #6
    - Discussion of issues and alternatives for the growth adjustment methodology in the WSAP formula
- WSAP 3-Year Review Process workshop #7
    - Continuation of prior workshop

June 2011

- WSAP 3-Year Review Process workshop #8
    - Continuation of prior workshop, discussion of WSAP implementation exit strategy
- WSAP 3-Year Review Process workshop #9
    - Continuation of exit strategy discussion, discussion of baseline inflation due to conservation and related conservation demand hardening issues

July 2011

- WSAP 3-Year Review Process workshop #9
    - Continued discussion of baseline inflation and conservation issues, and discussion of sharing allocations between agencies with common local resources

August 2011

- WSAP 3-Year Review Process workshop #10
    - Discussion of WSAP Allocation Year timing vs. Tier 1-Tier 2 rate cycle timing, discussion of approaches for encouraging completion of WSAP local supply certifications
- Review WSAP at Member Agency Managers Meeting
    - Discussion of proposed WSAP adjustments to address baseline inflation issues, revise the growth adjustment methodology, and establish a WSAP exit strategy

September 2011

- MWD Board of Directors action item

Resulting Changes

- Baseline Inflation Adjustment
  - Removed non-potable recycling and conservation from the WSAP baseline
    - Increases in recycling and conservation will be subtracted annually from the Base Period forward
    - The annual population growth rate will be applied after deducting the annual increases in recycling and conservation
    - If an agency ends up in allocation penalty, a penalty reduction will be applied in an amount equal to the Code-Based and rate Structure conservation savings that were removed from the WSAP baseline
- Changed the Growth Adjustment methodology
  - Growth will be allocated at historical per capita rate capped at the 2010 Integrated Water Resource Plan (IRP) Target for Water Use Efficiency
    - For years up to and including 2014, the cap will be 163 GPCD
    - For years 2015-2020, the cap will reduce linearly from 163 to 145 GPCD
  - If an agency exceeds its allocation, a penalty reduction will be applied based on either:
    - The differential Evapotranspiration (ETo) of its service area compared to the MWD average, or
    - Certified and documented 20 x 2020 targeted GPCD
- Exit Strategy
  - Clarified the course of action for an existing WSAP allocation when Metropolitan's Board makes a declaration decision for the following WSAP year
    - If there is an allocation for the next year, then the current allocation stays in place
    - If there is no allocation for the next year, then the current allocation is lifted concurrent with the April decision

Appendix E: 2014 Review Process and Results

July 2014

- WSAP Workgroup Meeting #1
  - First meeting of the 2014 WSAP Review process; review of the existing WSAP policy and formula; review of the process timeline; began discussion of issues related to base period selection
- WSAP Workgroup Meeting #2
  - Discussion of base period selection

August 2014

- WSAP Workgroup Meeting #3
  - Continuation of prior workshop discussion; comparison of base period alternatives

September 2014

- WSAP Workgroup Meeting #4
  - Discussion of a base period proposal; discussion of replenishment issues in the WSAP; discussion of 2015 water supply scenarios
- Review WSAP at Member Agency Managers Meeting
  - Review of WSAP workgroup process; discussion on issues related to base period, demand hardening, and local resources development
- WSAP Workgroup Meeting #5
  - Review of base period recommendation; discussion of issues regarding agencies in mandatory conservation during a base period; discussion on replenishment in the WSAP

October 2014

- WSAP Workgroup Meeting #6
  - Continuation of prior workshop discussion; discussion of alternative methods for conservation demand hardening credit; discussion of new and existing local supplies
- Review WSAP at Member Agency Managers Meeting
  - Review of WSAP workgroup process; discussion of issues related to base period and demand hardening

November 2014

- WSAP Workgroup Meeting #7
  - Review and discussion of issues and potential methods for base period selection and adjustment, replenishment allocation, and conservation demand hardening credit; review of estimated effects of potential WSAP changes at the regional level
- WSAP Workgroup Meeting #8
  - Review of proposed recommendations for the WSAP based on workgroup discussion
- Review WSAP at Member Agency Managers Meeting
  - Review of proposed recommendations for the WSAP based on workgroup discussion

Resulting Changes

- Base Period Update to FY2013 and FY2014
    - Changed the WSAP Base Period from calendar years 2004-2006 to fiscal years ending July 2013 and 2014
    - Mandatory Conservation Adjustment
        - Agencies with mandatory conservation in effect during the base period (FY 2013 and/or FY 2014) may qualify for a demand hardening adjustment, adjustment is subject to a consultation process that includes consideration historical demand and GPCD information
- Modify Conservation Demand Hardening Credit
    - Replaced device calculation-based estimates of conservation savings with a GPCD-based method
        - Conservation savings are calculated by comparing GPCD from a historical baseline to the Allocation Year; the difference is converted to acre-feet using the Allocation Year population.
            - Baseline GCPD is 10-year average ending between 2004 and 2010, with gross water, using gross water use minus non-potable recycled water production and documented historical population
    - Replaced formula for calculating the credit for each Regional Shortage Level
    - Conservation Demand hardening credit will be based on an initial 10 percent of GPCD-based conservation savings plus an additional 5 percent for each level of Regional Shortage; the credit will also be adjusted for the overall percentage reduction in retail water demand and the member agency's dependence on Metropolitan.
- Allocation Surcharge
    - Replaced the WSAP Penalty Rate with an Allocation Surcharge based on the estimated cost of Turf Replacement conservation programs

Appendix F: Summary of Historical Shortage Plans

These five elements incorporated into the WSAP have, in four out of five instances, been used in previous shortage plans. Both the IICP and the 1995 DMP used a historical base period calculation, adjusted for growth, made local supply adjustments, and used conservation hardening credits in their formulations. The retail impact adjustment is the only feature of the WSAP that has not been used historically.

Table 5: Historical Shortage Plan Overview

Plan Element	1991 IICP	1995 DMP	WSAP
Historical Base Period	√	√	√
Growth Adjustment	√	√	√
Local Supply Adjustment	√	√	√
Conservation Hardening Credit	√	√	√
Retail Impact Adjustment			√

Appendix G: Water Supply Allocation Formula Example

The following example gives a step-by-step description of how the formula would be used to calculate an allocation of Metropolitan supplies for a hypothetical member agency. All numbers are hypothetical for the purpose of the example and do not reflect any specific member agency.

Step 1: Calculate Base Period Retail Demand

Base Period Local Supplies: Calculated using a two-year average of groundwater (gw), groundwater recovery (gwr), Los Angeles Aqueduct supply (laa), surface water (sw), seawater desalination (sd), and other non-Metropolitan imported supplies (os). For the purpose of this example, assume that the two year average is 59,000 af.

$$[(gw1+gwr1+laa1+sw1+sd1+os1) + (gw2+gwr2+laa2+sw2+sd2+os2)] \div 2 = 59{,}000 \text{ af}$$

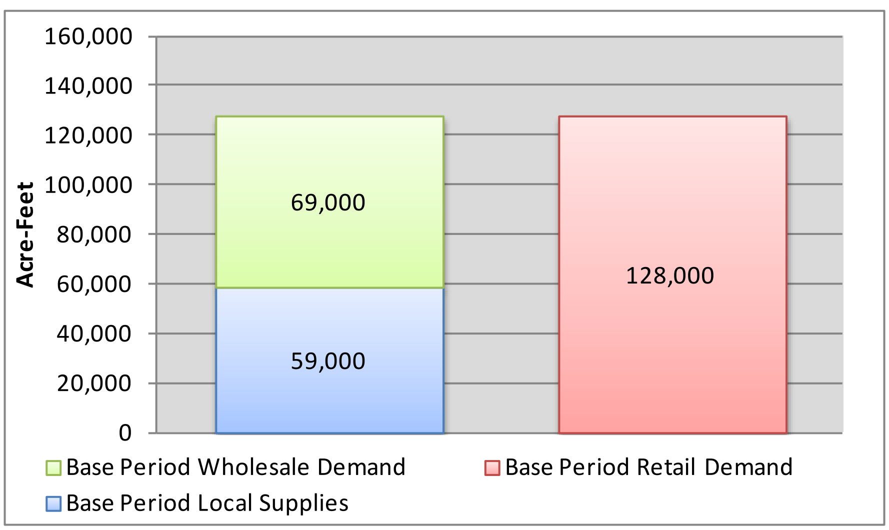
Base Period Wholesale Demands: Calculated using the same two-year time period as the Base Period Local Supplies. The Base Period Wholesale Demands include firm purchases (fp) and in-lieu deliveries to long-term groundwater replenishment (il), conjunctive use (cup), cyclic (cyc), and supplemental storage programs (ss). For the purpose of this example, assume that the two year average is 69,000 af.

$$[(fp^1{+}{+}il^1+cup^1+cyc^1+ss^1) + (fp^2+il^2+cup^2+cyc^2+ss^2)] \div 2 = 69{,}000 \text{ af}$$

Base Period Retail Demands: Calculated as the sum of the Base Period Local Supplies and Base Period Wholesale Demand.

$$59{,}000 + 69{,}000 = 128{,}000 \text{ af}$$

Figure 1: Base Period Retail Demand Calculation



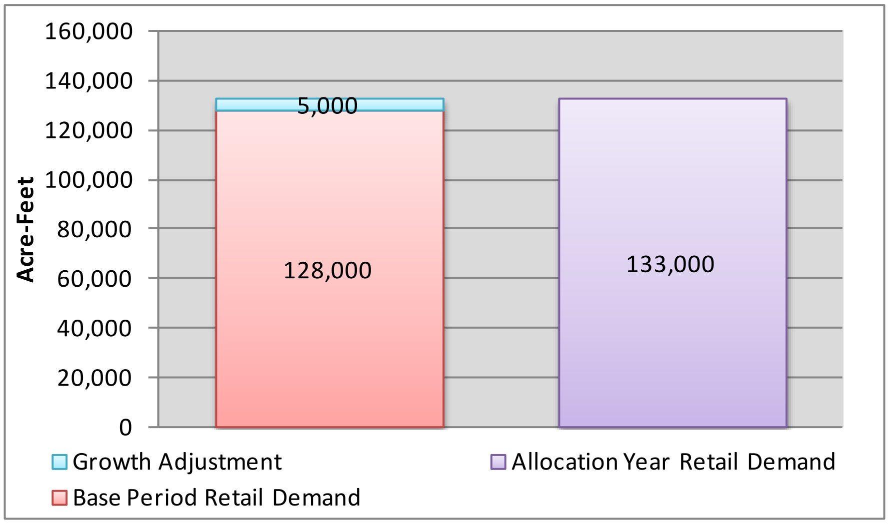
Calculate Adjustment for Base Period Mandatory Rationing (if applicable): The hypothetical agency used in this example is assumed not to qualify for the Base Period Mandatory Rationing Adjustment. A detailed discussion of the adjustment methodology can be found in Appendix I: Base Period Rationing Adjustment Example.

Step 2: Calculate Allocation Year Retail Demand

Allocation Year Retail Demand: Calculated by adjusting the Base Period Retail Demand for any baseline inflation and growth that occurred since the Base Period.

128,000 af + 5,000 af (net adjustment to retail demand) = 133,000 af

Figure 2: Allocation Year Retail Demand Calculation



Step 3: Calculate Allocation Year Wholesale Demand

Allocation Year Local Supplies: Estimates of Allocation Year Local Supplies are provided by the member agencies upon implementation of a WSAP. If estimates are not provided, Metropolitan will use the sum of the Base Period Local Supplies and Base Period In-Lieu Deliveries as a default. Agencies may provide updated estimates at any time during the Allocation Year to more accurately reflect their demand for Metropolitan supplies. For this example assume that the Allocation Year Local Supplies total 65,000 acre-feet.

Allocation Year Local Supplies = 65,000 af

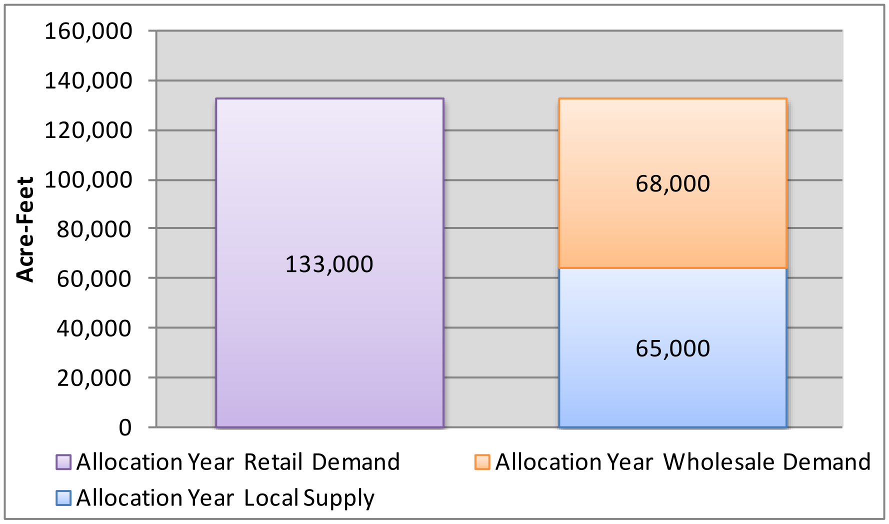
For this example assume also that this agency has an additional 5,000 acre-feet of supplies that meet the determinations for Extraordinary Supply. These supplies are withheld from the allocation formula except for in calculating the Retail Impact Adjustment Allocation.

Extraordinary Local Supplies = 5,000 af

Allocation Year Wholesale Demands: Calculated by subtracting the Allocation Year Local Supplies (65,000 af) from the Allocation Year Retail Demands (133,000 af).

133,000 af - 65,000 af = 68,000 af

Figure 3: Allocation Year Wholesale Demand Calculation



Step 4: Calculate the Wholesale Minimum Allocation

Wholesale Minimum Percentage: Calculate from Table 1 for Regional Shortage Level 4.

Table 1: Shortage Allocation Index		
(a) Regional Shortage Level	(b) Wholesale Minimum Percentage	(c) Maximum Retail Impact Adjustment Percentage
4	70.0%	10.0%

Wholesale Minimum Allocation: Calculated by multiplying the agency's Allocation Year Wholesale Demand (68,000 af) by the Wholesale Minimum Percentage (70%) from the Table 1 for Regional Shortage Level 4.

68,000 af * 70% = 47,600 af

Step 5: Calculate the Retail Impact Adjustment Allocation

Maximum Retail Impact Adjustment Percentage: Calculate from Table 1 for Regional Shortage Level 4.

Retail Impact Adjustment Allocation: Calculated first by determining the agency's dependence on Metropolitan by dividing the Allocation Year Wholesale Demand (68,000 af) minus the Extraordinary Supply (5,000 af) by the Allocation Year Retail Demand (133,000 af) and multiplying by 100.

[(68,000 af - 5,000 af)/ 133,000 af] * 100 = 47%

Next, this percentage dependence on Metropolitan (47%) is multiplied by the Maximum Retail Impact Percentage for Shortage Level 4 (10%).

47% * 10% = 4.7%

This percentage is now multiplied by the Allocation Year Wholesale Demand (68,000 af) for the Retail Impact Adjustment Allocation.

68,000 af * 4.7% = 3,221 af

Step 7: Calculate the Conservation Demand Hardening Adjustment

Calculate Baseline GPCD: To estimate conservation savings, each member agency will establish a historical baseline GPCD calculated in a manner consistent with California Senate Bill SBx7-7, using a 10 or 15-year average ending between 2004 and 2010, using gross water use minus non-potable recycle water production and documented historical population. For this example assume that the Baseline GPCD is 154 GPCD

Baseline GPCD = 154 GPCD

Calculate Allocation Year GPCD: Next, calculate the allocation year GPCD by converting the Allocation Year Retail Demand to GPCD and dividing by the Allocation Year Population from the WSAP. For this example the Allocation Year Retail Demand is 133,000 AF (see Step 2 above) and assume the Allocation Year Population is 905,000 persons. The resulting GPCD is 131 GPCD.

Allocation Year GPCD = 133,000 af/year * 325,851 gallons/af ÷ 365 days/year ÷ 905,000 persons = 131 GPCD

Calculate Reduction in GPCD: Subtract Allocation Year GPCD from Baseline GPCD to determine the GPCD Reduction.

GPCD Reduction = 154 GPCD – 131 GPCD = 23 GPCD

Calculate Conservation Savings: Convert the GPCD Reduction to the equivalent annual conservation savings in acre-feet, using the Allocation Year Population.

$$\text{Conservation Savings} = \frac{\text{((GPCD Reduction) x 365 days/yr x Population)}}{\text{325,851 gallons/af}}$$

Conservation Savings = 23 x 365 x 905,000 ÷ 325,851 = 23,316 af

Multiply by Regional Shortage Level Percentage: Multiply the Conservation Savings by 10 percent plus an additional 5 percent for each level of Regional Shortage (see Step 4 above). This example assumes a Regional Shortage Level of 4. This scales the hardening credit by the level of regional shortage, thereby increasing the credit as deeper shortages occur when demand hardening has a larger impact on the retail consumer.

23,316 af x (10% + (4 x 5%) = 6,995 af

Multiply by Conservation Savings Percentage: Next, multiply by the percentage of an agency's demand that was reduced through conservation. This scales the hardening by the total percentage reduction to recognize that increased hardening occurs as increasing amounts of conservation are implemented.

Conservation Savings Percentage = 1 + ((Baseline GPCD – Allocation Year GPCD)/Baseline GPCD)

Conservation Savings Percentage = 1+ ((154 GPCD – 131 GPCD)/154 GPCD) = 115%

6,995 af x 115% = 8,044 af

Multiply by Dependence on MWD: Next, multiply by the agency's percentage dependence on MWD as shown in Step 5 above. This scales the credit to the member agency's dependence on MWD to ensure that credits are being applied to the proportion of water demand that is being affected by reductions in MWD's supply. For this example, dependence on MWD is 47%.

8.044 af x 47% = 3,781 af

Summary: The Conservation Demand Hardening Adjustment calculation is summarized by the following formula:

Conservation Demand Hardening Adjustment = Conservation Savings x (10% + Regional Shortage Level %) x (1+Conservation%) x Dependence on MWD %

Conservation Demand Hardening Adjustment = 23,316 af x (10% + (4 x 5%)) x (115%) x (47%) = 3,781 af

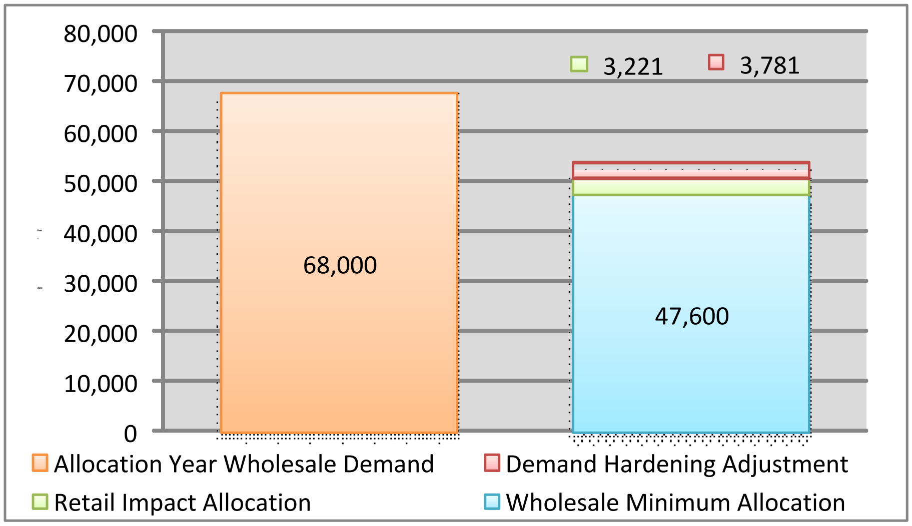
Step 8: Calculate the Low Per-Capita Adjustment Allocation: The hypothetical agency used in this example is assumed not to qualify for the Low Per-Capita Adjustment. A detailed discussion and example of the Low Per-Capita Adjustment calculation can be found in Appendix J: Per Capita Water Use Minimum Example.

Step 9: Calculate the total WSAP Allocation

WSAP Allocation: Calculated by adding the Wholesale Minimum Allocation (47,600 af), the Maximum Retail Impact Adjustment (3,221 af), the Demand Hardening Adjustment (3,781 af), and the Low Per-Capita Adjustment (0 af).

47,600 af + 3,221 af + 3,781 af + 0 af = 54,602 af

Figure 4: WSAP Allocation Regional Shortage Level 4



Step 10: Calculate total retail level reliability

Retail level reliability: Calculated by adding the WSAP Allocation (54,602 af), the Allocation Year Local Supply (65,000 af) and the Extraordinary Local Supply (5,000 af) and dividing by the Allocation Year Retail Demand (133,000 af).

(54,602 af + 65,000 af + 5,000 af) ÷ 133,000 af = 93.7%

Total Metropolitan Supply Allocations: In addition to the WSAP Allocation described above, agencies may also receive separate allocations of supplies for groundwater replenishment and seawater barrier demands. More information on the groundwater replenishment allocation is located in Appendix L: Groundwater Replenishment Allocation.

Appendix H: Board Policy Principles on Determining the Status of Extraordinary Supply

At the June 8, 2010 Water Planning and Stewardship Committee meeting Metropolitan's Board of Directors adopted the following policy principles to guide staff in determining the Extraordinary Supply status of future member agency supply programs.

No Negative Impacts to Other Member Agencies

A potential Extraordinary Supply for a member agency should not decrease the amount of Metropolitan water supply that would be available to the other member agencies in a WSAP. Programs that utilize Metropolitan supplies as a primary or in-lieu source or as a means of payback or future replenishment may have the effect of decreasing supplies, available to other agencies, if designated as Extraordinary Supply.

Provides Supply in Addition to Existing Regional Supplies

A potential Extraordinary Supply should provide a water supply that increases the overall water supplies that are available to the region in a WSAP. A program that is designed to move existing regional supplies from year to year would not qualify.

Specifically Designed Program or Supply Action

A potential Extraordinary Supply must be intentionally created and operated to provide additional supply yield. Normal variations in existing and planned local supply programs would not qualify.

Intended for Consumptive Use in a WSAP

A potential Extraordinary Supply should be designed with the primary intention to deliver water supply to a member agency only at a time when Metropolitan is allocating supplies. Programs designed to deliver water on a regular basis would not qualify. Exceptions for reasonable use of a supply program for emergency or other extenuating local circumstances should be considered.

Fully Documented Resource Management Actions

A potential Extraordinary Supply should have a full description as to the source, transmission, distribution, storage, and delivery of the water supply.

These principles are intended to identify deliberate actions taken by member agencies to augment supplies only when Metropolitan is allocating supplies through the WSAP. Production from existing local supplies, programs that are operated on an ongoing basis, and incidental increases in water supply would not qualify as Extraordinary Supply. The intent of the Extraordinary Supply designation is to recognize programs and actions that are additive to the total regional water supply as the region continues to confront the water supply challenges from drought and regulatory conditions. To that end, any supply actions taken after the initial implementation of the WSAP in July 2009 that utilize Metropolitan supplies either as a primary source, or to refill or replenish an incurred obligation or deficit at a future date would not qualify as Extraordinary Supply.

Appendix I: Base Period Mandatory Rationing Adjustment

Agencies that were under mandatory water use restrictions during the Base Period may have water use that is lower due to the mandatory actions already taken. Without adjusting for this, those agencies could be required to enforce even higher levels of restrictions under an allocation than those agencies that had not started mandatory restrictions.

To qualify for a Base Period Mandatory Rationing Adjustment, the member agency must provide Metropolitan staff with the following information:

- Time period when the mandatory conservation was in effect; it must be in effect during the Base Period
- A statement, with documentation, of how drought restrictions comply with the following Mandatory Conservation qualifications:
  - Governing Body-authorized or enacted
  - Includes mandatory demand reduction actions, restrictions or usage limitations including penalty-backed water budgets
  - Enforced by assessing penalties, fines, or rates based upon violating restrictions or exceeding usage limitations
- If the agency in question is a retail subagency, then the retailer's base period water demands during the Base Period in order to determine proportion to the member agency's total demand
- Historical data to construct GPCD base and trend for the consultation

Calculating the Base Period Rationing Adjustment involves following steps:

- Use the Baseline GPCD 10 or 15-year period selected by member agency for the Conservation Demand Hardening Adjustment calculation.
- Interpolate from the GPCD value of the midpoint of the Baseline GPCD period to the average GPCD of the two years preceding the agency's mandatory conservation
- Extrapolate to the WSAP Base Period (FY2013 and FY2014)
- Calculate the difference between estimated and observed GPCD for FY2013 and FY2014
- Convert to Acre-Feet and add to the member agency's Base Period Retail Demands

Appendix J: Per-Capita Water Use Minimum Example

This adjustment creates a minimum per capita water use threshold. Member agencies' retail-level water use under the WSAP is compared to two different thresholds. The minimum water use levels are based on compliance guidelines for total and residential water use established under Senate Bill X7-7.

Total Retail Level Use: 100 GPCD
Residential Retail Level Use: 55 GPCD

Agencies that fall below either threshold under the WSAP would receive additional allocation from Metropolitan to bring them up to the minimum GPCD water use level. To qualify for this credit, member agencies must provide documentation of the total agency level population and the percent of retail level demands that are residential; no appeal is necessary.

The following example gives a step-by-step description of how the Low Per-Capita Water Use Adjustment would be calculated for a hypothetical member agency. All numbers are hypothetical for the purpose of the example and do not reflect any specific member agency. This example was calculated using the following assumptions:

Allocation Year Retail Demand: 50,000 acre-feet
Allocation Year Local Supplies: 25,000 acre-feet;
Allocation Year Wholesale Demand: 25,000 acre-feet
Base Period Conservation: 5,000 acre-feet
Agency Population: 375,000
Percent of Retail Demands that are Residential: 60%

Step 1: Calculate Total Retail-Level Allocation Year Supplies

Table 6 shows the Allocation Year Local Supply, WSAP Allocation, and the total Allocation Year Supplies for the example agency at each Regional Shortage Level. The WSAP Allocation was calculated using the methodology detailed in Appendix G: Water Supply Allocation Formula Example and the assumptions listed above.

Table 6: Total Retail Level Allocation Year Supplies			
Regional Shortage Level	Allocation Year Local Supply	WSAP Allocation	Total Allocation Year Supply
1	25,000	23,594	48,594
2	25,000	22,188	47,188
3	25,000	20,781	45,781
4	25,000	19,375	44,375
5	25,000	17,969	42,969
6	25,000	16,563	41,563
7	25,000	15,156	40,156
8	25,000	13,750	38,750
9	25,000	12,344	37,344
10	25,000	10,938	35,938

Step 2: Calculate the Equivalent Total and Residential GPCD

The next step is to calculate the equivalent water use in gallons per capita per day (GPCD) for the Total Allocation Year Supply. The following equation shows the GPCD calculation under Regional Shortage Level 10.

35,938 af * 325,851 gallons ÷ 375,000 people ÷ 365 days = 85.6 GPCD

The residential per-capita water use is calculated in the same manner. Based on the assumption that 60% of the agency demands are residential, the following equation shows the residential GPCD calculation under Regional Shortage Level 10.

35,938 af * 60% * 325,851 gallons ÷ 375,000 people ÷ 365 days = 51.3 GPCD

Step 3: Compare the Total and Residential GPCD to the Minimum Water Use Thresholds

The next step is to compare the total GPCD water use to the 100 GPCD total water use threshold. In a Regional Shortage Level 10, the WSAP results in an allocation that is 14.4 GPCD below the minimum threshold.

100 GPCD – 85.6 GPCD = 14.4 GPCD

Likewise the residential GPCD water use is compared to the 55 GPCD residential water use threshold.

55 GPCD – 51.3 GPCD = 3.7 GPCD

Step 4: Determine the Allocation Adjustment in Acre-Feet

The final step is to calculate the acre-foot equivalent of the GPCD that fell below the minimum threshold. In a Regional Shortage Level 10, the adjustment provides 6,068 acre-feet of additional allocation to the agency; the results for Shortage Levels 1-10 are shown in Table 7.

14.4 GPCD ÷ 325,851 gallons * 375,000 people * 365 days = 6,068 acre-feet

Table 7: Total Per-Capita Water Use Adjustment				
Regional Shortage Level	**Allocation Year Supply**	**Equivalent GPCD**	**GPCD Below Threshold**	**Allocation Adjustment**
1	48,594	115.7	0	0
2	47,188	112.3	0	0
3	45,781	109.0	0	0
4	44,375	105.6	0	0
5	42,969	102.3	0	0
6	41,563	98.9	1.1	443
7	40,156	95.6	4.4	1,849
8	38,750	92.3	7.7	3,255
9	37,344	88.9	11.1	4,662
10	35,938	85.6	14.4	6,068

Again, this step is repeated for the residential water use. In a Regional Shortage Level 10, the adjustment provides 1,540 acre-feet of additional allocation to the agency; the residential water use results for Regional Shortage Levels 1-10 are shown in Table 8.

3.7 GPCD ÷ 325,851 gallons * 375,000 people * 365 days = 1,540 acre-feet

Table 8: Residential Per-Capita Water Use Adjustment				
Regional Shortage Level	**Allocation Year Supply**	**Equivalent GPCD**	**GPCD Below Threshold**	**Allocation Adjustment**
1	29,156	69.4	0	0
2	28,313	67.4	0	0
3	27,469	65.4	0	0
4	26,625	63.4	0	0
5	25,781	61.4	0	0
6	24,938	59.4	0	0
7	24,094	57.4	0	0
8	23,250	55.4	0	0
9	22,406	53.3	1.7	697
10	21,563	51.3	3.7	1,540

Agencies that fall below either threshold under the WSAP would receive additional allocation from Metropolitan to bring them up to the minimum GPCD water use level. If an agency qualifies under both thresholds, the one resulting in the maximum allocation adjustment would be given. Under this example the agency would receive 6,068 acre-feet of additional allocation in a Regional Shortage Level 10.

Appendix K: Qualifying Income-Based Rate Allocation Surcharge Adjustment Example

The following example provides a step by step description of how the qualifying income-based rate allocation surcharge adjustment is calculated. To qualify for this adjustment, member agencies must provide documentation showing the amount of retail demands that are covered by a qualifying income-based rate; no appeal is necessary.

The following list summarizes the allocation year demands, local supplies, and allocation as calculated in Appendix G: Water Supply Allocation Formula Example for a hypothetical agency under a Level 4 Regional Shortage. For detailed instructions on how to calculate these figures, reference Appendix G: Water Supply Allocation Formula Example.

Allocation Year Retail Demand: 133,000 acre-feet
Allocation Year Local Supplies: 68,000 acre-feet;
Level 4 WSAP Allocation: 52,735 acre-feet

Step 1: Allocation Surcharge Calculation

(a) **Water Use above Allocation:** The first step in calculating the income-based rate Allocation Surcharge adjustment is to calculate the agency's total Allocation Surcharge under the WSAP. If the agency did not incur any Allocation Surcharge from the allocation year, the income-based rate allocation surcharge adjustment would not apply. For the purpose of this example, the agency used 61,000 acre-feet of MWD supplies in the allocation year. This represents 8,265 acre-feet of use above the water supply allocation.

WSAP Allocation	52,735 af
Actual MWD Water Use	61,000 af
Use Above WSAP Allocation	8,265 af

(b) **Total Allocation Surcharge:** In this example the agency used 115.7% of its water supply allocation. 7,910 of the 8,265 acre-feet of use above the allocation would be assessed the Allocation Surcharge at an amount of $1,480 per acre-foot and 354 of the 8,265 acre-feet of use above the allocation would be assessed the Allocation Surcharge at an amount of $2,960.

Between 100% and 115% of Allocation	7,910 af	$1,480/af	$11,706,800
Greater than 115% of Allocation	354 af	$2,960/af	$1,047,840
Total	8,265 af		$12,754,640

Step 2: Effective Income-Based Rate Cutback

(a) **Calculate Retail Cutback:** The second step in calculating the income-based rate allocation surcharge adjustment is to calculate the amount of supply cutback that would have been expected from qualifying income-based rate customers under the WSAP. Using the water supply allocation that was calculated above, the total retail level impact on the agency can be determined. In this example the agency receives a retail level cutback of 15,265 acre-feet, or 11.5% of their retail level demand.

WSAP Allocation + Allocation Year Local Supplies	117,735 af
Allocation Year Retail Demand	133,000 af
Effective Cutback	**15,265 af (11.5%)**

(b) **Income-based Rate Customer Retail Cutback:** To calculate the effective income-based rate cutback, the amount of demand covered by a qualifying income-based rate is multiplied by the effective retail level cutback. For this example assume that the agency has 10,000 acre-feet of qualifying demands.

Qualifying Income-Based Rate Demand	10,000 af
Effective Cutback Percentage	11.5%
Effective Income-Based Rate Cutback	**1,148 af**

(c) **Income-based Rate Cutback Allocation Surcharge:** Once the effective cutback has been calculated, the amount of Allocation Surcharge that is associated with qualifying income-based rate customers can be determined.

Between 100% and 115% of Allocation	794 af	$1,480/af	$1,175,120
Greater than 115% of Allocation	354 af	$2,960/af	$1,047,840
Total	**1,148 af**		**$2,222,960**

(d) **Adjusted Allocation Surcharge Calculation:** Finally, the Allocation Surcharge attributable to qualifying income-based rate customers is subtracted from the total Allocation Surcharge that was calculated above to determine the qualifying income-based rate adjusted allocation surcharge. In the case that the monetary amounts associated with the Income-Based Rate are greater than the total amounts an agency incurs, no Allocation Surcharge will be incurred.

Total Allocation Surcharge	$12,754,640
Qualifying Income-Based Rate Allocation Surcharge	$2,222,960
Qualifying Income-Based Rate Adjusted Allocation	**$10,531,680**

Appendix L: Groundwater Replenishment Allocation

Groundwater basins help provide vital local supplies that can buffer the region from short-term drought impacts. Longer droughts can result in reductions to the many sources of water that replenish groundwater basins, resulting in lower basin levels and potential impacts to the overlying consumptive demands. Limited imported deliveries under these conditions may help avoid impacts to the basins that may be drawn out of their normal operating range or subject to water quality or regulatory impacts. To this end, Metropolitan provides a limited allocation for drought impacted groundwater basins based on the following framework:

a) Staff hold a consultation with qualifying member agencies who have taken groundwater replenishment deliveries since 2010 and the appropriate groundwater basin managers to document whether their basins are in one of the following conditions:
    i. Groundwater basin overdraft conditions that will result in water levels being outside normal operating ranges during the WSAP allocation period; or
    ii. Violations of groundwater basin water quality and/or regulatory parameters that would occur without imported deliveries.
b) Provide an allocation based on the verified need for groundwater replenishment. The allocation would start with a member agency's ten-year average purchases of imported groundwater replenishment supplies (excluding years in which deliveries were curtailed). The amount would then be reduced by the declared WSAP Regional Shortage Level (5 percent for each Regional Shortage Level).
c) Any allocation provided under this provision for drought impacted groundwater basins is intended to help support and maintain groundwater production for consumptive use. As such, a member agency receiving an allocation under this provision will be expected to maintain groundwater production levels equivalent to the average pumping in the Base Period. Any adjustments to a member agency's M&I allocation due to lower groundwater production would be reduced by deliveries made under this provision.
d) Agencies for which this allocation does not provide sufficient supplies for the needs of the groundwater basin may use the WSAP Appeals Process to request additional supply (subject to Board approval). The appeal should include a Groundwater Management Plan that documents the need for additional supplies according to the following tenets:
    i. Maintenance of groundwater production levels;
    ii. Maintenance of, or reducing the further decline of, groundwater levels;
    iii. Maintenance of key water quality factors/indicators;
    iv. Avoidance of permanent impacts to groundwater infrastructure or geologic features; and
    v. Consideration of severe and/or inequitable financial impacts.

Final amounts and allocations will be determined following the consultations with groundwater basin managers and member agencies.

Appendix M: Water Rates, Charges, and Definitions

Table 9: Water Rates and Charges Dollars per acre-foot (except where noted)			
Rate	Effective 1/1/2014	Effective 1/1/2015	Effective 1/1/2016
Tier 1 Supply Rate	$148	$158	$156
Tier 2 Supply Rate	$290	$290	$290
System Access Rate	$243	$257	$259
Water Stewardship Rate	$41	$41	$41
System Power Rate	161	$126	$138
Tier 1	$593	$582	$594
Tier 2	$735	$714	$728
Treatment Surcharge	$297	$341	$348
Full Service Treated Volumetric Cost			
Tier 1	$890	$923	$942
Tier 2	$1,032	$1,055	$1,076
Readiness-to-Serve Charge (millions of dollars)	$166	$158	$153
Capacity Charge (dollars per cubic foot second)	$8,600	$11,100	$10,900

Definitions:

(1) **Tier 1 Supply Rate -** recovers the cost of maintaining a reliable amount of supply.

(2) **Tier 2 Supply Rate** - set at Metropolitan's cost of developing additional supply to encourage efficient use of local resources.

(3) **System Access Rate** – recovers a portion of the costs associated with the delivery of supplies.

(4) **System Power Rate** – recovers Metropolitan's power costs for pumping supplies to Southern California.

(5) **Water Stewardship Rate** – recovers the cost of Metropolitan's financial commitment to conservation, water recycling, groundwater clean-up and other local resource management programs.

(6) **Treatment Surcharge** – recovers the costs of treating imported water.

(7) **Readiness-to-Serve Charge -** a fixed charge that recovers the cost of the portion of system capacity that is on standby to provide emergency service and operational flexibility.

(8) **Capacity Charge** – the capacity charge recovers the cost of providing peak capacity within the distribution system.

Source: http://www.mwdh2o.com/WhoWeAre/Management/Financial-Information

Appendix N: Allocation Appeals Process

Step 1: Appeals Submittal

All appeals shall be submitted to the Appeals Liaison in the form of a written letter signed by the member agency General Manager. Each appeal must be submitted as a separate request, submittals with more than one appeal will not be considered. The appeal request is to include:

- A designated member agency staff person to serve as point of contact.
- The type of appeal (erroneous baseline data, loss of local supply, etc.).
- The quantity (in acre-feet) of the appeal.
- A justification for the appeal which includes supporting documentation.

A minimum of 60 days are required to coordinate the appeals process with Metropolitan's Board process.

Step 2: Notification of Response and Start of Appeals Process

The Appeals Liaison will phone the designated member agency staff contact within 3 business days of receiving the appeal to provide an initial receipt notification, and schedule an appeals conference. Subsequent to the phone call, the Liaison will send an e-mail to the Agency General Manager and designated staff contact documenting the conversation. An official notification letter confirming both receipt of the appeal submittal, and the date of the appeals conference, will be mailed within 2 business days following the phone contact

Step 3: Appeals Conference

All practical efforts will be made to hold an appeals conference between Metropolitan staff and member agency staff at Metropolitan's Union Station Headquarters within 15 business days of receiving the appeal submittal. The appeals conference will serve as a forum to review the submittal materials and ensure that there is consensus understanding as to the spirit of the appeal. Metropolitan staff will provide an initial determination of the size of the appeal (small or large) and review the corresponding steps and timeline for completing the appeals process.

Steps 4-7 of the appeals process differ depending upon the size of the appeal

Small Appeals

Small appeals are defined as those that would change an agency's allocation by less than 10 percent, or are less than 5,000 acre-feet in quantity. Small appeals are evaluated and approved or denied by Metropolitan staff.

Step 4: Preliminary Decision

Metropolitan staff will provide a preliminary notice of decision to the member agency within 10 business days of the appeals conference. The preliminary decision timeline may be extended to accommodate requests for additional information, data, and documentation. The Appeals Liaison will mail a written letter to the member agency staff contact and General Manager, stating the preliminary decision and the rationale for approving or denying the appeal.

Step 5: Clarification Conference

Following the preliminary decision the Appeals Liaison will schedule a clarification conference. The member agency may choose to decline the clarification conference if they are satisfied with the preliminary decision. Declining the clarification conference serves as acceptance of the preliminary decision, and the decision becomes final upon approval by Metropolitan's executive staff.

Step 6: Final Decision

Metropolitan staff will provide a final notice of decision to the member agency within 10 business days of the clarification conference, pending review by Metropolitan's executive staff. The Appeals Liaison will mail a written letter to the member agency staff contact and General Manager, stating the final decision and the rationale for the decision. A copy of the letter will also be provided to Metropolitan executive staff.

Step 6a: Board Resolution of Small Appeal Claims

Member agencies may request to forward appeals that are denied by Metropolitan staff to the Board of Directors through the Water Planning and Stewardship Committee for final resolution. The request for Board resolution shall be submitted to the Appeals Liaison in the form of a written letter signed by the member agency General Manager. This request will be administered according to Steps 6 and 7 of the large appeals process.

Step 7: Board Notification

Metropolitan staff will provide a report to the Board of Directors, through the Water Planning and Stewardship Committee, on all submitted appeals including the basis for determination of the outcome of the appeal.

Large Appeals

Large appeals are defined as those that would change an agency's allocation by more than 10 percent, and are larger than 5,000 acre-feet. Large appeals are evaluated and approved or denied by the Board of Directors.

Step 4: Preliminary Recommendation

Metropolitan staff will provide a preliminary notice of recommendation to the member agency within 10 business days of the appeals conference. The preliminary decision timeline may be extended to accommodate requests for additional information, data, and documentation. The Appeals Liaison will mail a written letter to the member agency staff contact and General Manager, stating the preliminary recommendation and the rationale for the recommendation. A copy of the draft recommendation will also be provided to Metropolitan executive staff.

Step 5: Clarification Conference

Following the preliminary recommendation the Appeals Liaison will schedule a clarification conference. The member agency may choose to decline the clarification conference if the satisfied with preliminary recommendation. Declining the clarification conference signifies acceptance of the preliminary recommendation, and the recommendation becomes final upon approval by Metropolitan's executive staff.

Step 6: Final recommendation

Metropolitan staff will provide a final notice of recommendation to the member agency within 10 business days of the clarification conference, pending review by Metropolitan executive staff. The Appeals Liaison will mail a written letter to the member agency staff contact and General Manager, stating the final recommendation and the rationale for the recommendation. A copy of the final recommendation will also be provided for Metropolitan executive review.

Step 7: Board Action

Metropolitan staff shall refer the appeal to the Board of Directors through the Water Planning and Stewardship Committee for approval.

Appendix O: Appeals Submittal Checklist

Appeal Submittal

- ☐ Written letter (E-mail or other electronic formats will not be accepted)
- ☐ Signed by the Agency General Manager

Mailed to the appointed Metropolitan Appeals Liaison

Contact Information

- ☐ Designated staff contact
  - Name
  - Address
  - Phone Number
  - E-mail Address
- ☐ General Manager
  - Name
  - Address
  - Phone Number
  - E-mail Address

Type of Appeal

- ☐ State the type of appeal
  - Erroneous historical data used in base period calculations
    - Metropolitan Deliveries
    - Local Production
    - Growth adjustment
    - Conservation savings
  - Exclusion of physically isolated areas
  - Extraordinary supply designation
  - Groundwater Replenishment Allocation
  - Base Period Mandatory Rationing Adjustment
  - Other

Quantity of Appeal

- ☐ State the quantity in acre-feet of the appeal

Justification and Supporting Documentation

- ☐ State the rationale for the appeal
- ☐ Provide verifiable documentation to support the stated rationale
  - Examples of verifiable documentation Include, but are not limited to:
    - Billing Statements
    - Invoices for conservation device installations
    - Basin Groundwater/Watermaster Reports
    - California Department of Finance economic or population data
    - California Department of Public Health reports

Attachment C

Resolution Adopting the Water Shortage Contingency Plan

Resolution 9281

RESOLUTION
OF THE BOARD OF DIRECTORS
OF THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
ADOPTING THE WATER SHORTAGE CONTINGENCY PLAN

WHEREAS, the Urban Water Management Planning Act requires urban water suppliers providing water for municipal purposes to more than 3,000 customers or supplying more than 3,000 acre-feet of water annually to prepare and adopt, in accordance with prescribed requirements, a water shortage contingency plan;

WHEREAS, the Urban Water Management Planning Act specifies the requirements and procedures for adopting such Water Shortage Contingency Plans;

WHEREAS, the Urban Water Management Planning Act requires urban water suppliers to conduct an annual water supply and demand assessment (Annual Assessment) each year and to include in their water shortage contingency plans the procedures they use to conduct the Annual Assessment;

WHEREAS, the procedures used to conduct an Annual Assessment include, but are not limited to, the written decision-making process that an urban water supplier will use each year to determine its water supply reliability;

WHEREAS, The Metropolitan Water District of Southern California's (Metropolitan's) water shortage contingency plan provides that by June of each year, Metropolitan staff will present a completed Annual Assessment for approval by Metropolitan's Board of Directors or by the Board's authorized designee with expressly delegated authority for approval of Annual Assessment determinations;

and

WHEREAS, the Board of Directors of The Metropolitan Water District of Southern California has duly reviewed, discussed, and considered such Water Shortage Contingency Plan and has determined the Water Shortage Contingency Plan to be consistent with the Urban Water Management Planning Act and to be an accurate representation of the planned actions during shortage conditions for The Metropolitan Water District of Southern California.

NOW, THEREFORE, BE IT RESOLVED by the Board of Directors of The Metropolitan Water District of Southern California that, on May 11, 2021, this District hereby adopts this Water Shortage Contingency Plan for submittal to the State of California and expressly authorizes the General Manager of The Metropolitan Water District of Southern California to approve the Annual Assessment each year.

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 May 11, 2021.

Judy Abdo

Secretary of the Board of Directors
of The Metropolitan Water District
of Southern California

Appendix 5

LOCAL PROJECTS

(From 2020 IRP local supply survey and Member Agency Coordination)

Table A.5-1
Recycled Water Projects

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Anaheim		
Anaheim GWRS Purchases	120	2011
Anaheim Water Recycling Demonstration Project	110	2014
City of Burbank		
Burbank Recycled Water System Project	1,300	1967
Burbank Recycled Water System Expansion Project - Phase I	850	1995
Burbank Recycled Water System Expansion Project - Phase II	960	2009
Calleguas Municipal Water District		
Camrosa Water Reclamation Facility Project	1,600	1997
City of Camarillo Recycled Distribution System	1,502	1955
Conejo Creek Diversion Project	9,000	2003
Lake Sherwood Reclaimed Water System	420	1997
Oak Park/North Ranch Recycled Water Distribution System	1,300	1994
Oxnard Advanced Water Purification Facility Project Phase I	5,000	2015
Simi Valley Recycled Water Project	90	2001
VCWWD No. 1 WWTP Recycled Water Distribution System	1,100	2003
Central Basin Municipal Water District		
Albert Robles Center for Water Recycling & Environmental Learning	10,000	2020
Century/Rio Hondo Reclamation Program	5,000	1992
Cerritos Reclaimed Water System	1,750	1978
Cerritos Reclamation Extension Project	260	1993
Lakewood Water Reclamation Project	500	1989
Montebello Forebay Groundwater Recharge Project	54,500	1962
Eastern Municipal Water District		
Eastern Recycled Water System Expansion Project	5,000	2012
Original Customers, Reach 1 Phase I & Reach 2	28,950	1966
Rancho California Reclamation Expansion Project - Rancho Division	5,250	1993
Rancho California Reclamation Project - Rancho Division	225	1989
Reach 1 Phase II	1,700	2000
Reach 16 Phase I	707	2006
Reach 16 Phase II	Not Provided	Not Provided
Reach 3 & Reach 7	4,830	2012
Foothill Municipal Water District		
La Cañada Flintridge Country Club Controlled Access Irrigation	90	1962
City of Glendale		
Glendale Water Reclamation Project	400	1986
Glendale Water Reclamation Expansion Project	500	1992
Glendale Verdugo-Scholl and Brand Park Project	1,760	1995

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Inland Empire Utilities Agency		
Ely Basin Groundwater Recharge	14,000	1999
IEUA Regional Recycled Water Distribution System	13,500	1998
Regional Sewage Service Contract	3,500	1972
Las Virgenes Municipal Water District		
Calabasas Project	900	Not Provided
Calabasas Reclaimed Water System Extension Project	700	1989
Las Virgenes Reclamation Project	2,700	1984
Las Virgenes Valley Project	500	Not Provided
City of Long Beach		
Alamitos Barrier Reclaimed Water Project	3,025	2005
Leo J. Vander Lans Water Treatment Facility Expansion Project	3,475	2018
Long Beach Reclamation Project	1,700	1986
Long Beach Recycled Water System Expansion Phase I	2,750	2004
Original Customers	400	1980
THUMS	1,429	1981
City of Los Angeles		
Burbank Deliveries to Los Angeles	9	2018
Central City/Elysian Park Project Phase I - Taylor Yard Park	150	2009
Downtown Water Recycling Project	2,116	2018
Griffith Park South Water Recycling Project	450	2019
Hansen Area Water Recycling - Hansen Dam Golf Course	500	2015
Hansen Area Water Recycling Phase I Project	2,115	2008
Harbor Water Recycling Project	5,000	2005
Los Angeles Greenbelt Project	1,766	1993
North Atwater Area Water Recycling Project	50	2015
Original Deliveries from West Basin Reclamation Program	740	1996
Sepulveda Basin Water Reclamation Project Phase IV	445	2010
Sepulveda Basin Water Reclamation Project Phases I - III	1,500	2007
South Gardena Lateral	95	2019
Van Nuys Area Water Recycling Project	150	2011
Municipal Water District of Orange County		
Capistrano Valley Non-Domestic Water System	565	1989
Capistrano Valley Non-Domestic Water System Expansion Project	1,011	2006
El Toro Recycled Water System	260	1998
El Toro Recycled Water System Expansion Project - Phase I	1,050	2015
El Toro Recycled Water System Expansion Project - Phase II	350	2019
Green Acres Reclamation Project - Coastal MWD & Orange County	2,480	1991
GWRS Initial Expansion	30,000	2015
GWRS Phase I	74,880	2008

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Irvine Reclamation Expansion Project - Post 2003 Michelson & Los Alisos Dual Distribution System	8,500	2008
Irvine Reclamation Expansion Project - Pre 2003 Michelson & Los Alisos Dual Distribution System	1,500	Not Provided
Irvine Reclamation Project - Post 1983 Michelson System	10,000	1986
Irvine Reclamation Project - Pre 1983 Michelson System	6,000	1967
Moulton Niguel Reclamation Project - Phases I & II	470	1968
Moulton Niguel Reclamation Project - Phases III & IV	9,276	1993
San Clemente Recycled Water System Expansion Project	1,000	2015
San Clemente Water Reclamation Project	500	1990
San Clemente Water Reclamation Project - Municipal Golf Course	200	1957
Santa Margarita - Irvine Ranch Recycled Water Purchase Agreement	321	2001
Santa Margarita Advanced Purified Water Project	300	2018
Santa Margarita Chiquita Water Reclamation Project	2,772	2005
Santa Margarita Oso Water Reclamation Expansion Project	3,600	1988
Santa Margarita Oso Water Reclamation Project	1,200	1978
South Laguna Reclamation Expansion Project	0	1991
South Laguna Reclamation Project	860	1985
Trabuco Canyon Reclamation Expansion Project	800	1992
Trabuco Canyon Reclamation Project	280	1987
City of Santa Ana		
Green Acres Reclamation Project - Santa Ana	320	2008
City of Santa Monica		
Santa Monica Urban Runoff Recycling Facility	210	2005
San Diego County Water Authority		
4S Ranch WRF/ Olivenhain MWD	1,145	2003
Camp Pendleton Marine Corps Base Recycled Water System	1,950	1997
Connection #1 - North City Water Reclamation Plant/City of San Diego	465	2003
Connection #2 - North City Water Reclamation Plant/City of San Diego	25	2003
Del Mar San Elijo WRF/ San Elijo JPA	130	2000
Del Mar San Elijo WRF/ San Elijo JPA additional verifiable expansions	20	2000
Encina Basin Phases I & II - Carlsbad WRF/ Carlsbad MWD	2,315	1993
Encina Basin Phases I & II - Carlsbad WRF/ Carlsbad MWD additional verifiable expansions	135	1993
Encina Basin Phases I & II - Gafner WRF/ Leucadia CWD	260	1993
Encina Basin Phases I & II - Gafner WRF/ Leucadia CWD additional verifiable expansions	15	1993
Encina Basin Phases I & II - Meadowlark WRF (via Mahr Reservoir)/Vallecitos WD	2,425	1993
Encina Basin Phases I & II - Meadowlark WRF (via Mahr Reservoir)/Vallecitos WD additional verifiable expansions	140	1993

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Fallbrook Public Utility District Water Reclamation Project	1,200	1990
Fallbrook Public Utility District Water Reclamation Project Verifiable Expansions	500	Not Provided
Hale Avenue Resources Recovery Facility (HARRF)/City of Escondido	993	2004
Hale Avenue Resources Recovery Facility (HARRF)/City of Escondido additional verifiable expansions	127	2004
Hale Avenue RRF/City of Escondido HGWRP/Rincon MWD	648	2004
Hale Avenue RRF/City of Escondido HGWRP/Rincon MWD Verifiable Expansions	1,352	2004
Northwest Quadrant/Meadowlark WRF/Vallecitos WD	728	2009
Oceanside Water Reclamation Project	200	1992
Oceanside Water Reclamation Project Additional Verifiable Expansion	4,840	1992
Olivenhain SEJPA1-Quail Gardens	110	2000
Olivenhain SEJPA1-Quail Gardens additional verifiable expansions	13	2000
Olivenhain SEJPA2-Village Park, Manchester/Phase I	210	2000
Olivenhain SEJPA2-Village Park, Manchester/Phase I additional verifiable expansions	26	2000
Otay Recycled Water System Phases I & II	7,062	1991
Padre Dam Reclaimed Water System Phase I	850	1998
San Diego Northern Recycled Water Distribution System	12,619	1998
San Diego Northern Recycled Water Distribution System - deliveries to Poway	645	2009
San Diego Southern Recycled Water Distribution System	1,154	2006
San Dieguito San Elijo WRF/ San Elijo JPA	620	2000
San Dieguito San Elijo WRF/ San Elijo JPA additional verifiable expansions	80	2000
San Vicente Recycled Water System	230	1996
San Vicente Recycled Water Treatment Upgrades	340	2010
Santa Fe ID San Elijo WRF/ San Elijo JPA	530	2000
Santa Fe ID San Elijo WRF/ San Elijo JPA additional verifiable expansions	70	2000
Santa Maria Recycled Water System	400	1999
Santee Lakes Existing Project	65	1959
Santa Fe Valley WRF/Rancho Santa Fe CSD	153	2003
Woods Valley Ranch Water Reclamation Facility Phase I	47	2005
Three Valleys Municipal Water District		
City Industry Regional Recycled Water Project - Rowland Portion	1,017	2008
City Industry Regional Recycled Water Project - Walnut Valley Portion	2,135	2008
Pomona Recycled Water Distribution System	1,500	1973
Rowland Non-Potable Water System	340	1985
Walnut Valley Recycled Water System	1,100	1986
Walnut Valley Recycled Water System Expansion Project	500	1993

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Torrance		
Torrance Recycled Water Purchases	7,800	1995
Upper San Gabriel Valley Municipal Water District		
City of Industry Recycled Water Distribution System	8,500	1983
County Sanitation Districts of Los Angeles County Deliveries	4,475	1978
Direct Reuse Project - Phase I	1,600	2003
Direct Reuse Project - Phase IIA Rosemead Extension	720	2011
Direct Reuse Project - Phase IIA Whittier Narrows Project	2,258	2006
Direct Reuse Project - Phase IIB Industry (Packages 1 - 4)	1,963	2011
Rose Hills Expansion	530	2015
South El Monte Recycled Water Expansion Project (Packages 1 - 5)	72	2019
West Basin Municipal Water District		
West Basin Water Recycling Program Phase I - IV	29,460	1995
West Basin Water Recycling Program Phase V	8,000	2013
Western Municipal Water District of Riverside County		
Corona Reclaimed Water Distribution System	4,750	2007
Elsinore Valley Horsethief Canyon Recycled Water System	400	1985
Elsinore Valley Railroad Canyon Recycled Water System	1,000	1984
Elsinore Valley Wildomar Recycled Water Project	300	2014
Jackson Street Recycled Water Pipeline Project - Phase 1	820	2018
Rancho California Reclamation Expansion Project - Rancho Division	750	1993
Rancho California Reclamation Project - Santa Rosa Division	225	1989
Riverside Recycled Water Program Phase	260	1997
Western Water Recycling Facility	900	1940
Western Water Recycling Facility Upgrade Project	1,300	2014

Under Construction Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Central Basin Municipal Water District		
CBMWD Recycled Water System Expansion Phase 1 (Gateway Cities)	500	2022
City of Los Angeles		
Los Angeles Groundwater Replenishment Project Initial Phase	7,000	2024
Los Angeles Groundwater Replenishment Project Second Phase	4,000	2026
North Hollywood Area Water Recycling Project	300	2025
Pershing Drive Recycled Water Pipeline Project	750	2022
Sepulveda Basin Sports Complex Water Recycling Project Phases I & II	350	2021
Terminal Island Recycled Water Expansion Project	8,000	2025
Westside Area Water Recycling Project	150	2021

Under Construction Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Municipal Water District of Orange County		
GWRS Final Expansion	29,150	2023
Santa Margarita Water District Trampas Canyon RW Reservoir	5,000	2020
San Diego County Water Authority		
East County Advanced Water Purification Program	12,882	2025
Escondido Membrane Filtration Reverse Osmosis Facility (Hale Avenue Resources Recovery Facility (HARRF)/City of Escondido)	3,280	2025
Oceanside Pure Water and Recycled Water Expansion Phase I Project	6,000	2025
Oceanside Pure Water and Recycled Water Expansion Phase I Project Additional Verifiable Yield	720	2025
San Diego Pure Water North City Phase I	33,600	2025
City of Santa Monica		
Advanced Water Treatment	1,100	2021
Santa Monica Urban Runoff Recycling Facility Upgrades	350	2021
Upper San Gabriel Valley Municipal Water District		
La Puente Valley County Water District Recycled Water Project	60	2024

CEQA Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Anaheim		
Anaheim South Recycled Water Project	850	2027
Central Basin Municipal Water District		
West San Gabriel Recycled Water Expansion Project (Montebello Hills)	240	2020

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Calleguas Municipal Water District		
Camarillo Water Reclamation Plant Effluent Transfer Pipeline	1,120	2025
City of Camarillo Recycled Distribution System Expansion	2,583	2025
Oxnard Advanced Water Purification Facility Project - Phase II	5,000	2025
Oxnard Aquifer Storage and Recovery Completion	Not Provided	2024
Oxnard Aquifer Storage and Recovery Wells #2 and #3	Not Provided	2024
VCWWD No. 1 WWTP Recycled Water Distribution System Expansion Phase I	500	2025
Central Basin Municipal Water District		
City of Monterey Park Recycled Water Expansion Project	750	Not Provided
East Los Angeles Recycled Water Expansion Project	500	Not Provided
La Mirada Recycled Water Expansion Project	900	Not Provided

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Compton		
Recycled Water Feasibility Study	262	2025
Eastern Municipal Water District		
Purified Water Replenishment, Phase I	4,000	2023
Purified Water Replenishment, Phase II	8,000	2035
Rancho Indirect Potable Reuse Project	4,000	2025
Foothill Municipal Water District		
Descanso Gardens MBR Plant	Not Provided	Not Provided
City of Glendale		
Public Works Yard Recycled Water Main Extension Project	80	Not Provided
Inland Empire Utilities Agency		
IEUA Regional Recycled Water Distribution System Expansion Ph I & II	33,000	Not Provided
Las Virgenes Municipal Water District		
Pure Water Project	3,100	2030
City of Los Angeles		
Airport Police Facility Water Recycling Project	39	2024
Extension to ConRAC Water Recycling Project	10	2024
Forest Lawn Tank	450	2024
Harbor Connection to Joint Pollution Control Plant	3,500	2023
Harbor Extension On Gaffey	4,500	2023
Harbor Extension on Port of LA Right-of-Way	1,000	2022
Second Dominguez Gap Connection and Harbor Potable Backup	6,661	2021
Terminal Island Recycled Water Expansion Project	1,000	2021
Municipal Water District of Orange County		
Moulton Niguel Reclamation Project - Phase V	2,000	2025
Santa Margarita Chiquita Water Reclamation Expansion Project	3,000	Not Provided
Santa Margarita Recycled Water Conversion Projects	2,420	Not Provided
City of Pasadena		
Pasadena Non-Potable Water Project - Ph I	700	Not Provided
Pasadena Non-Potable Water Project - Ph II: Southern Extension I	400	2023
Pasadena Non-Potable Water Project - Ph III: Southern Extension II	900	2027
Pasadena Non-Potable Water Project - Ph IV: Annandale Extension	280	2030
Pasadena Non-Potable Water Project - Ph V: Northwestern Extension	390	2033
Pasadena Non-Potable Water Project - Ph VI: Northeastern Extension	390	2036
San Diego County Water Authority		
Additional Planned - Carlsbad WRF/ Carlsbad MWD	495	2025
Connection #1 - North City Water Reclamation Plant/City of San Diego (Extension 153)	489	2030
East County Advanced Water Purification Program Expansion	2,803	2045
Escondido Potable Reuse Project	5,000	2035

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Hale Avenue Resources Recovery Facility (HARRF)/City of Escondido Additional Planned Expansions	6,800	2025
Indirect Potable Recharge	900	2020
Joint RW Transmission Project with SFID and OMWD/TBD (Bridges)	400	2030
Lilac Hills Ranch WRF/VCMWD	294	2035
Los Flores and Santa Margarita Basin Injection Project	1,320	2020
Lower Moosa Canyon Water Reclamation Facility Treatment Process Upgrade and Reclamation System	700	2020
Meadowlark Water Reclamation Facility Direct Potable Reuse	2,200	2030
Meadowood Water Reclamation Facility	143	2025
North County One Water Program - Carlsbad MWD	3,500	2035
North County One Water Program - Olivenhain MWD	2,500	2035
North County One Water Program - Poway	2,000	2035
North County One Water Program - San Dieguito WD	2,000	2035
North County One Water Program - Santa Fe ID	3,000	2035
North County One Water Program - Vallecitos WD	5,500	2030
North District Recycled Water Project Phase I	4,400	2030
North Village Water Reclamation Facility	105	2040
Olivenhain - SEJPA 1 (Gardenview Rd)	44	2030
Olivenhain SEJPA 3 (Manchester Avenue Phases I and II)	40	2025
Rancho Cielo Project	100	2030
Ray Stoyer Expansion	317	2025
San Diego Pure Water Phases II	59,360	2035
Welk Water Reclamation Facility	140	2025
Woods Valley Ranch Water Reclamation Facility Phase II	184	2020
Woods Valley Ranch Water Reclamation Facility Phase III	168	2030
City of Santa Monica		
Santa Monica Connection	100	Not Provided
Three Valleys Municipal Water District		
Los Angeles County Fairplex Recharge	1,000	2020
Pomona Recycled Water Distribution System Expansion	1,000	2020
Recharge in Chino Basin	2,405	2025
Western Municipal Water District of Riverside County		
Corona Reclaimed Water Distribution System Expansion	1,760	2020
Demineralization of Recycled Water	550	2026
Elsinore Valley Horsethief Canyon Recycled Water System Expansion	500	2022
Indirect Potable Reuse Project	5,700	2035
Jackson Street Recycled Water Pipeline Project - Phase 2	2,550	Not Provided
Riverside Habitat, Parks & Water Project (RHPWP)	10,000	2025

Table A.5-2
Groundwater Recovery Projects

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Beverly Hills		
Beverly Hills Desalter Project	2,600	2003
Maple Wells (Shallow Wells)	350	2020
City of Burbank		
Burbank Operable Unit/Lockheed Valley Plant	11,000	1996
Calleguas Municipal Water District		
Round Mountain Water Treatment Plant	1,000	2014
Tapo Canyon Groundwater Treatment Plant	1,000	2010
Central Basin Municipal Water District		
Juan Well Filter Facility	900	2001
Water Quality Protection Plan	5,807	2007
Eastern Municipal Water District		
Menifee Basin Desalter Project	3,360	2002
Perris I Desalter	4,500	2006
Foothill Municipal Water District		
Glenwood Nitrate Water Reclamation Project	1,600	1993
Olive Avenue IX GAC Groundwater Treatment Plant	2,000	2004
City of Glendale		
Glendale Operable Unit	7,700	2001
Verdugo Park Water Treatment Plant	1,000	1997
Inland Empire Utilities Agency		
Chino Basin Desalination Program Phase I	9,600	2000
Chino Basin Desalination Program Phase II & III	12,800	2006
Las Virgenes Municipal Water District		
Westlake Wells-Tapia WRF Intertie Project	150	2000
Municipal Water District of Orange County		
Capistrano Beach Desalter Project	1,300	2007
Deep Aquifer Treatment System	8,000	2002
El Toro Groundwater Remediation Project	4,000	2007
Garden Grove Nitrate Blending Project	4,000	1990
Irvine Desalter Project	6,700	2007
IRWD Wells 21 & 22 Desalter	6,400	2013
Mesa Water Reliability Facility	8,941	2001
San Juan Basin Desalter Project Phase I	4,800	2004
Tustin 17th Street Desalter	3,200	1996
Tustin Main St Treatment Plant	2,000	1989
San Diego County Water Authority		
Mission Basin Desalter Facility Phases I & II	2,800	1994

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Richard A. Reynolds Groundwater Desalination Facility	3,600	2000
Richard A. Reynolds Groundwater Desalination Facility Expansion	2,600	2017
Three Valleys Municipal Water District		
Cal Poly Pomona Water Treatment Plant	250	2016
Harrison Groundwater Treatment Facility	981	2008
Towne Groundwater Treatment Plant & Well 3 Treatment Facility	4,678	1997
City of Torrance		
Robert W. Goldsworthy Desalter	2,400	2002
Robert W. Goldsworthy Desalter Expansion	2,600	2019
West Basin Municipal Water District		
C. Marvin Brewer Desalter	1,524	1993
Western Municipal Water District of Riverside County		
Arlington Basin Groundwater Desalter Project	6,100	1990
Chino Basin Desalination Program Phases II & III	12,800	2006
Existing Groundwater Threshold	9,500	2001
Temescal Basin Desalting Facility Project	10,000	2001

Under Construction Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Calleguas Municipal Water District		
North Pleasant Valley Regional Desalter	3,800	2020
Eastern Municipal Water District		
Perris II Desalter	5,400	2021
San Diego County Water Authority		
Fallbrook Groundwater Desalter Project	3,100	2025

CEQA Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Calleguas Municipal Water District		
Los Robles Golf Course Groundwater Utilization Project	930	Not Provided

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Beverly Hills		
La Brea Subbasin Groundwater Development	1,700	2023
City of Burbank		
Deliveries from North Hollywood Operable Unit's offline wells	Not Provided	2022

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Calleguas Municipal Water District		
Moorpark Desalter Project	5,000	2030
Santa Rosa Basin Desalter	1,000	2025
Simi Groundwater Basin Reverse Osmosis Desalter	830	2025
Simi Valley Desalter Project	5,500	2025
Eastern Municipal Water District		
Perris North Basin Groundwater Contamination Prevention and Remediation Program	6,750	2023
City of Los Angeles		
West Coast Basin Brackish Water Reclamation	8,000	2024
San Diego County Water Authority		
Middle Sweetwater River Basin Groundwater Well System	1,000	2035
Otay Mesa Lot 7 Groundwater Well System	400	2035
Rancho del Rey Brackish Groundwater Development	500	2035
San Dieguito River Basin Groundwater Recovery and Treatment Project	1,120	2025
San Marcos Groundwater Basin Supply Options	2,000	2030

Table A.5-3
Seawater Desalination Projects

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
San Diego County Water Authority		
Claude "Bud" Lewis Carlsbad Desalination Plant - Carlsbad MWD	2,500	2015
Claude "Bud" Lewis Carlsbad Desalination Plant - SDCWA	50,000	2015
Claude "Bud" Lewis Carlsbad Desalination Plant - Vallecitos WD	3,500	2015

CEQA Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Municipal Water District of Orange County		
Doheny Ocean Desalination Project	16,800	2025
Huntington Beach Seawater Desalination Project	56,000	2027
West Basin Municipal Water District		
West Basin Seawater Desalination Project	21,500	2030

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
San Diego County Water Authority		
Otay Mesa Conveyance and Disinfection System Project (Purchase)	6,700	2030

Appendix 6

CONSERVATION ESTIMATES AND WATER SAVINGS FROM CODES, STANDARDS, AND ORDINANCES

Appendix 6
CONSERVATION ESTIMATES AND WATER SAVINGS FROM CODES, STANDARDS, AND ORDINANCES

Background

Unlike traditional water supplies, which can be directly measured, conservation reduces water demand in ways that may only be indirectly quantified. Demand is reduced through changes in consumer behavior and savings from water-efficient fixtures. There are numerous approaches for estimating and projecting conservation savings, and many of them are utility-specific to meet the unique needs of different water agencies. Metropolitan estimates savings from the extensive existing conservation programs that it funds directly, as well as savings produced by plumbing codes. Metropolitan also incorporates the savings due to the impacts of price on consumers in its demand forecasts. These conservation savings estimates are incorporated into Metropolitan's long-term planning documents such as the Integrated Water Resources Plan (IRP) and its Urban Water Management Plan (UWMP).

Conservation savings are commonly estimated from a base-year water-use profile. Beginning with the 1996 IRP, Metropolitan identified 1980 as the base year for estimating conservation because it marked the effective date of a new plumbing code in California. Among other changes, the new code required toilets in new construction to be rated at 3.5 gallons per flush or less. Between 1980 and 1990, Metropolitan's service area saved an estimated 250 TAF per year as the result of this 1980 plumbing code and unrelated water rate increases. Within Metropolitan's planning framework, these savings are referred to as "pre-1990 savings." Metropolitan's conservation accounting combines pre-1990 savings and estimates of more recently achieved savings from the following sources of conservation:

- Active Conservation – Water saved directly as a result of conservation programs by water agencies. Active conservation is unlikely to occur without agency action.
- Code-Based Conservation – Water saved as a result of changes in water efficiency requirements for plumbing fixtures in plumbing codes. Sometimes referred to as "passive conservation," this form of conservation would occur as a matter of course without any additional action from water agencies.
- Price-Effect Conservation – Water saved by retail customers attributable to the effect of changes in the real (inflation-adjusted) price of water. Because water has a positive price elasticity of demand, increases in water price will decrease the quantity of water demanded.

Metropolitan's Conservation Estimate

In September 19, 2014, Governor Brown signed SB 1420 (Wolk, D-Davis), which added Section 10631(e)(4) to the Water Code. This Section provided that "water use projections may display and account for the water savings estimated to result from adopted codes, standards, ordinances, or transportation and land use plans" if that information is available and applicable to an urban water supplier. SB 606 (Hertzberg) amended Water Code Section 10631(e)(4), which is now Section 10631(d)(4) and applies only to retailers. This Section now requires that water use projections, where available, must "display and account for the water savings estimated to result from adopted codes, standards, ordinances, or transportation and land use plans identified by the urban water supplier, as applicable to the service area."

Metropolitan's conservation estimate is a comprehensive representation of Metropolitan's active conservation activities. It includes a combination of: (1) fixture/program-related savings, and (2) an estimate of code-based plumbing code conservation savings from a 1990 base year. In addition, price-effect savings are calculated using Metropolitan's MWD-EDM, a statistical model used to forecast retail water demands. Potential savings from public outreach and education programs are not included in Metropolitan's conservation estimate.

Distinguishing between active, code-based, and price-effect conservation can be complex when, for example, active programs for fixtures are implemented concurrently with conservation-related plumbing codes. Metropolitan's conservation estimate combines active, code-based, and price-effect conservation savings using methods that avoid double counting. Currently, 96 devices and programs are accounted for in estimating active conservation. These devices are spread across residential, landscape, commercial, industrial, and institutional sectors. There are eight fixtures tied to Code-based conservation estimate.

Metropolitan's conservation estimate is developed in cooperation with its 26 member agencies and falls into three general categories:

- Single-family residential (SFR),
- Multi-family residential (MFR), and
- Commercial, industrial, and institutional (CII).

Active Conservation

Estimated savings for active conservation account for programs administered by Metropolitan and its member agencies since 1990. These savings are calculated by combining counts of active program activity – numbers of devices and/or program implementations – with device-related water savings factors. These factors include:

- Savings per device/implementation
- Device life expressed in years
- Decay rate expressed as percent decay per year

Device savings estimates reflect the key assumptions outlined above. Devices may be represented more than once due to different implementation methods or savings factors. Assumptions are periodically reviewed to ensure they represent the best available savings estimates. Device-specific savings are adjusted to account for performance decay rates, or device life, but not both. For example, a residential premium high-efficiency toilet (PHET) saves about 9.4 gallons per day when replacing a 1.6 gallons per flush toilet. Lifetime savings would assume a physical life of 20 years and no performance decay.

Code-Based Conservation

Code-Based conservation accounts for water saved as a result of changes in water efficiency requirements for plumbing fixtures in plumbing codes. Plumbing code conservation is the impact of plumbing codes and other ordinances on water demand. Metropolitan's Code-Based conservation estimate represents plumbing code conservation with demographically-driven stock models. The stock models are device- or fixture- specific and are based on the same demographic data used in Metropolitan's retail demand projection. Each stock model considers the stocks and flows of conserving and non-conserving water devices, providing estimates of the impacts of plumbing codes on device saturation and overall savings.

Metropolitan's Code-based conservation estimate accounts for the following:

- New Construction: Water fixtures installed due to new construction are assumed to be in compliance with the plumbing codes in effect when the new construction occurs. For instance, a house built in 1997 would meet the efficiency standards set by California's 1992 plumbing code. Therefore, new construction is assumed to result in measurable savings from 1990, which is the baseline for conservation savings calculations. Estimates and projections of the number of fixtures added through new housing units and offices are based on growth in housing units or employment.
- Natural Replacement: Natural replacement accounts for the savings that accrue when fixtures are replaced with more efficient models due to remodeling, failure, or for other reasons. Metropolitan's savings estimate represents this effect with a "natural replacement rate" that is expressed as a percentage of existing fixtures that are replaced in a given year. Natural replacement rates vary by device and are linked to the expected life of the device. Devices with short lifespans will be replaced more frequently and thus have higher natural replacement rates. A simple percentage is used to account for this natural turn-over in non-conserving fixtures because it is difficult to back-calculate the age of the fixtures in pre-1990 construction.
- Fixtures Up for Renewal: As water-conserving fixtures reach their useful lives and become defective or inefficient, they may be replaced with water conserving fixtures due to plumbing codes. The water savings from the device is then considered "renewed" savings, which is tracked in Metropolitan's savings estimate. For example, a fixture that was installed through an active conservation program provides water savings that otherwise would not have been realized without plumbing codes. However, subsequent adoption of efficient plumbing codes means that when the fixture reaches the end of its life, it will be replaced by the same or more water-efficient model.

Stock Models

The number of efficient fixtures for each stock model is the sum of fixtures from active programs, new construction, natural replacement, and fixtures up for renewal. Table A.6-1 below shows the fixtures and devices that are assigned stock models based on existing plumbing codes.

Table A.6-1
Stock Models

Residential	CII
Toilets	Toilets
Showerheads	Urinals
Faucet Aerators	Pre-Rinse Spray Heads
Washing Machines	Washing Machines

The Stock Models generate separate annual estimates of devices and fixtures for tracking active conservation savings, while also accounting for the impacts of active programs on the overall device saturation rate. As a result, increased levels of active conservation lead to lower levels of plumbing code conservation. This helps avoid double counting in Metropolitan's conservation savings estimate.

Plumbing Code Assumptions

Plumbing code savings are determined by the device-specific assumptions used in the stock models, presented in Table A.6-2. The stock models are driven by projections of housing and employment consistent with the demand projections. Initial device counts and growth in the number of devices are determined by the combination of demographic information and the following assumptions:

- Devices per Household or Per Employee: This factor represents the average number of devices per household or per employee and is multiplied by the demographic projections to develop estimates of total number of devices or "stock." Devices per household and employee can vary by agency and change over time.
- Plumbing Code Compliance Rate: The plumbing code compliance rate is expressed as a percent and serves two purposes: (1) it indicates the presence of a plumbing code in a specific year, and (2) it determines the overall compliance rate with the plumbing code. This allows plumbing code effects to be phased in over several years.
- Natural Replacement Rate: This represents the rate at which existing non-conserving devices are converted to conserving devices due to remodeling or device failure. It has a strong impact on the saturation rate of devices that existed prior to plumbing codes, such as pre-1992 toilets.
- Device Life: The stock models also account for device life for water-efficient devices installed after 1990. This allows the stock model to track devices installed through active conservation as they reach the end of their life and are replaced due to plumbing codes. The stock models use the same device life specified in the savings assumptions.

Table A.6-2
Plumbing Code Assumptions

Stock Model	Device per Household/ Employee	Compliance Rate	Natural Replacement Rate	Plumbing Code Year
Res. Toilets	2	99%	2%	1994/2014
Res. Shower Heads	1.8	95%	10%	1994
Res. Aerators	3.5	90%	33%	1994
Res. Washing Machine	0.74	100%	6.7%	2018
CII Toilets	0.27*	100%	2%	1994/2014
CII Urinals	0.06	100%	4%	1994
CII Pre-Rinse Spray Heads	0.0055*	95%	16.7%	2006
CII Washing Machine	0.0073*	100%	5%	2007

* Varies over time and by agency (based on CUWCC BMPs savings factors)

These assumptions are derived from California Urban Water Conservation Council (CUWCC) conservation reports, American Water Works Association Research Foundation's 1999 end use study, Metropolitan's Orange County Saturation Study, and other sources. In the residential sector, devices per household combine single family and multifamily trends.

Model Water Efficient Landscape Ordinance

The California Water Commission adopted an updated Model Water Efficient Landscape Ordinance (MWELO) on July 15, 2015. The MWELO promotes efficient landscapes in new developments and retrofitted landscapes. The MWELO increases water efficiency standards for new and retrofitted landscapes through more efficient irrigation systems, greywater usage, onsite storm water capture, and by limiting the portion of landscapes that can be covered in turf. Local agencies had until December 1, 2015 to adopt the MWELO or to adopt a Local Ordinance which must be at least as effective in conserving water as MWELO. Local agencies working together to develop a Regional Ordinance had until February 1, 2016 to adopt, but they are still subject to the December 2015 reporting requirements. Local agencies were required to report on the implementation and enforcement of local ordinances by December 31, 2015.

Metropolitan's modeling of Code-based conservation includes a calculation of savings that would result from 50 percent of new households having efficient outdoor water use consistent with MWELO. The 50 percent compliance rate for new households is a conservative estimate based on an assessment of the efficacy of the current MWELO ordinance.

Price Savings Assumptions

Price-effect savings are calculated by comparing MWD-EDM demand projections with price increases to demand projections with constant 1990 water rates. The difference is the price-effect savings measured from a 1990 base. Price-effect savings increase as prices rise over time; they also increase as the household and employment base grow. A price increase applied to 1,000 households will generate more water savings than the same price increase applied to 500 households.

Un-metered Water Use Savings

A final category of savings tracked by Metropolitan is a product of other conservation efforts. MWD-EDM projects un-metered water use as a fixed percentage of total retail M&I demand. As conservation savings lowers residential and CII demands, it lowers un-metered use by the same percent. For instance, if conservation reduces M&I demands by 10 percent in 2020 (compared to demands before conservation), un-metered water use is also reduced 10 percent. This reduction is based on the assumption that un-metered use varies according to overall demand and that reducing overall use also reduces un-metered use. The reduction in un-metered water use is captured in the MWD-EDM model and included as a conservation source.

The total conservation savings are shown in Table A.6-3.

Table A. 6-3 Conservation Savings (acre-feet)

	1990	1995	2000	2005	2010	2015	2020	2025	2030	2035	2040	2045	2050
Active Savings	0	26,000	59,000	94,000	133,000	152,000	144,000	93,000	55,000	35,000	25,000	17,000	0
Code-Based Savings	0	83,000	177,000	244,000	291,000	370,000	472,000	560,000	623,000	665,000	701,000	731,000	757,000
Price Savings	0	31,000	62,000	94,000	125,000	156,000	187,000	205,000	229,000	258,000	293,000	333,000	379,000
Un-metered Water Savings	0	9,000	18,000	26,000	35,000	44,000	52,000	53,000	54,000	55,000	56,000	57,000	58,000
Pre-1990 Savings	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Total	**250,000**	**399,000**	**566,000**	**708,000**	**834,000**	**972,000**	**1,105,000**	**1,161,000**	**1,211,000**	**1,263,000**	**1,325,000**	**1,388,000**	**1,444,000**

Note: Metropolitan's conservation savings projection includes savings from Metropolitan's Conservation Credits Program, code-based conservation, price effect conservation, and pre-1990 device retrofits. The projection does not include savings from the implementation of future active conservation programs.

Appendix 7

DISTRIBUTION SYSTEM WATER LOSSES

Appendix 7
DISTRIBUTION SYSTEM WATER LOSSES

California Water Code Section 10631(d)(3) requires urban retail suppliers to quantify distribution system water loss for each of the five years preceding the plan update, based on water system balance methodology developed by the American Water Works Association (AWWA). For the 2020 UWMP, Metropolitan is voluntarily reporting its distribution system water loss. Metropolitan followed the AWWA Water Audit methodology to track all sources of treated water and uses of treated water within its system. The AWWA Water Audit methodology quantifies real and apparent water system losses in an agency's distribution system.

For its voluntary reporting of distribution system water losses, Metropolitan included its water balance audit for calendar years 2015 through 2019. The results of Metropolitan's audit showed that the average water losses for its treated distribution system over the last five years from 2015 to 2019 is approximately 7.8 TAF. The water loss estimates are presented in Tables A.7-1 through A.7-5.

In addition to the distribution system losses described in the AWWA tables, Metropolitan estimates that 41.6 TAF was lost from reservoir evaporation occurring in Lake Mathews, Lake Skinner, and Diamond Valley Lake during calendar year 2019.

A.7-2

Table A.7-1
Metropolitan's Distribution System Water Loss (AF)
Calendar Year 2015

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: Metropolitan Water District of Southern California
Reporting Year: 2015 | 1/2015 - 12/2015
Data Validity Score: 95

Own Sources (Adjusted for known errors) 791,352.381	System Input 791,352.381	Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
		Water Supplied 791,352.381	Authorized Consumption 781,504.700	Billed Authorized Consumption 780,724.000	Billed Metered Consumption (water exported is removed) 780,724.000	Revenue Water 780,724.000
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 780.700	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 10,628.381
					Unbilled Unmetered Consumption 780.700	
			Water Losses 9,847.681	Apparent Losses 2,001.800	Unauthorized Consumption 0.000	
					Customer Metering Inaccuracies 1,951.800	
					Systematic Data Handling Errors 50.000	
Water Imported 0.000				Real Losses 7,845.881	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

Table A.7-2
Metropolitan's Distribution System Water Loss (AF)
Calendar Year 2016

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: Metropolitan Water District of Southern California
Reporting Year: 2016 | 1/2016 - 12/2016
Data Validity Score: 95

Own Sources (Adjusted for known errors) 754,436.090	System Input 754,436.090	Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
		Water Supplied 754,436.090	Authorized Consumption 746,636.500	Billed Authorized Consumption 745,890.600	Billed Metered Consumption (water exported is removed) 745,890.600	Revenue Water 745,890.600
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 745.900	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 8,545.490
					Unbilled Unmetered Consumption 745.900	
			Water Losses 7,799.590	Apparent Losses 1,914.700	Unauthorized Consumption 0.000	
					Customer Metering Inaccuracies 1,864.700	
					Systematic Data Handling Errors 50.000	
Water Imported 0.000				Real Losses 5,884.890	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

Table A.7-3
Metropolitan's Distribution System Water Loss (AF)
Calendar Year 2017

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: Metropolitan Water District of Southern California
Reporting Year: 2017 1/2017 - 12/2017
Data Validity Score: 95

		Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
Own Sources (Adjusted for known errors) 850,417.043	System Input 850,417.043	Water Supplied 850,417.043	Authorized Consumption 843,331.300	Billed Authorized Consumption 842,488.800	Billed Metered Consumption (water exported is removed) 842,488.800	Revenue Water 842,488.800
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 842.500	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 7,928.243
					Unbilled Unmetered Consumption 842.500	
			Water Losses 7,085.743	Apparent Losses 2,156.200	Unauthorized Consumption 0.000	
					Customer Metering Inaccuracies 2,106.200	
					Systematic Data Handling Errors 50.000	
Water Imported 0.000				Real Losses 4,929.543	Leakage on Transmission and/or Distribution Mains *Not broken down*	
					Leakage and Overflows at Utility's Storage Tanks *Not broken down*	
					Leakage on Service Connections *Not broken down*	

Table A.7-4
Metropolitan's Distribution System Water Loss (AF)
Calendar Year 2018

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: Metropolitan Water District of Southern California
Reporting Year: 2018 | 1/2018 - 12/2018
Data Validity Score: 95

Own Sources / Water Imported	System Input	Water Supplied / Exported	Authorized Consumption / Water Losses	Components	Sub-components	Revenue / Non-Revenue Water
		Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
Own Sources (Adjusted for known errors) 770,999.499	System Input 770,999.499	Water Supplied 770,999.499	Authorized Consumption 766,774.500	Billed Authorized Consumption 766,008.500	Billed Metered Consumption (water exported is removed) 766,008.500	Revenue Water 766,008.500
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 766.000	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 4,990.999
					Unbilled Unmetered Consumption 766.000	
			Water Losses 4,224.999	Apparent Losses 1,965.000	Unauthorized Consumption 0.000	
					Customer Metering Inaccuracies 1,915.000	
					Systematic Data Handling Errors 50.000	
Water Imported 0.000				Real Losses 2,259.999	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

Table A.7-5
Metropolitan's Distribution System Water Loss (AF)
Calendar Year 2019

AWWA Free Water Audit Software: Water Balance

WAS v5.0

Water Audit Report for: Metropolitan Water District of Southern California
Reporting Year: 2019 | 1/2019 - 12/2019
Data Validity Score: 95

Own Sources / Water Imported	System Input	Water Exported / Water Supplied	Authorized Consumption / Water Losses	Components	Detail	Revenue
Own Sources (Adjusted for known errors) 706,766.917	System Input 706,766.917	Water Exported 0.000			Billed Water Exported	Revenue Water 0.000
		Water Supplied 706,766.917	Authorized Consumption 700,559.700	Billed Authorized Consumption 699,859.800	Billed Metered Consumption (Water exported is removed) 699,859.800	Revenue Water 699,859.800
					Billed Unmetered Consumption 0.000	
				Unbilled Authorized Consumption 699.900	Unbilled Metered Consumption 0.000	Non-Revenue Water (NRW) 6,907.117
					Unbilled Unmetered Consumption 699.900	
			Water Losses 6,207.217	Apparent Losses 1,799.600	Unauthorized Consumption 0.000	
					Customer Metering Inaccuracies 1,749.600	
					Systematic Data Handling Errors 50.000	
Water Imported 0.000				Real Losses 4,407.617	Leakage on Transmission and/or Distribution Mains Not broken down	
					Leakage and Overflows at Utility's Storage Tanks Not broken down	
					Leakage on Service Connections Not broken down	

Appendix 8

METROPOLITAN's EMERGENCY STORAGE OBJECTIVE

Appendix 8
METROPOLITAN'S EMERGENCY STORAGE OBJECTIVE

Metropolitan established its original criteria for determining emergency storage requirements in the October 1991 Final Environmental Impact Report for the Eastside Reservoir, which is now named Diamond Valley Lake. Emergency storage requirements are based on the potential of a major earthquake that would damage all supply aqueducts isolating Southern California from its imported water sources. The emergency storage criteria developed within the Eastside Reservoir EIR were again discussed in the 1996 Integrated Water Resources Plan. Metropolitan's Board approved both of these documents.

In 2019, Metropolitan and its member agencies completed a process to update the emergency criteria and methodology for determining the regional planning estimate of emergency storage under Metropolitan's Emergency Storage Objective. This planning estimate of emergency storage represents the amount of water that Metropolitan would store for the region to prepare 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. These emergency supplies, stored in Metropolitan and DWR existing surface reservoirs within the region, will allow Metropolitan to deliver reserve supplies to the member agencies to supplement their local production during a catastrophic earthquake or other disaster. This helps avoid severe water shortages during periods when the imported water aqueducts may be out of service.

The Emergency Storage Objective considers a six- and twelve-month outage period for the imported supply aqueducts, based on latest seismic information and estimates of repair duration for the different aqueducts. It also accounts for the operational flexibility of Metropolitan's distribution system, a retail water demand cutback ranging from 25 to 35 percent considering the level of conservation that the region achieved during the recent drought, and an aggregated loss of 10 to 20 percent of local supplies accounting for factors that could affect local production during emergency conditions.

Under this update, Metropolitan's Emergency Storage Objective was set to 750,000 acre-feet, as this level of storage would prevent severe water shortages to the region given new information on expected recovery durations. While the emergency storage would allow Metropolitan to deliver reserve supplies to the member agencies to meet their water needs during a catastrophic event, it is not intended to set a basis or a policy for allocating or apportioning storage for any individual member agency.

Included in this appendix is a copy of the Board Information Letter to Metropolitan's Water Planning and Stewardship Committee dated May 14, 2019. This Board Information Letter and the attached draft white paper review the history, policy, and criteria for evaluating a regional planning estimate for emergency storage and describe the more than year-long coordination process between Metropolitan and its member agencies in developing the region's estimate for Emergency Storage Objective.

- **Board of Directors**
  Water Planning and Stewardship Committee

5/14/2019 Board Meeting

9-3

Subject

Update of Metropolitan's Emergency Storage Objective

Executive Summary

In February 2018, The Metropolitan Water District of Southern California (Metropolitan) and its member agencies embarked on a process to evaluate regional storage including how the storage programs performed during this post decade of drought and revisiting the size and management of Metropolitan's emergency storage reserve. This process aims to maximize the potential for optimizing performance and operations of Metropolitan's storage programs. As part of the process, a Workgroup comprised of Metropolitan staff and representatives from member agencies evaluated Metropolitan's emergency storage objective.

Metropolitan, in coordination with the Workgroup, completed the attached draft White Paper on emergency storage, which summarizes the progress to date in estimating a planning objective for the region's emergency storage.

Details

The White Paper reviews the history, policy, and criteria for evaluating a regional planning estimate for emergency storage. This evaluation prepares for major earthquake or other damage to the aqueducts that import water to Southern California. The emergency storage would allow Metropolitan to deliver reserve supplies to the member agencies to supplement local production. This would help avoid severe water shortages while one or more of the imported water aqueducts may be out of service.

The White Paper also describes the mechanisms the Workgroup employed, including: (1) updated emergency criteria, and (2) a revised methodology to evaluate emergency storage.

Updating emergency criteria involved revising the outage durations based on the latest seismic information, and revisiting retail water demands and locally available supplies within the service area. It also accounted for the member agencies' unique situations in identifying practicable ranges of reduction of retail water demands through conservation and production levels of local water supplies during an imported supply emergency outage.

The proposed emergency storage volume considers various combinations of criteria to determine an envelope of acceptable scenarios designed to prevent severe shortages during the outage. Under this approach, the Workgroup focused on a range of values from 520,000 to 830,000 acre-feet (AF). With input from the Workgroup, staff recommends increasing the emergency storage objective to 750,000 AF. This recommended volume would be distributed amongst the available capacities of in-region Department of Water Resources and Metropolitan surface reservoirs.

The recommended emergency storage volume of 750,000 AF is an increase from the current planning target of 630,000 AF. A longer outage period based on damage restoration analysis and a consideration of lower local supply production attributed to this recommended increase in emergency storage.

The emergency storage volume presented in the White Paper represents a planning estimate for the amount of water that Metropolitan would store for the region in preparation for a catastrophic earthquake or other disaster. It is not intended to set a basis or a policy for allocating or apportioning storage for any individual member agency. Staff will review and incorporate additional Board and Workgroup feedback in finalizing the White Paper. Staff will transmit the final White Paper to the Board and the member agencies.

Staff proposes to revisit the emergency storage periodically, and incorporate the analysis into the Integrated Water Resources Plan update process. In addition, a detailed review of the spatial distribution of storage and operation of the distribution system will be part of Metropolitan's continued efforts to evaluate the storage portfolio. This next phase of evaluating Metropolitan's regional storage portfolio is expected to be completed by spring of 2020.

Policy

By Minute Item 50358, dated January 12, 2016, the Board adopted the 2015 Integrated Water Resources Plan Update, as set forth in Agenda Item 8-3 board letter.

By Minute Item 50473, dated May 10, 2016, the Board adopted the 2015 Urban Water Management Plan, as set forth in Agenda Item 8-6 board letter.

Fiscal Impact

None

Bradley M. Coffey 5/1/2019

Brad Coffey *Date*
Manager, Water Resource Management

5/1/2019

Jeffrey Kightlinger *Date*
General Manager

Attachment 1 – Draft White Paper on Metropolitan's Emergency Storage Objective (May 2019)

Ref# wrm12661707

2018 Evaluation of Regional Storage Portfolio
DRAFT Evaluation of Metropolitan's Emergency Storage Objective

SUMMARY

In February 2018, the Metropolitan Water District of Southern California (Metropolitan) and its member agencies embarked on a process for the Evaluation of Regional Storage Portfolio (ERSP) to maximize potential for performance and operations of Metropolitan's storage programs. As part of the ERSP process, a Workgroup comprised of Metropolitan staff and representatives from member agencies evaluated Metropolitan's Emergency Storage Objective (Emergency Storage).

This White Paper provides a summary of the history, policy, and criteria for evaluating a regional planning estimate for the Emergency Storage. This evaluation assumes major earthquake damage to the aqueducts that transport imported water supplies to Southern California. The Emergency Storage allows Metropolitan to deliver reserve supplies to the member agencies to supplement local production. This helps avoid severe water shortages during periods when the imported water aqueducts may be out of service.

This White Paper describes: (1) updating the emergency criteria, and (2) revising the methodology for calculating the Emergency Storage.

In the review and update of emergency criteria, the Workgroup considered the 2015 Integrated Water Resources Plan (IRP) and centered on the following:

- A retail water demand cutback of 25 to 35 percent appears reasonable, based on the level of conservation that the region achieved during the recent drought; and
- A six-and 12-month aggregated loss of 10 to 20 percent of local production reported in the IRP seems reasonable. This allows a contingency for some damage to local facilities and accommodates variable durations of local repairs.

The Workgroup discussion also led to a new concept of an "envelope of solutions" to estimate an appropriate Emergency Storage for the region. The envelope concept shifts from a single equation and volume for determining emergency storage. Instead, it considers various combinations of criteria to determine a range of acceptable scenarios for Emergency Storage. The prior methodology assumed a single region-wide scenario of conservation and local production loss. This envelope concept underscores member agencies' unique situations while taking into account their inputs in identifying practicable ranges of decreases in retail water demands and local production. The Workgroup focused on an acceptable range of Emergency Storage values from 520,000 to 830,000 acre-feet (AF).

Based on input from the process, staff recommends the following:

- The Emergency Storage Objective should increase from 630,000 AF to 750,000 AF. This level of storage would prevent severe water shortages to the region given new information on expected recovery durations.
- Metropolitan should revisit the Emergency Storage Objective periodically, possibly following the completion of any new IRP with the latest information on damage scenarios, local supplies, imported water demand, and attainable conservation.

DETAILED REPORT

Background

Metropolitan's need for Emergency Storage is based on the potential for major earthquake damage to the Colorado River Aqueduct, California Aqueduct, and Los Angeles Aqueduct. Metropolitan coordinates with the member agencies in setting the emergency criteria, which forms the basis for establishing the Emergency Storage. These criteria assume that damage from such a catastrophic event could render the aqueducts that transport imported water supplies to Southern California out of service, isolating the region from its imported water supplies. Metropolitan's objective is to provide regional emergency storage that could allow Metropolitan to deliver supplies to all its member agencies during this period of outage. The Emergency Storage allows Metropolitan to continue deliveries to its member agencies to supplement local water production and release from local storage. This helps avoid severe water shortages during periods when aqueducts are out of service. In addition to Emergency Storage, Metropolitan may draw from dry-year storage during an emergency, if necessary and available.

Metropolitan's emergency planning criteria were previously established and reported in the following documents:

1. Final Environmental Impact Report for the Eastside Reservoir (now named the Diamond Valley Lake) dated October 1991, which was adopted by the Board on September 24, 1991;
2. Southern California's 1996 Integrated Water Resources Plan, which was adopted by the Board on January 9, 1996;
3. Reports on Metropolitan Water Supplies dated February 2002 and March 2003;
4. 2006 IRP Implementation Report, which was presented to the Board on September 11, 2006 and transmitted on October 9, 2006;
5. Metropolitan's Emergency Storage Requirement, a written report presented to the Board on May 11, 2010; and
6. The 2015 Urban Water Management Plan dated June 2016, which was adopted by the Board on May 10, 2016.

Metropolitan's Current Emergency Criteria

Metropolitan's current emergency criteria provide for a six-month water supply at 75 percent of member agencies' retail demand under normal hydrologic conditions. Metropolitan's emergency plan outlines that under catastrophic loss of water supply the following actions will be implemented, which serve as the criteria for determining Metropolitan's Emergency Storage:

1. any existing interruptible water deliveries would be suspended;
2. firm supplies to member agencies would be restricted by a mandatory cutback of 25 percent from normal year retail demand levels;
3. water stored in the surface reservoirs and groundwater basins under Metropolitan's interruptible program would be made available;
4. full local groundwater production, recycled water, and local surface emergency storage reserve production would be sustained; and
5. Metropolitan would draw on its emergency storage as well as other available storage.

These emergency planning criteria were the basis for the current Metropolitan's Emergency Storage planning level of 630, 000 AF.

Review and Update of Metropolitan's Emergency Criteria

The following sections detail the updated assumptions and changed conditions since the last evaluation of Emergency Storage in 2010. These include demand and supply forecasts developed for the 2015 IRP, updated studies on the potential for seismic damage and outage periods for the imported supply aqueducts, and flexibility improvements within Metropolitan's distribution system implemented as a result of recent drought and supply challenges. This new information is critical to the review and update of the emergency criteria, which forms the basis for revising the Emergency Storage.

Outage Period Criteria

The outage period pertains to the amount of time the regional aqueducts that deliver imported water to Southern California may be out of service. This outage period is derived from the estimated restoration timelines based on the nature of potential damage to the aqueduct coupled with the operational ability to deliver supplies to the area served by that specific aqueduct. During an emergency outage period, Metropolitan's member agencies will depend on previously stored imported and local supplies to supplement continued local production in meeting reduced levels of retail demands. It is acknowledged that some areas could be more impacted because they are primarily or exclusively fed by an imported aqueduct which is assumed to sustain damage. However, Metropolitan's objective is to continue building and operating its system with flexibility to respond to various potential damage scenarios.

Recent Seismic Studies

In August 2015, Metropolitan, Los Angeles Department of Water and Power (LADWP), and California Department of Water Resources (DWR) formed the Seismic Resilience Water Supply Task Force (Task Force) for the purpose of collaborating on studies and mitigation measures to improve the reliability of imported water supplies to Southern California. The specific goals of the Task Force included:

- Revisiting historical assumptions regarding potential aqueduct outages;
- Establishing a common understanding about individual agency aqueduct vulnerability assessments, projected damage scenarios, and planning assumptions; and
- Discussing ideas for improving the resilience of Southern California's imported water supplies through multi-agency cooperation.

Through exchange of information and ideas between the three agencies and experts from the industry and academia, the Task Force assessed potential aqueduct damage and restoration timeline for a M 7.8 earthquake on the San Andreas Fault. This scenario assumes severe damage to the Colorado River Aqueduct (CRA), the California Aqueduct, and the Los Angeles Aqueduct (LAA). A complete description of probable seismic damages and repair durations is presented in Metropolitan's *"Seismic Resilience Water Supply Task Force Report No. 1536"* dated June 2017 (http://www.mwdh2o.com/PDF_About_Your_Water/Report1536_Final.pdf).

Table 1 presents a summary of the estimated outage duration under the earthquake scenario based on the nature of damage for each of the aqueducts.

Table 1
Estimated Outage Duration for Imported Supply Aqueducts (M 7.8 earthquake)

Aqueduct	Estimated Outage Duration
Colorado River Aqueduct	2 to 6 months (recovery of 80% CRA capacity) 3 to 5 years (recovery of 100% CRA capacity)
California Aqueduct: East Branch	12 to 24 months
California Aqueduct: West Branch	6 to 12 months
Los Angeles Aqueduct	18 months

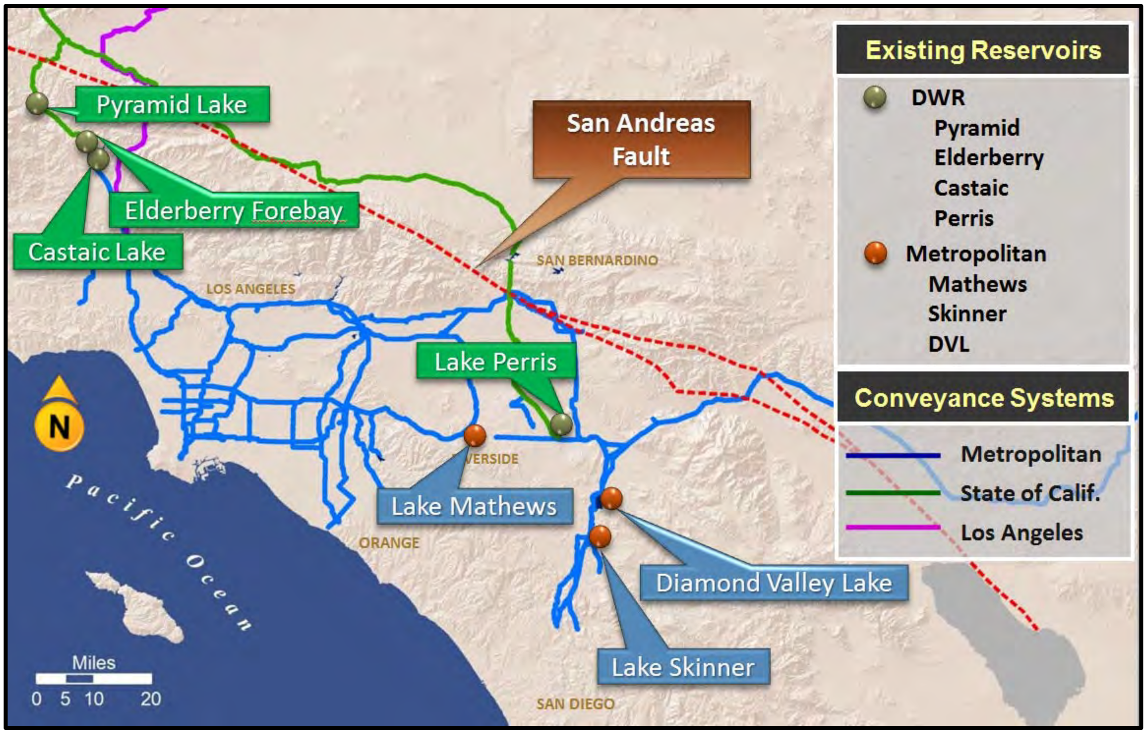
Operational Flexibility

Metropolitan's integrated system provides operational flexibility. The flexibility in Metropolitan's distribution system was demonstrated during the unprecedented drought of 2014-2016. Facing consecutive years of low SWP supplies, Metropolitan pushed CRA and Diamond Valley Lake (DVL) supplies to areas that Metropolitan normally serves only with SWP supplies or at higher blend of SWP. Figure 1 illustrates Metropolitan's operations during that period of extraordinary drought when SWP supplies were at a historic low. Metropolitan can utilize much of the same operational flexibility in its distribution system to facilitate movement of stored supplies during a prolonged outage. This flexibility combined with retail demand reduction through additional conservation and local production at appropriate levels will allow the region to meet its demands in most areas during emergency outages. Although it is not possible for Metropolitan to predict the specific damage to the system in an event of a catastrophic emergency, it seeks to ensure the most flexibility possible throughout the system to respond to different damage scenarios.

Figure 1
Metropolitan Operations during Extraordinary Drought Actions (2014-16)

During an emergency outage, previously stored imported supplies will be withdrawn to meet the region's supplemental water needs. Emergency Storage is used first and dry-year storage is then used, if necessary and available. Figure 2 shows the locations of existing DWR and Metropolitan surface reservoirs in various parts of the region.

Figure 2
Existing DWR and Metropolitan Surface Reservoirs
South of the San Andreas Fault



Metropolitan can draw from emergency supplies stored in Castaic Lake, Elderberry Forebay, and Pyramid Lake during an outage to serve the western areas that previously received SWP water. A limited quantity of CRA supplies could also be available to these areas when 80 percent of the CRA capacity is restored within six months to supplement emergency water needs in this area. Metropolitan can also supply up to 50 cfs of water from Greg Avenue Pump Station to the far western portion of its service area while repairs to the three aqueducts are being completed. This operational flexibility is also useful in the event that stored water was not adequate within the Castaic/Pyramid system.

Metropolitan can draw from emergency supplies stored in DVL, Lake Skinner, Lake Mathews, and Perris Lake during an outage to serve the eastern areas that previously received CRA and SWP water. When the CRA is restored to 80 percent of capacity within six months, it could provide up to 960,000 acre-feet per year (AFY) of imported water to the region. This volume is more than the 15-year historic average (2003 to 2017) CRA delivery of approximately 885,000 AFY and more than the 2015 IRP CRA delivery target of 900,000 AFY for a normal year. During outages, portions of the eastern area are expected to continue to receive treated CRA and/or stored emergency supplies through Weymouth. Some areas that normally receive SWP water from the East Branch may be served by delivering DVL water to Mills through the Inland Feeder/Lakeview Pipeline intertie. Metropolitan recognizes that there are currently no options to supply the Rialto Pipeline from emergency storage reservoirs during an outage of the East Branch of the California Aqueduct. However, water stored in Silverwood Lake (which is not included in Metropolitan's Emergency Storage portfolio) could be available to supply the Rialto Area as soon as repairs to damaged penstocks and pipelines downstream of Silverwood Lake are completed. This could likely require less time than repairs to the East Branch north of Silverwood Lake. In addition, other potential options to supply the Rialto region include several conceptual pump back operations and increased groundwater storage and extraction capacity for emergencies.

Metropolitan will continue to deliver treated water from stored emergency supplies during an outage and from imported supplies upon service restoration. Four of Metropolitan's five water treatment plants have redundant power feeds from the power provider. A project is currently underway to also equip the fifth plant with a redundant power feed. All five water treatment plants have backup emergency generators that support all treatment processes with the exception of ozone. Disinfection using chlorine would occur when the plants are reliant on generator power for treatment operations during a loss of utility power. Metropolitan maintains a minimum 30 day supply of chlorine in the region.

Updated Outage Criteria

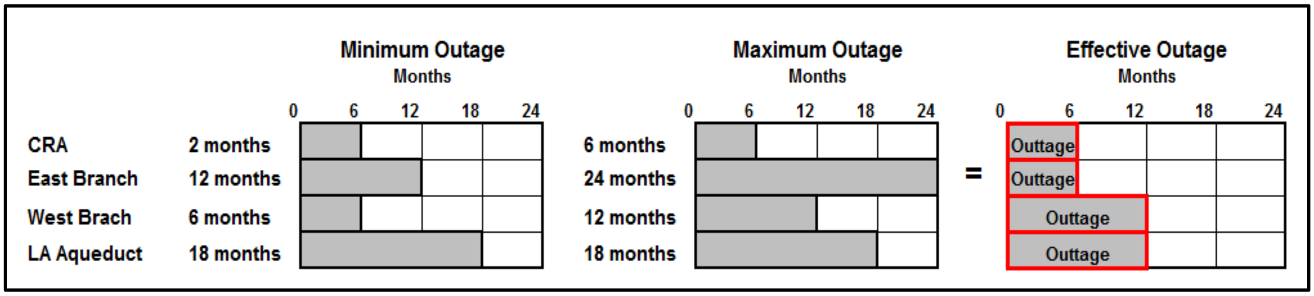
In updating the emergency outage criteria, the Workgroup considered both the duration of aqueduct repair based on the nature of potential seismic damage and recently demonstrated operational flexibilities of Metropolitan's distribution system.

Figure 3 shows the range of outage durations for the CRA, California Aqueduct East and West Branches, and the LAA. The effective outage period is then derived by accounting for the estimated durations of repair for each regional aqueduct coupled with the operational ability to deliver supplies to the area served by that specific aqueduct. In updating the outage period, the Workgroup considered the following operational assumptions:

- The estimated outage duration and repair of LAA under the earthquake scenario is 18 months. However, when the West Branch comes back in service within 12 months, it can supply water to LADWP through LA-35 while the LAA repairs continue.
  - ***Assumed outage period: 12 months for member agencies receiving supplies from West Branch and LAA.***
- The estimated outage duration and repair time of East Branch is 12 to 24 months. However, when 80 percent of the CRA capacity comes back in service within 6 months, CRA supplies would be available to many Metropolitan member agencies that normally receive SWP supplies. Thus, some areas that are normally served with water imported through the East Branch may be served with water imported through the CRA, using delivery of DVL water to Mills and several other options that should be evaluated in the Rialto area discussed above.
  - ***Assumed outage period: 6 months for member agencies receiving supplies from CRA and East Branch (with the exception of Rialto agencies).***

Using these assumptions, the effective new outage criteria presented in Figure 3 calls for storing supplemental supplies for 12 months in the West Branch and LAA areas (supplied by emergency storage in Castaic, Pyramid, and Elderberry) and 6 months in the CRA and East Branch areas (supplied by emergency storage in Perris, Skinner, Mathews, and DVL). In addition to the 12-month stored emergency supplies, West Branch areas could also be served with limited amounts of CRA supplies within 6 months to help meet demands in areas normally served with SWP supplies and higher blend areas. It is not possible to predict the specific damage to the system as a result of a catastrophic event. Therefore, system flexibility is important to ensure all supplies may be moved, if necessary and possible.

Figure 3
Updated Emergency Outage Criteria



Retail Demand Cut Back Criteria

Demand Projection

The first step in calculating the Emergency Storage is to determine the total amount of emergency retail water demand at the member agency level. The Emergency Storage is intended to reflect estimated supplemental water demands on Metropolitan during an emergency outage now updated to a period of 6 or 12 months. Thus, the aggregate of emergency retail demand is used to determine the aggregate supplemental demands on Metropolitan during such emergency, which excludes non-firm deliveries. Those deliveries are assumed to be suspended during an outage, as shown in Table 2.

Calculations of the emergency retail demand are provided for the year 2018 based on forecasts reported in the 2015 IRP. The retail demands in Table 2 were calculated at the member agency level. The numbers shown in this table represent the aggregate total retail demand (M&I and agricultural), replenishment, and seawater barrier demands over the emergency outage period considered. The total retail demands are based on forecasts from the Southern California Association of Government's (SCAG) 2012 Regional Transportation Plan/Sustainable Community Strategy and from the San Diego County Association of Government's (SANDAG) Series 13: 2050 Regional Growth Forecast (October 2013) forecast. The SCAG and SANDAG regional growth forecasts are the core assumptions in the econometric demand modeling for Metropolitan's 2015 IRP.

Table 2
Firm Retail Demands (Average Year)
(Acre-Feet)

	2018 Demands for 6-months and 12-months[1]
Total Retail Demand	2,735,617
Replenishment	(197,103)
Seawater Barrier	(52,000)
Firm Retail Demand	**2,486,514**

Note: (1) Retail demands are assessed for the 6-month outage period for member agencies receiving supplies from CRA and East Branch, and 12-months for member agencies receiving supplies from West Branch and LAA (see Attachment A).

Reduced Retail Demands during Emergency Outage

The next step in calculating the emergency storage demand on Metropolitan is to subtract a percentage reduction, or cutback, in water use from the retail demands. For illustrative purposes, Table 3 below shows the resulting reduction in retail demands during emergency outage after a cutback of 25 percent is imposed on the 2018 average condition retail demands. The retail demands in Table 3 are calculated at the member agency level. The numbers represent the aggregated total over the emergency outage period considered.

The assumption of a 25 percent retail demand cutback is a planning criterion that is consistent with previous Metropolitan studies that showed overall outdoor water use at approximately 30 percent. That cutback criterion is also consistent with the Public Policy Institute of California (PPIC) report *(Building Drought Resilience in California's Cities and Suburbs, June 2017)* based on lessons learned during drought. A higher level of austerity, public awareness, and a likely emergency declaration during an outage may support a higher cut back through additional conservation actions.

Table 3
Retail Level Emergency Demands (Average Year)
(Acre-Feet)

	2018 Demands for 6-months and 12-months[1]
Firm Retail Demand	2,486,514
25% Reduction (Cutback)	(621,629)
100% IAWP Reduction	N/A
Retail Demand during Emergency	**1,864,885**

Note: (1) Retail demands are assessed for the 6-month outage period for member agencies receiving supplies from CRA and East Branch, and 12-months for member agencies receiving supplies from West Branch and LAA (see Attachment A).

Local Production Level Criteria

The next step in calculating the Emergency Storage is to determine the amount of local supplies (local production of in-region supplies and release from local storage) available to meet retail demands at the member agency level. The local production represents the member agencies' highest potential production from the various types of supplies available within their service areas with consideration to each member agency's supply, capacity, and demand limitations. For this evaluation, the year 2018 forecast from the 2015 IRP is initially used to estimate the local production for the 6-month and 12-month emergency outage periods. In addition, Metropolitan also considered the factors that could limit each member agency's local supplies production. These include:

- Supply limitation – Considers all supplies available during an emergency outage (including additional groundwater rights, allowable over pumping in the basin, or similar mechanism if available and needed)
- Capacity limitation – Considers all available local production capacity (including extra well capacities to produce the any additional groundwater supplies if available and needed)
- Demand limitation – Considers the projected demand during the outage period (to determine the needed supplies from local and supplemental sources)

The Unused Local Production represents the aggregated production of individual member agencies above what is needed to meet their demands. In contrast, the Effective Local Production is the aggregated amount of locally available supplies that are produced to meet the reduced retail demands during an emergency outage. The Effective Local Production is derived by subtracting Unused Local Production from the aggregate total local production. For planning purposes in determining the Emergency Storage for the region, the Effective Local Production is calculated with the assumption that locally available supplies will be used only within the producing member agency's service areas and not be used or exported to meet the demands of other agencies. However, in real emergency outages, it is likely that member agencies would implement region-wide and inter-agency coordination for the most efficient operation and use of available supplies.

As part of evaluating the Effective Local Production, Metropolitan also assessed the additional local groundwater that could be theoretically produced and local surface storage that could be reasonably available during an emergency outage. This evaluation revealed that additional groundwater supplies, while theoretically available, could not be produced due to one or a combination of limiting factors. The local surface storage, on the other hand, includes all reasonably available surface water storage that the member agency could produce and use within its service area during extended shortages. The Local Surface Storage in Table 4 includes SDCWA's calculated Emergency Storage Requirement of 20,000 AF (as reported to their Water Planning Committee in July 18, 2018) and a portion of its carryover storage. Under the Carryover Storage Policy Guidelines, included in SDCWA's Water Shortage Contingency Plan Appendix A dated August 2017, SDCWA will maintain a carryover target volume of 70,000 AF and a maximum of 100,000 AF to be utilized over five consecutive dry-years. During an emergency outage, the region will most likely draw supplies from all reasonably available storage to meet demands. This evaluation reasonably assumes that in addition to its emergency storage, one-fifth of SDCWA's 70,000 AF target carryover storage, amounting to 14,000 AF, would be available for a catastrophic emergency outage based on the low likelihood that that all carryover supplies would have been withdrawn over multiple dry-years.

Table 4 shows the aggregate total for each type of locally available supplies over the emergency outage period considered. For illustrative purposes for 2018, Table 4 also presents the local production at 100 percent, 90 percent, and 80 percent. The LAA production is excluded from this calculation because the Emergency Storage assumes the loss of all imported water supplies. The member agency local production data is included as Attachment A.

Table 4
Effective Local Production
(Acre-Feet)

	2018 Local Production for 6-months and 12-months[(1)]		
	At 100%	At 90%	At 80%
Groundwater	832,000	748,800	665,600
Surface Water	54,935	49,442	43,948
Local Surface Storage[(2)]	34,000	30,600	27,200
Recycling and GW Recovery	353,797	318,417	283,038
Seawater Desalination	25,319	22,787	20,255
Los Angeles Aqueduct	0	0	0
Other	13,100	11,790	10,480
IRP Targets[(3)]	18,087	18,087	18,087
Subtotal Local Production	1,331,238	1,199,923	1,068,608
Unused Local Production	(152,021)	(86,449)	(31,056)
Effective Local Production	**1,179,216**	**1,113,474**	**1,037,551**

Note: (1) Local production are assessed for the 6-month outage period for member agencies receiving supplies from CRA and East Branch, and 12-months for member agencies receiving supplies from West Branch and LAA 9 (see Attachment A).
(2) Local Surface Storage is comprised of emergency storage plus reasonably available storage above emergency.
(3) Conservation and locally available supply targets from the 2015 IRP for Year 2018.

Emergency Demands on Metropolitan

The final step in calculating the Emergency Storage is to subtract the Effective Local Production from the retail demands during an emergency outage for each member agency. The resulting difference represents the supplemental water demands on Metropolitan during an outage period This is the Emergency Storage planning level for the region. Table 5 shows the aggregated totals at varying local production levels for 2018. The table below illustrates that the emergency demand on Metropolitan, and in effect the Emergency Storage, increases as Effective Local Production decreases under the 90 percent and 80 percent scenarios.

Table 5
Emergency Demands on Metropolitan
(Acre-Feet)

	Local Production		
	At 100%	**At 90%**	**At 80%**
Retail Demand during Emergency	1,864,885	1,864,885	1,864,885
Effective Local Production	(**1,179,216**)	(**1,113,474**)	(**1,037,551**)
Metropolitan Emergency Demand	**685,666**	**751,411**	**827,334**

Sensitivity Analysis

A sensitivity analysis of retail cutback and loss of local supplies were conducted. To explore the sensitivities of the Emergency Storage from these two criteria, Metropolitan evaluated various percentages of demand cut backs and levels of local production. Table 6 shows the resulting Emergency Storage at various combinations of retail demand cutback and local production levels. This matrix of emergency storage values presents retail demand cut backs of 0 percent, 25 percent, 35 percent, and 50 percent and local production levels of 100 percent, 90 percent, and 80 percent.

Table 6
Range of Potential Emergency Storage Objectives for Year 2018
(Acre-Feet)

Local Production Level	Retail Demand Cutback			
	0%	25%	35%	50%
100%	1,176,600	685,700	513,300	294,000
90%	1,286,600	751,400	570,700	332,300
80%	1,417,900	827,300	636,300	377,300

Envelope Concept for Metropolitan's Emergency Storage Objective

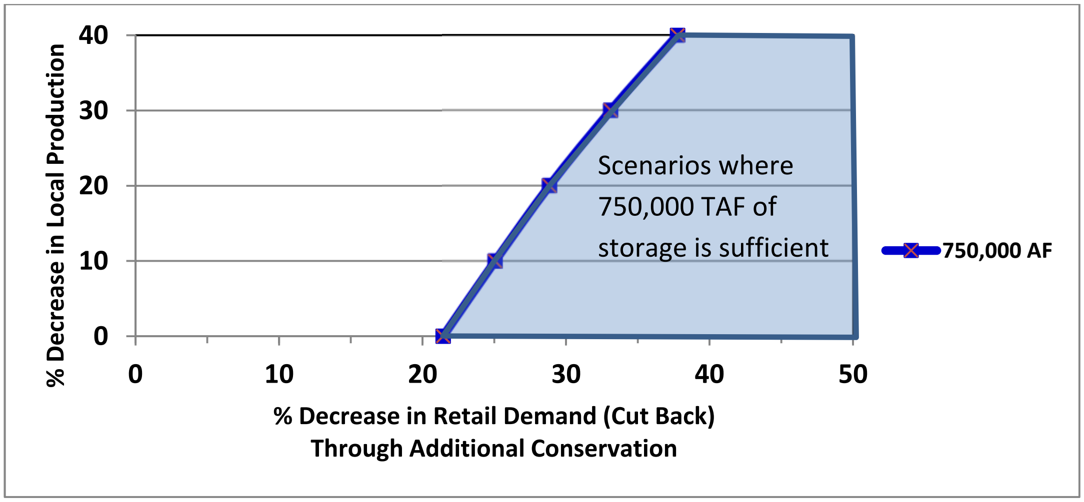
Rather than considering a specific region-wide scenario of conservation and local production loss, the Workgroup discussion led to the development of a range of emergency storage values that could provide reliability during the outage period. The concept of an envelope of solutions emerged, with the idea that an envelope of solutions will yield an appropriate Emergency Storage for the region. The Emergency Storage, in turn, could be achieved through various combinations of (1) retail demand cutback from achievable conservation and (2) local production level taking into account potential damages to local facilities. This envelope concept underscores member agencies' individual and unique situations while taking into account their inputs in identifying practicable ranges of decreases in retail demand and local production.

For the retail demand cut back, most member agencies considered the 25 to 35 percent range to be reasonable. This range is based on the level of conservation that the region was able to achieve during the recent drought. For the local production, several member agencies expected some damage to local facilities during the earthquake. In addition, Metropolitan acknowledges that retail demand cutback may also lead to reduction of non-potable recycled water use. Thus, for local production, the Workgroup focused on a range from 80 percent to 100 percent of the member agencies' reported local production in the 2015 IRP. This would allow contingency planning for uncertainties in damage to local facilities and accommodate different durations of local repairs. This is a modification from the previous assumption of full local production at the IRP level during an outage period.

As indicated in Table 6, a scenario using the criteria of 25 percent retail demand cut back and 100 percent local production level yield an estimated Emergency Storage of 686,000 AF for year 2018. However, the Workgroup focused on an envelope of alternatives for Emergency Storage that could provide reliability during the outage period. The same table matrix of values above highlights the range from 520,000 to 830,000 AF. Within this range, an Emergency Storage of 750,000 AF is recommended. This level of storage would prevent severe water shortages in the region with practicable ranges of reduced demands through conservation and plausible levels of local production during an emergency outage. Figure 4 shows that the

Emergency Storage would be sufficient to cover various combinations of practicable ranges of decreases in retail demand and local production.

Figure 4
Emergency Storage Objective derived from the Envelope Concept



Allocation of Emergency Storage in Regional Reservoirs

Once the Emergency Storage is determined, it can then be allocated to the various surface reservoirs within the region, previously illustrated in Figure 2, south of the San Andreas Fault. The total storage capacity of existing DWR and Metropolitan surface reservoirs and the allocation to emergency storage, seasonal, regulatory, and drought carryover needs are shown in Table 7 through 11. For the DWR reservoirs, the values in the tables reflect the normal maximum operating and dead pool storages indicated in the DWR report *"California State Water Project, Volume III, Storage Facilities, Bulletin 200"* dated November 1974. For this evaluation, recreational waters in DWR reservoirs are assumed to be available for emergency use during outage periods. On a short-term basis for operational purposes, storage at any specific reservoir may be below these planning levels. When this happens, the emergency storage is shifted temporarily to any of the other existing reservoirs.

Department of Water Resources Surface Reservoirs

Table 7 below shows the five major reservoirs owned and operated by DWR in or near Metropolitan's service area. Castaic Lake, Elderberry Forebay, and Pyramid Lake are located on the West Branch of the California Aqueduct. Silverwood Lake and Lake Perris are on the East Branch of the California Aqueduct. The total storage capacity of these five reservoirs is approximately 721,600 AF. When cost allocation factors from DWR Bulletin 132 Appendix B, Table B-2 are applied to the operational storage capacities, Metropolitan's share of storage in the reservoirs is equivalent to 644,400 AF.

Table 7
Allocation of Storage Capacities in DWR Reservoirs
(Acre-Feet)

Reservoir	Total Storage Capacity	Dead Storage	Storage Paid by Others	Storage Paid by Metropolitan
Pyramid Lake	169,900	4,800	7,000	158,100
Castaic Lake	323,700	18,600	12,500	292,600
Elderberry Forebay	28,200	800	1,100	26,300
Silverwood Lake	73,000	4,000	24,300	44,700
Lake Perris	126,800	4,100	0	122,700
Total	**721,600**	**32,300**	**44,900**	**644,400**

Source: California Department of Water Resources (1974). California State Water Project, Volume III, Storage Facilities, Bulletin 200, pages 294, 340, 367, 407, and 408.

From 2005 to 2017, DWR temporarily lowered the maximum storage elevation in Lake Perris because of seismic safety issues. This elevation change resulted in reduction of storage available to Metropolitan in Lake Perris, which was taken into account in past emergency storage evaluations. In 2018, the seismic retrofit of Lake Perris was completed, which restored storage to its full capacity. For purposes of the emergency storage analysis provided herein, it is assumed that 122,700 AF could be available to Metropolitan from Lake Perris. Furthermore, the Monterey Amendment, executed by the DWR and most of the State Water Contractors in 1995 and 1996, addresses the allocation of SWP water in times of shortage and deals with a number of other issues that facilitate more water management flexibility for Contractors.

Table 8 shows the distribution of Metropolitan's emergency storage in DWR reservoirs. Of the total 644,400 AF of storage in DWR Reservoirs that is for Metropolitan use, almost 381,000 AF of this amount is allocated to emergency storage and the remaining 263,600 AF is for seasonal, regulatory, and dry-year storage.

Silverwood Lake capacity does not add to the total Emergency Storage Capacity because of its location outside of major earthquake faults assumed for the emergency storage calculation methodology. However, Silverwood Lake could be available after a seismic event upon restoration of any damaged distribution system components downstream of the lake. It is expected that the portion of the distribution system downstream of the lake could be restored more expeditiously after an event due to its relatively short length, accessibility of the pipelines, and redundancies in the system.

Table 8
Allocation of Emergency Storage in DWR Reservoirs
(Acre-Feet)

Reservoir	Metropolitan Storage Capacity	Seasonal, Regulatory and Dry-Year Storage	Emergency Storage Capacity
Pyramid Lake	158,100	0	158,100
Castaic Lake	292,600	153,900	138,700
Elderberry Forebay	26,300	0	26,300
Silverwood Lake	44,700	44,700	0
Lake Perris	122,700	65,000	57,700
Total	**644,400**	**263,600**	**380,800**

Metropolitan Surface Reservoirs

Table 9 shows the allocation of storage resources in Metropolitan's three major surface reservoirs, Lake Mathews, Lake Skinner, and DVL. These three reservoirs provide approximately 1,036,000 AF of total storage capacity to Metropolitan's service area.

Lake Mathews has available storage of approximately 178,500 AF and distributes CRA water to Riverside, Orange, Los Angeles, and San Bernardino counties. Lake Skinner has approximately 43,800 AF of available storage and receives CRA and SWP water for distribution to Riverside and San Diego counties. DVL is Southern California's largest reservoir with approximately 810,000 AF of total capacity, with 798,500 AF of available capacity to meet demands and provide emergency water supplies.

Table 9
Allocation of Storage Capacities in Metropolitan Reservoirs
(Acre-Feet)

Reservoir	Total Storage Capacity	Dead Storage	Available Capacity
Lake Mathews	182,000	3,500	178,500
Lake Skinner	44,000	200	43,800
Diamond Valley Lake	810,000	11,500	798,500
Total	**1,036,000**	**15,200**	**1,020,800**

Table 10 shows the components of storage, including emergency, seasonal, regulatory, and dry-year storages, for all of Metropolitan's reservoirs. Under the recommended Emergency Storage of 750,000 AF, out of the roughly 1,021,000 AF of available Metropolitan storage capacity, approximately 369,200 AF are reserved for emergency storage, with the remaining storage capacity available for seasonal, regulatory, and dry-year storage.

Table 10
Allocation of Emergency Storage in Metropolitan Reservoirs
(Acre-Feet)

Reservoir	Available Capacity	Emergency Storage Objective at 750 TAF	
		Seasonal, Regulatory and Drought Storage	Emergency Storage
Lake Mathews	178,500	100,000	78,500
Lake Skinner	43,800	10,000	33,800
Diamond Valley Lake	798,500	541,600	256,900
Total	**1,020,800**	**651,600**	**369,200**

Emergency Storage Capacities in DWR and Metropolitan Reservoirs

The Emergency Storage presented in this white paper is evaluated based on regional aggregation of retail demands and locally available supplies within the service area. The resulting Emergency Storage is assumed to be distributed amongst the available capacities within the existing DWR and Metropolitan surface reservoirs. During an outage, Metropolitan delivers supplement water to member agencies from previously stored emergency supplies, and dry-year supplies if necessary and available, based on the most effective operation of the distribution system under emergency conditions.

Table 11 presents the storage of emergency supplies in DWR Reservoirs, Lake Mathews, and Lake Skinner to be fixed quantities, with any remaining need reflected as changes in DVL's emergency storage allocation under the recommended 750,000 AF of Emergency Storage.

Table 11
Allocation of Emergency Storage in Existing Reservoirs[(1)]
(Acre-Feet)

Reservoir	Emergency Storage Objective at 750 TAF
Pyramid Lake	158,100
Castaic Lake	138,700
Elderberry Forebay	26,300
Lake Perris	57,700
Lake Mathews	78,500
Lake Skinner	33,800
Diamond Valley Lake	256,900
Total	**750,000**

Note: (1) This allocation provides operational guidance but does not create a minimum emergency storage volume in any single reservoir.

Conclusion

This white paper summarizes the progress to date of the Workgroup coordination process to estimate a planning objective for the region's emergency storage, as part of Metropolitan's ERSP. Evaluating the Emergency Storage involves the regional aggregation of retail water demands and locally available supplies within the service area. It also accounts for the member agencies' unique situations in identifying practicable ranges of additional conservation actions that could yield decreases in retail demand and levels of local production that could be accomplished during emergency outage.

Under the new envelope concept, the Workgroup focused on an acceptable range of regional emergency storage values from 520,000 to 830,000 AF. **Based on feedback to date, staff recommends an Emergency Storage of 750,000 AF.** This level of storage would prevent severe water shortages for the region with practicable ranges of water demand reduction achievable conservation actions and plausible levels of local production. This recommended regional emergency storage is assumed to be distributed amongst the available capacities within the existing DWR and Metropolitan surface reservoirs, as shown in Table 11.

The Emergency Storage presented in this white paper is a regional planning objective. It is an estimate for the amount of Metropolitan water that the region targets to store in preparation for a catastrophic earthquake event. This evaluation of Emergency Storage is not intended to set a basis or a policy for allocating or apportioning storage for each individual member agency.

The Workgroup proposes that this storage objective be revisited periodically, possibly following the completion of a new IRP. Metropolitan also considers spatial distribution for the purpose of determining generally where to store its emergency water. However, specific operations during an emergency will depend on the actual conditions at that time. Since member agency demands for supplemental water will be met through deliveries of supplies from storage, evaluation of spatial distribution of storage and most effective operation of the distribution system will be accomplished as part of Metropolitan's continued efforts and coordination within the ERSP's storage portfolio evaluation or other regional planning processes.

Attachment A

2018 Member Agency Total Retail Demand and Local Production
(Source data for Tables 2, 3, and 4)

	Total Retail Demand	Groundwater	Surface Production	Recycling + GW Recovery Reclamation	Other Imports	Seawater Desal	Local Surface Storage	IRP Target	
Agencies at 6 month Outage									
Foothill MWD	9,204	3,970	200	120	0	0	0	67	
Pasadena	16,217	6,000	0	0	0	0	0	118	
San Marino	2,700	2,250	0	0	0	0	0	20	
Three Valleys MWD	63,226	21,650	3,100	4,384	0	0	0	447	
Upper San Gabriel MWD	106,945	74,163	4,500	4,354	0	0	0	625	
Anaheim	34,253	23,932	0	39	0	0	0	249	
Fullerton	14,315	10,376	0	0	0	0	0	104	
MWDOC	310,510	107,945	2,000	93,163	0	0	0	1,651	
Santa Ana	19,074	13,478	0	160	0	0	0	139	
Eastern MWD	126,051	40,400	1,550	25,112	0	0	0	890	
Western MWD	147,318	73,700	2,750	21,295	0	0	0	1,064	
IEUA	143,302	74,800	16,240	28,573	0	0	0	969	
San Diego County Water Authority	315,373	5,900	24,595	19,956	0	25,319	34,000	2,204	
Agencies at 12 month Outage									
Central Basin MWD	296,066	182,300	0	55,972	0	0	0	1,590	
Compton	7,766	6,400	0	0	0	0	0	56	
Long Beach	68,633	28,700	0	10,118	0	0	0	452	
Torrance	28,420	2,700	0	9,150	0	0	0	207	
West Basin MWD	179,750	34,600	0	33,621	0	0	0	1,173	
Santa Monica	13,732	8,200	0	145	0	0	0	100	
Burbank	27,819	300	0	13,985	0	0	0	159	
Glendale	30,319	1,500	0	8,984	0	0	0	221	
Los Angeles	566,486	77,794	0	11,681	0	0	0	4,070	
San Fernando	3,150	3,143	0	0	0	0	0	23	
Calleguas MWD	164,638	27,700	0	7,483	13,100	0	0	1,198	
Beverly Hills	11,938	0	0	700	0	0	0	87	
Las Virgenes MWD	28,413	100	0	4,804	0	0	0	207	
MWD TOTAL	**2,735,617**	**832,000**	**54,935**	**353,797**	**13,100**	**25,319**	**34,000**	**18,087**	**1,331,238**

Note: Member agency local production are approximation for year 2018 based on 2015 IRP and are estimated for the outage periods indicated.
This table shows individual member agency estimates used to develop Metropolitan's Emergency Storage Objective for the region.
For agencies along the Rialto Pipeline, see discussion on pages 5-6 related to system limitations for receiving CRA supplies.
Local surface storage includes all reasonably available surafce storage that the member agency could produce and use within its service area. Includes SDCWA's calculated ESP storage requirement reported to their Water Planning Committee in July 2018 and a portion of their target carryover storage as discussed in page 9.

Appendix 9

SEISMIC RISK ASSESSMENT AND MITIGATION PLAN

Appendix 9
SEISMIC RISK ASSESSMENT AND MITIGATION PLAN

Beginning January 2020, CWC Section 10632.5 mandates UWMPs to 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, this required assessment and plan are accomplished as part of developing its resilience strategy and are presented in detail in Metropolitan's seismic resiliency reports attached to this appendix.

Over its nearly 90-year history, Metropolitan has been proactive in mitigating seismic risks posed to its expansive infrastructure, as well as improving its ability to maintain (or quickly restore) water deliveries following a major earthquake. 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 holistic strategy for seismic resilience follows a "defense in depth" multi-layered approach for managing risk. Metropolitan's Seismic Resilience Strategy has three primary objectives:

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

Metropolitan's Seismic Resilience Strategy is implemented through four components that encompass the various internal functions that promote the organization's seismic resilience objectives. These components are supplemented by Metropolitan's commitment to inter-agency coordination when preparing and responding to a seismic event and other emergencies. The strategy is shown below in Figure A.9-1.

Figure A.9-1
Seismic Resiliency Strategy

A brief description of the components of Metropolitan's Seismic Resilience Strategy and examples of their implementation are provided below.

Planning

The goals of the planning component are to develop and maintain a diversified water resource portfolio; provide a flexible system that allows for operational changes to handle variations in water supply, planned or unplanned system outages; and to maintain adequate emergency storage supplies. Metropolitan has developed a diverse water resource portfolio through the enactment of various exchange and water banking programs. These water supply programs are described in detail in Section 3 and Appendix 3. In addition to existing supply programs, development of the Regional Recycled Water Program would provide Metropolitan with an additional water resource and would be strategically located on the coastal side of the San Andreas Fault. Metropolitan also strives for regional seismic resilience by incentivizing local agencies to develop increased conservation, recycling, storage, and other water management programs.

As Metropolitan expanded its system over the years, it has continually improved the flexibility of the system to handle changes in water supply or pipeline or facility outages. One example of Metropolitan's system flexibility is the Common Pool service area, which can be supplied by the Jensen, Weymouth, or Diemer water treatment plants. Additionally, Metropolitan has constructed its system such that most of the service area can be supplied by either Colorado River or State Water Project supplies.

Metropolitan's imported water supplies from the CRA and SWP East and West Branches cross the San Andreas Fault (SAF) Zone prior to reaching Metropolitan's service area. A major earthquake on the SAF has the potential of damaging all three aqueducts and disrupting imported supplies for up to six months. Metropolitan constructed Diamond Valley Lake (DVL) on the coastal side of the fault to mitigate the potential impacts of a major SAF earthquake to its service area. Completion of DVL nearly doubled Metropolitan's available surface water storage in the region and, along with other local reservoirs, is used to maintain 6 to 12 months of emergency water storage supply. Water from DVL can supply four of Metropolitan's five regional water treatment plants.

Engineering

The goal of the engineering component is to assess and mitigate seismic risk to individual facilities, and the system. This is accomplished through Metropolitan's Seismic Resilience of Structures Program, the Seismic Resilience of Pipelines Program, the Dam Safety Program, and special seismic assessments.

Seismic Resilience of Structures

Metropolitan's program to increase the seismic resilience of structures is an ongoing program with the goal of protecting life safety and critical infrastructure to minimize water delivery interruptions following a seismic event. The initial program focused on evaluating the seismic risk of above ground structures (e.g., water treatment plants) constructed prior to 1990 and upgrading structures to mitigate the risk when found to be seismically deficient. The program has recently expanded to include post-1990 structures due to the progress made on the initial list of structures. Examples of seismically upgraded facilities include the Colorado River Aqueduct pump plant buildings, the Weymouth East and West Wash Water Tanks, and the Diemer and Jensen Administration Buildings.

Seismic Resilience of Pipelines

Metropolitan's conveyance and distribution system has been built in conformance with standards and practice at the time of design. In keeping with the goals of the Seismic Resilience Strategy, Metropolitan is developing seismic design criteria for new pipelines based on current state of practice, geotechnical and seismicity criteria, operating conditions, and asset management strategies. The planned design approach for new pipelines will be to establish performance criteria, identify seismicity and ground conditions along the alignment, and design the pipeline to resist damage from ground shaking and deformation. Specialized pipe joints and sections can be designed to accommodate ground deformation from fault displacement or liquefaction. For existing pipelines, seismic resilience will be incorporated as a component of pipeline rehabilitation projects. Metropolitan will evaluate each upgrade individually to balance risk, performance, and cost. Metropolitan's Casa Loma Siphon Barrel No. 1 Seismic Upgrade Project is an example of the organization incorporating seismic design in the rehabilitation of existing pipelines. The existing siphon, which crosses a segment of the San Jacinto Fault Zone and is subject to long-term subsidence, will be replaced with earthquake-resistant ductile iron pipe. The pipe joints are designed to accommodate ground displacement without failure to allow for continued service following an earthquake.

Dam Safety Program

Metropolitan has an ongoing Dam Safety Initiatives Program that has initiated several plans to improve Metropolitan's dam seismic safety and earthquake readiness. These initiatives are being coordinated with the California Division of Safety of Dams (DSOD) and Office of Emergency Services and include the following:

- Ongoing preparation of Emergency Action Plans, including inundation maps
- Performing training exercises at the dam site to test processes during a seismic event
- Providing training and guidance on overall dam safety
- Reviewing operation and maintenance methods for reservoir drawdown and operations after a seismic event
- Updating guidelines and procedures on protection against seismic risk
- Establishing a strong communications system on seismic information
- Performing structural strengthening of dams, including rehabilitation and improvement of spillways and inlet/outlet towers such as Lake Skinner Outlet Tower
- Improving dam safety instrumentation, monitoring, and reporting capabilities

Special Seismic Assessments

Metropolitan conducts special seismic assessments to increase understanding of the vulnerability of the organization's assets and operations to various seismic hazards. The studies focus on hazards specific to individual facilities or the system as a whole and identify options to mitigate the risks posed by the hazards. In addition, 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. The following is a list of some of the reports that Metropolitan has completed:

- Liquefaction Susceptibility Mapping for the Metropolitan Water District of Southern California's Feeder System (Report No. 1625), Carollo Engineers, Inc., 2019.

- Colorado River Aqueduct – San Gorgonio Pass Seismic Event Vulnerability Study (Report No. 1484), GeoPentech, July 2014.
- Potential Effects of Southern California Seismic Events on Metropolitan Water Deliveries (Report No. 1335), Metropolitan Facility Planning staff, January 2009.

Operations

The goal of the operations component is to maintain effective emergency planning and response capabilities. This is accomplished through maintaining an effective Emergency Response Organization, conducting routine emergency response training exercises, and maintaining emergency construction capabilities.

Metropolitan's Emergency Response Organization (ERO) is comprised of over 200 predesignated employees who work in the Emergency Operations Center (EOC), the Incident Command Posts, or the field during emergencies. ERO staff has completed specialized training that meets State and Federal requirements. Metropolitan's emergency response structure follows the National Incident Management System (NIMS) and the State of California's Standardized Emergency Management System (SEMS).

In addition to specialized NIMS training, Metropolitan staff routinely participate in emergency response training exercises that are often based on a postulated seismic event. In 2019, Metropolitan started a new five-year emergency exercise plan that will allow all member agencies to participate in at least one of Metropolitan's annual emergency exercises. The first of these exercises was a tabletop exercise for the Orange County member agencies on August 29, 2019, which focused on a hypothetical incident at the Diemer Water Treatment Plant.

Metropolitan has conducted over 100 exercises since February 2018. This included two large functional emergency exercises for the EOC and multiple tabletop exercises, workshops, and seminars for the 12 Incident Command Posts located at the water treatment plants, conveyance and distribution facilities, and other strategic locations in Metropolitan's service area.

Metropolitan maintains 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 addition, Metropolitan has upgraded its satellite phones to ensure communication ability following a seismic event and is in the process of installing high frequency radios at all Incident Command Posts and the Emergency Operations Center.

Reporting

Metropolitan has committed to providing annual updates to its Board of Directors on the organization's Seismic Resilience Strategy and its progress toward identified short-term and long-term goals. The organization has also committed to providing a formal report on a five-year interval summarizing accomplishments related to seismic resilience and changes in directives to the Seismic Resilience Strategy.

Inter-Agency Coordination

Improving the region's seismic resilience requires that member agencies understand the seismic risks to the imported water supplies so that they may appropriately plan on the local level. Opportunities for inter-agency coordination are provided through the Local Resources Program where Metropolitan incentivizes the development of local groundwater, recycling, and other supply resources to offset imported demands. As stated previously, Metropolitan provides member agencies the opportunity to participate in emergency response exercises. As part of a recent study, Metropolitan developed maps that define the relative liquefaction susceptibility of the region inclusive of the conveyance and distribution system and has made these maps available to member agencies. Recently, the organization updated the emergency storage goals through several workshops in coordination with member agencies.

Metropolitan is also a member of the Seismic Resilience Water Supply Task Force, along with the California Department of Water Resources (DWR) and the Los Angeles Department of Water and Power (LADWP). As the owners of the three conveyance facilities that provide imported water to the region, Metropolitan, DWR, and LADWP have recognized the importance of coordinating responses following a major seismic event that disrupts the imported water supplies. Each agency has provided an overview of the seismic risk to their respective systems and are in the process of developing a Water Mutual Assistance Agreement to formalize the coordination efforts following a major earthquake that disrupts service to the imported water supplies.

Metropolitan's Seismic Resilience Reports

The various components of Metropolitan's resilience strategy summarized above are described in detail in Metropolitan's Seismic Resilience Report First Biennial Report (February 2018) and Seismic Resilience Report 2020 Update (February 2020) presented as part of this appendix. These reports are also available on Metropolitan's website:
http://mwdh2o.com/AboutYourWater/Planning/Seismic-Resilience-Report/

This page intentionally left blank.

REPORT

SEISMIC RESILIENCE

FIRST BIENNIAL REPORT

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

Report No. 1551
February 2018

SEISMIC RESILIENCE
FIRST BIENNIAL REPORT

Prepared By:

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

Report Number 1551
February 2018

Prepared under the direction of:

Gordon Johnson	Chief Engineer

Prepared by:

Robb Bell	Engineering Services
Don Bentley	Water Resource Management
Winston Chai	Engineering Services
David Clark	Engineering Services
Greg de Lamare	Engineering Services
Ray DeWinter	Administrative Services
Edgar Fandialan	Water Resource Management
Ricardo Hernandez	Engineering Services
Rosa Lau	Engineering Services
Silvia Perez	Water System Operations
Ian Whyte	Water System Operations

Reviewed by:

Grace Chan	Water Resource Management
Heather Collins	Water System Operations
Kevin Donhoff	Water Resource Management
Jim Green	Water System Operations
Bob Harding	Water Resource Management
Mike Rojas	Engineering Services
Jack Safely	Water Resource Management
Deven Upadhyay	Assistant General Manager/Chief Operating Officer
Brent Yamasaki	Water System Operations

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

Extensive efforts have been made to ensure that the material contained in this document is accurate as of the date of publication. There are many factors, however, related to the content and applicability of this document which are beyond the control of MWD. In addition, the contents of this publication will be periodically updated, so the reader should inquire about any such changes in addition to reading this document. Finally, the reader is encouraged to seek appropriate technical and/or legal advice when specific facts or circumstances arise that raise questions concerning the applicability or interpretation of the policies and procedures discussed herein.

PUBLICATION HISTORY:

Initial Release (First Biennial Report)	*February 2018*

TABLE OF CONTENTS

TABLE OF CONTENTS (cont'd)

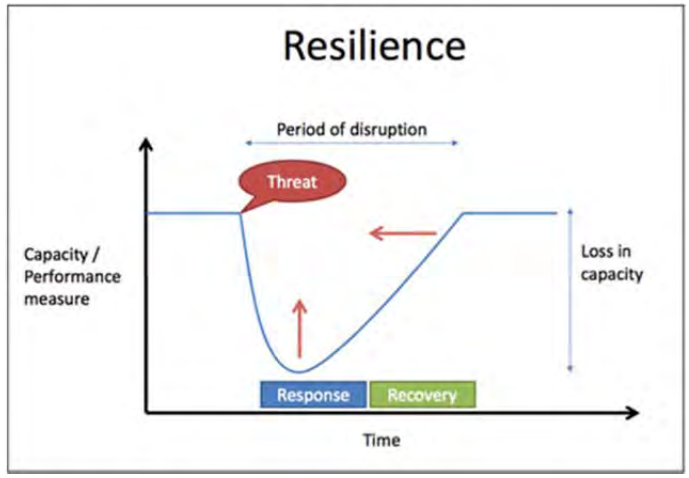
List of Appendices

EXECUTIVE SUMMARY

The ability to maintain, or quickly restore, water deliveries after a seismic event.

--Definition of "Seismic Resilience" for a water agency

An interruption in a key lifeline service such as water delivery can be devastating to a community's recovery after an earthquake. As the agency responsible for delivering imported water to over 19 million people in one of the world's most seismically active regions, The Metropolitan Water District of Southern California (Metropolitan) has made substantial efforts to minimize the impact of a major earthquake on the people and businesses within its service area. In 2017, Metropolitan refined and formalized its approach for addressing seismic resilience by fully integrating its planning, engineering, operations, and reporting functions.



This report documents Metropolitan's integrated Seismic Resilience Strategy, reports on key historic achievements, and communicates near-term goals aimed at further enhancing the seismic resilience of Metropolitan's infrastructure and water deliveries.

Seismic Resilience

"Resilience" is broadly defined as the ability of a system to absorb and rebound from shocks. The more resilient a system is, the smaller the impact will be that any given shock will have on the system, and the shorter the duration of recovery will be. Using the broad definition of resilience as a baseline, Metropolitan defines "seismic resilience" as the ability to maintain (or quickly restore) water deliveries following a seismic event. The more prepared a water agency is for earthquakes, and the more effective its emergency response capabilities are, the less impact the event will have on water deliveries to its customers.

Metropolitan's Seismic Resilience Strategy

Metropolitan's Seismic Resilience Strategy is a multi-faceted approach to prepare for and respond to seismic events. It involves close, formal coordination within the Metropolitan organization and with other owners of imported water conveyance systems that cross the Southern San Andreas Fault.

Coordination within Metropolitan and its member agencies focuses on diversifying water resources; enhancing operational flexibility; providing adequate emergency water supplies; and identifying and addressing infrastructure and system vulnerabilities. This coordination also involves development of effective emergency response capabilities.

The coordination with other owners of imported water conveyance systems is through a multi-agency task force. The members of this task force, which includes the California Department of Water Resources

(DWR) and the Los Angeles Department of Water and Power (LADWP) as well as other State and water industry organizations, work together to evaluate the unique seismic vulnerabilities of Southern California's imported water systems.

In addition to the coordination elements, Metropolitan's Seismic Resilience Strategy includes a reporting component to increase transparency and accountability. Each year, Metropolitan staff will update its Board of Directors on recent achievements and near-term goals. Every two years, a written report will be prepared to document these items.

Water is recognized as a critical resource, but having sufficient water available following an earthquake is essential. Seismic resilience has a goal that in most scenarios, water will be available for the vast majority of people and business affected by the event and for essential post-earthquake activities such as fire suppression.

Conclusion

Metropolitan's strategy for seismic resilience has evolved over time and has benefited from the lessons learned from major seismic events around the world. Because of this strategy, significant improvements in the overall seismic resilience of Metropolitan's water system have been made in each of the following key areas: water resource diversity, operational flexibility, emergency water storage capacity, resilience of existing infrastructure, and emergency response capabilities.

Metropolitan has also established a number of near-term goals within each of the planning, engineering, and operations components of seismic resilience that will further enhance this multi-layered approach.

Metropolitan's refined Seismic Resilience Strategy approach will maintain a clear and effective focus on long-term efforts, clearly communicate program achievements and goals to the Board, and provide member agencies with more clarity regarding projected seismic performance of Metropolitan's infrastructure.

SECTION 1 INTRODUCTION

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 nearly 90-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 earthquake. 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 "defense in depth" 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.

Over the last 20 years, Metropolitan has made significant progress in a number of key areas related to seismic resilience (see Appendix 1):

1. Increasing water supply resilience, flexibility, and emergency storage
2. Addressing the susceptibility of above-ground structures to damage from seismic events
3. Developing effective and robust emergency response capabilities

Recognizing the need for continuous improvement, Metropolitan recently re-assessed the various activities that enhance seismic resilience to refine, expand, and formalize its overall approach. The resulting Seismic Resilience Strategy is a fully integrated approach toward minimizing regional water delivery interruptions and restoring interrupted regional deliveries quickly after an earthquake.

The specific goals of the refined Seismic Resilience Strategy are to:

- Improve the integration of planning, engineering and operations activities focused on seismic resilience through regular collaborative meetings and integrated reporting
- Expand current programs to identify and address any additional seismic vulnerabilities
- Re-visit existing seismic performance objectives in light of advancements in the knowledge of earthquake hazards, earthquake engineering, and mitigation capabilities
- Document Metropolitan's seismic resilience activities to facilitate knowledge transfer and coordination
- Improve accountability by communicating seismic resilience goals and accomplishments to Metropolitan's Board of Directors and member agencies on an annual basis
- Enhance member agency planning efforts for emergency response and facility improvements by providing more clarity regarding the projected seismic performance of Metropolitan's infrastructure

This document describes Metropolitan's Seismic Resilience Strategy, summarizes key historical achievements, and communicates near-term goals that will further increase the seismic resilience of Metropolitan's system.

Seismic Resilience Strategy Structure

Metropolitan's Seismic Resilience Strategy (see **Figure 1-1**) is a multi-faceted approach that involves coordination among key functions within Metropolitan as well as formal coordination with other owners of imported water conveyance systems that cross the Southern San Andreas Fault.

Figure 1-1: Seismic Resilience Strategy Structure and High Level Goals

As shown in the figure, the coordination within Metropolitan and its member agencies focuses on the activities of planning, engineering/design, operations/emergency response, and reporting. These efforts are complemented by the efforts of the multi-agency Seismic Resilience Water Supply Task Force (Task Force). This Task Force includes the California Department of Water Resources (DWR) and the Los Angeles Department of Water and Power (LADWP) as well as other State and water industry organizations and focuses on the unique seismic vulnerabilities of Southern California's imported water supplies.

The purpose of Metropolitan's Seismic Resilience Strategy is to enable Metropolitan to restore water deliveries to its member agencies promptly after seismic events by maintaining a diversified supply portfolio, system flexibility, and emergency storage; minimizing damage to infrastructure; and supporting a robust emergency response and recovery capability. This integrated, comprehensive approach will maintain focus on effective long-term efforts, clearly communicate program achievements and goals to the Board, and provide more clarity to member agencies regarding projected regional seismic performance to enhance local facility and emergency response planning efforts.

Report Organization

This report is organized as follows:

- *Section 2 – Background.* Provides context regarding inherent seismic risks within Southern California, a definition of seismic resilience, and a summary of how Metropolitan's seismic resilience strategy developed over time.
- *Section 3 – Planning Component.* Describes planning activities that address seismic resilience through Metropolitan's diverse water supply portfolio and adaptive management approach to managing resources, including establishing emergency storage.
- *Section 4 – Engineering Component.* Describes technical programs that identify and mitigate the seismic vulnerability of Metropolitan's infrastructure and systems.
- *Section 5 – Operations Component.* Describes the emergency response organization, training exercises, and post-event capabilities that serve to minimize the disruption of water deliveries following earthquakes.
- *Section 6 – Reporting Component.* Explains the purpose and timing of the integrated reporting component.
- *Section 7 – Seismic Resilience Water Supply Task Force Component.* Describes the purpose of the collaborative task force, recent progress, and planned activities.
- *Section 8 – Seismic Resilience Performance Objectives and Near-Term Goals.* Summarizes existing objectives of the various components of seismic resilience, describes areas where new objectives are being considered, and provides high-level goals planned to be achieved by December 2019.

List of Abbreviations and Acronyms

BCP	Business Continuity Plan
CIP	Capital Investment Plan
CRA	Colorado River Aqueduct
DATs	Damage Assessment Teams
DSOD	Division of Safety of Dams
DVL	Diamond Valley Lake
DWR	California Department of Water Resources
EAP	Emergency Action Plan
EOC	Emergency Operations Center
ERO	Emergency Response Organization
FEMA	Federal Emergency Management Agency
ICCs	Incident Command Centers
IRP	Integrated Water Resources Plan

IT	Information Technology
ITP	IT Continuity Plan
LAA	Los Angeles Aqueduct
LADWP	Los Angeles Department of Water and Power
LRP	Local Resources Program
M	Magnitude
MARS	Member Agency Response System
MCE	Maximum Considered Earthquake
Metropolitan	The Metropolitan Water District of Southern California
MOU	Memorandum of Understanding
M_W	Moment Magnitude
MWD	The Metropolitan Water District of Southern California
NIAC	National Infrastructure Advisory Council
NIMs	National Incident Management System
O&M	Operation and Maintenance
OCC	Operations Control Center
PCCP	Prestressed Concrete Cylinder Pipe
PGA	Peak Ground Acceleration
SCE	Southern California Edison
SEMS	Standardized Emergency Management System
ShakeOut	Great Southern California ShakeOut Scenario
SWC	Security Water Center
SWP	State Water Project
Task Force	Seismic Resilience Water Supply Task Force
UBC	Uniform Building Code
UCERF3	Uniform California Rupture Forecast Version 3
USGS	United States Geological Survey
WSAP	Water Supply Allocation Plan
WSDM	Water Surplus Drought Management

SECTION 2 BACKGROUND

Seismic Risk

Within Southern California, there are a number of known active faults with varying levels of activity that are capable of generating significant earthquakes and causing widespread damage to infrastructure. Modern era earthquakes that occurred within or close to Metropolitan's primary service area with a magnitude above 6.3 (M6.3) are listed in Appendix 2. In 2015, the United States Geologic Survey (USGS) released the Uniform California Earthquake Rupture Forecast Version 3 (UCERF3), which provides a forecast for the likelihood of rupture for particular earthquake faults within California. UCERF3's forecast of the likelihood of a M6.7 earthquake or greater in the next 30 years on each active fault in Southern California is shown in **Figure 2-1**. As indicated in the figure, the Southern San Andreas Fault was identified as having the highest likelihood (19%) of a M6.7 earthquake or greater in the next 30 years. UCERF3 further states that the there is a 93% chance of a M6.7 or greater earthquake occurring on one of the faults within Southern California within the next 30 years, and a 36% chance of a M7.5 or greater earthquake occurring within the next 30 years.

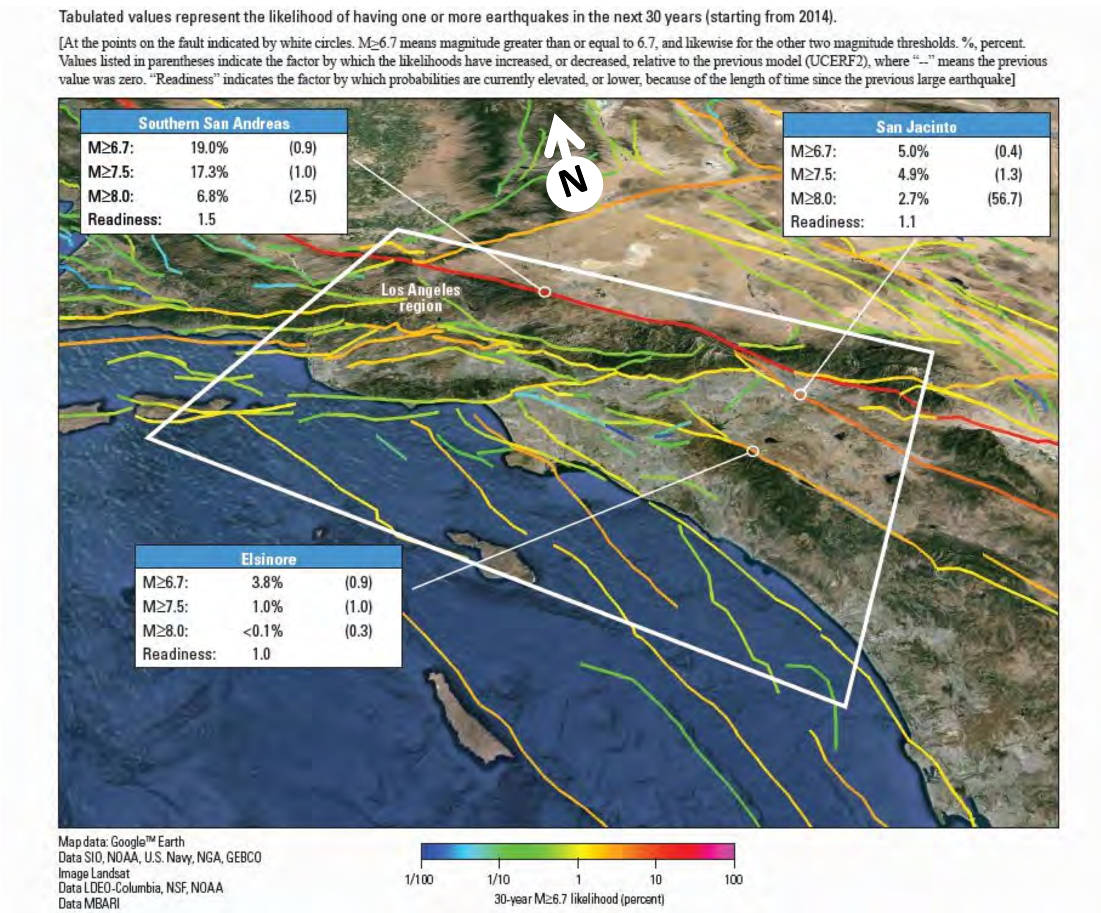


Figure 2-1: Likelihood of M6.7 or greater earthquake in the next 30 years (Source: UCERF3)

As shown in **Figure 2-2**, a significant portion of Metropolitan's infrastructure, including the Colorado River Aqueduct (CRA) and several treated water pipelines, is located near or crosses active faults.

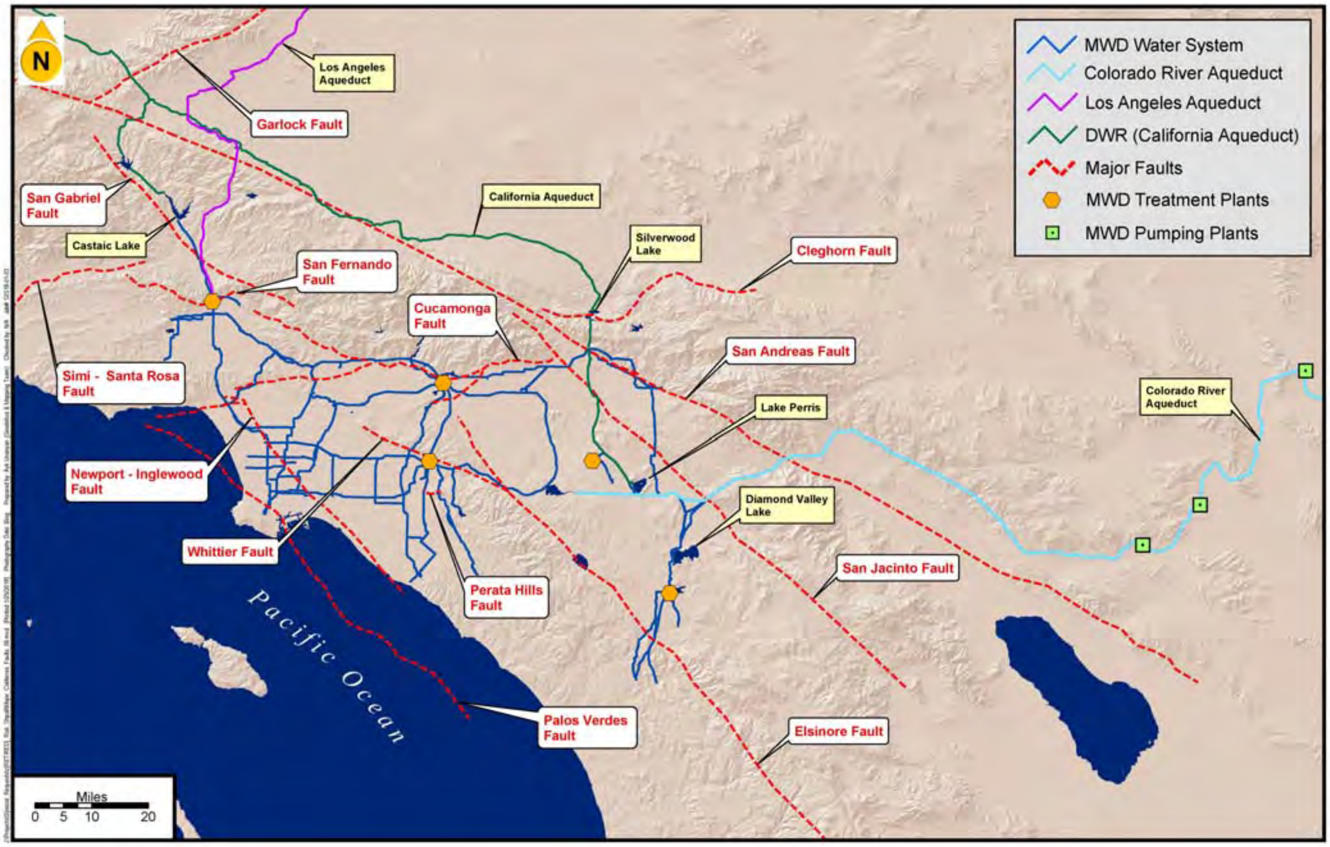


Figure 2-2: Major Earthquake Faults in Southern California

The risk of earthquake damage to Metropolitan's infrastructure from these active faults is manifested through different seismic hazards, including seismically induced ground shaking, seismically induced ground failure, and surface fault displacement.

- Seismically induced ground shaking can damage buildings, structures, aqueducts, pipelines, and tunnels. The intensity and duration of shaking at a particular location is dependent on a number of factors, including the earthquake magnitude, the distance from the earthquake epicenter, and local soil conditions.

Examples of typical effects of seismically induced ground shaking. The photograph on the left shows a damaged building from the 1994 M6.7 Northridge Earthquake. The building has essentially fallen backwards, and what was once a straight wall now appears curved. The photograph on the right shows the collapsed portion of a freeway overpass from the same earthquake.

- Seismically induced ground failure includes liquefaction, landslide, and seismic settlement. Liquefaction occurs when prolonged shaking causes saturated (water-bearing) soils to consolidate and lose their bearing capacity. This can compromise the support of structures that are constructed in these zones, including buildings and pipelines. Prolonged shaking can also lead to displacement of large areas of soil or rock, resulting in hazardous landslides and rock falls. The integrity of buildings and pipelines constructed in landslide zones can be compromised if the supporting ground experiences seismically induced failure; rockfalls can also result in structural damage due to the impacts of large boulders on structures. Seismic settlement is similar to liquefaction, except that the soil is not saturated.

Examples of seismically induced ground failures include liquefaction (left photo) and landslides (right photo) from the 2011 M6.3 Christchurch, New Zealand Earthquake and the 2016 M7.8 Kaikoura, New Zealand Earthquake, respectively.

- Surface fault displacement is usually only observed in large magnitude earthquakes but can result in devastating structural damage. The 1972 Alquist-Priolo Earthquake Fault Zoning Act prohibits construction of buildings in California within 50 feet of a known active fault trace. Therefore, surface fault displacement is generally not an issue for Metropolitan's buildings constructed after the early 1970s. However, several components of Metropolitan's conveyance and distribution infrastructure cross known active faults, including the CRA, various pipelines, and power transmission lines. These facilities are subject to damage from surface fault displacement.

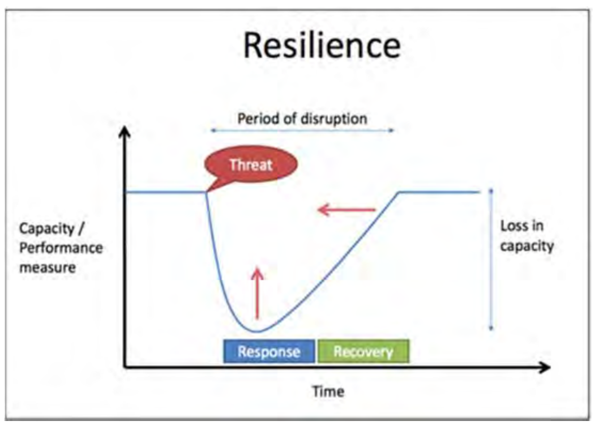
Examples of surface fault displacement. The photograph on the left shows railroad tracks displaced as a result of the 1952 M7.5 Kern County Earthquake. The photograph on the right shows a field that shifted as a result of the 2010 M7.1 earthquake in Canterbury, New Zealand.

Seismic Resilience

General

According to the National Infrastructure Advisory Council (NIAC), infrastructure resilience is "the ability to reduce the magnitude and/or duration of disruptive events." The effectiveness of a resilient infrastructure or enterprise depends upon its ability to "anticipate, absorb, adapt to, and rapidly recover from a potentially disruptive event." [ref. "*Critical Infrastructure Resilience Final Report and Recommendations*," September 8, 2009]**.** This event may be man-made, such as a cyber-attack, or a natural disaster, such as a drought, flood, or earthquake.

"Seismic resilience" (see **Figure 2-3**) narrows the focus of infrastructure resilience to only earthquakes. Using the definition of "infrastructure resilience" presented above, Metropolitan has defined seismic resilience for water agencies as the ability to reduce the magnitude and/or duration of water delivery interruptions resulting from seismic events. Rather than striving to make an entire water system "earthquake-proof," seismic resilience involves setting reasonable performance goals that provide sufficient benefits that justify the corresponding investments required by both an agency and its ratepayers. Metropolitan's seismic resilience performance objectives are summarized in Section 8 of this report.



Source: http://www.iparametrics.com/solutions/infrastructure-resilience.html

Figure 2-3: Resilience -- the ability to reduce the magnitude and/or duration of disruptive events

Applicability to Metropolitan

For over a decade, Metropolitan has had a well-defined approach to system reliability that addressed overall system resilience in five key areas: Water Supply Reliability, System Capacity, Infrastructure Reliability, System Flexibility and Emergency Response.

Seismic resilience is an essential aspect of Metropolitan's overall reliability strategy. Water deliveries are extremely crucial following earthquakes for fire suppression, for the general welfare of local residents, and for the regional economy that relies on imported water. Metropolitan's approach to seismic resilience has evolved over time to become one that is highly effective and recognized within the water industry [ref. "*Water Supply in Regard to Fire Following Earthquake*," Charles Scawthorn, Pacific Earthquake Engineering Research Center, November 2011]**.**

Metropolitan's Historical Approach to Seismic Resilience

"The aqueduct is being built for the future as well as the present, and must stand and give adequate service for an indefinitely long time."

From the "Design" Chapter of "The Great Aqueduct" book by Julian Hinds, 1938.

"It was desirable that faults be crossed at right angles, to minimize damage in the event of movement, and that some flexible type of conduit on or near the surface be used so that if repairs become necessary they will be as simple as may be…"

From "Major Problems of Aqueduct Location" by Julian Hinds, Nov. 24, 1938 Engineering News-Record.

Since its inception, and particularly during the design and construction of the CRA, Metropolitan has recognized the potential vulnerability of water infrastructure to disruptions by earthquakes. This section provides a brief overview of Metropolitan's historical approach to seismic resilience, focusing on major earthquake events in the past and lessons learned from these events.

The 1906 M7.8 San Francisco earthquake struck the coast of Northern California at 5:12 a.m. on April 18. Severe shaking was felt from Eureka on the North Coast to the Salinas Valley. Broken gas lines resulted in fires that lasted for several days due to a lack of fire supply. As a result, about 3,000 people died and over 80% of the city of San Francisco was destroyed.

The 1933 M6.7 Long Beach earthquake took place on March 10 at 5:54 P.M. Damage to buildings was widespread and between 115 and 120 people died. The earthquake highlighted the need for earthquake-resistant design for structures in California.

Post-1906 San Francisco and 1933 Long Beach Earthquakes (1930-1970)

<u>Conveyance and Distribution System</u>: The majority of Metropolitan's conveyance and distribution system was constructed between the 1930s and the 1970s. Historical documents regarding the planning and design of this infrastructure describe a philosophy of "permanence," which may be considered as a forerunner to "resilience." This philosophy not only took into account decades of wear and tear, routine hazards, and large storms, but also provided for seismic resilience.

Despite having no provisions within design codes, Metropolitan took proactive measures to address seismic resilience while designing the CRA. Metropolitan geologists and engineers took into account the ground shaking and deformation that had occurred along the San Andreas Fault system during the 1857 Fort Tejon earthquake and lessons learned from 1906 San Francisco earthquakes, and supplemented their understanding of regional active faults through geologic mapping and analysis of stereo aerial photographs. This led to the aqueduct being designed to cross active faults near the ground surface in inverted siphons and cross fault traces at right angles. The designers also opted for a more flexible siphon design in fault regions than the rigid monolithic concrete construction used elsewhere on the CRA, and provided extra hydraulic grade at three siphons crossing active faults (Appendix 3). These provisions were intended to minimize the adverse effects of seismically induced ground movement and to simplify access for repairs.

Metropolitan's dams are inspected on a regular basis.

Photo of the 120-inch Froriep Vertical Turning Lathe (above) and the 5-inch G&L Horizontal Boring Mill (below) in the La Verne Machine shop.

Water Treatment Plants: Metropolitan's water treatment plants were also designed with features that enhance seismic resilience, beginning with the F. E. Weymouth Water Treatment Plant in 1940, and followed by the Robert B. Diemer Water Treatment Plant in 1963. The plants are modular in design and incorporate redundancy of key components. They are also situated strategically to maximize gravity flow to a majority of the distribution system.

Dams and Reservoirs: Metropolitan began a Safety of Dams program many years before formal reporting was required by the California Division of Safety of Dams (DSOD). Staff regularly inspects Metropolitan's dams for vulnerabilities, documents their findings, and reports these findings to DSOD.

La Verne Shops and Construction Equipment: The La Verne Shops were built in the 1940s to support the construction and maintenance of Metropolitan's initial infrastructure. The shops were expanded in the 1960s as Metropolitan's system grew along with its service area. These specialized shops provide support for routine maintenance activities and are also vital for responding to emergency events impacting Metropolitan and member agency facilities. The stockpiling of key materials and the ability to roll pipe and fabricate or repair specialty equipment greatly enhances seismic resilience. Many of Metropolitan's pumps, piping, valves, and related equipment are too large to be routinely stocked by vendors.

Post-1971 San Fernando Earthquake (1971-1990)

The San Fernando earthquake struck the greater Los Angeles region in the early morning of February 9, 1971. The M6.5 earthquake caused severe property damage over $500 million and the loss of life directly attributable to the earthquake reached 58.

There were over 145 post-earthquake ignitions, typically caused by severed gas lines. Metropolitan experienced widespread damage at the Jensen plant, including a severe break to a 72” influent conduit and damage to the new finished water reservoir (shown below).

Earthquake Committee: Following the San Fernando Earthquake in 1971, Metropolitan formed an Earthquake Committee to investigate damaged structures at the Joseph Jensen Water Treatment Plant and to recommend enhanced seismic design criteria and site improvements to mitigate the seismic risk from potential future events.

The recommended modifications, such as the addition of stone columns to prevent liquefaction, are believed to have contributed to improved seismic performance of the Jensen plant in the 1994 Northridge Earthquake (see Section 4 of this report).

The Earthquake Committee also evaluated other facilities and recommended additional improvements that resulted in the upgrade of several key structures throughout Metropolitan’s system. The Committee’s efforts evolved over time into the current formal approach, with its emphasis on improving the seismic resilience of structures.

Emergency Response Plan: This period also saw Metropolitan adopt its Emergency Response Plan and establish a formal Emergency Response Organization (ERO). These steps led to regular emergency response training for staff, and eventually to staging formal emergency response exercises. As part of this effort, Metropolitan coordinated with its member agencies to establish the Member Agency Response System (MARS). Engineering Damage Assessment Teams (DATs) were also created to rapidly assess damage and help prioritize and initiate repair efforts.

La Verne Shops and Construction Equipment: The La Verne Shops were further expanded in the 1980s to support a major rehabilitation of the main pumps on the Colorado River Aqueduct. The additional fabrication capacity increased Metropolitan’s ability to respond to emergency events.

Local Projects Program: To decrease reliance upon imported water, Metropolitan established the Local Projects Program in 1982 to provide financial incentives to member agencies for the development of recycled water projects throughout the region. A more diversified water portfolio helps the region’s overall water supply reliability, which improves seismic resilience for the entire service area.

Post-1989 Loma Prieta and 1994 Northridge Earthquake (1990-2010)

During this period, Metropolitan greatly enhanced seismic resilience by performing seismic risk assessments, updating seismic design criteria, strengthening dozens of at-risk structures, encouraging development of local water resources, increasing emergency storage supplies, and enhancing emergency response capabilities.

The M6.9 Loma Prieta earthquake occurred in Northern California on October 17, 1989, at 5:04 p.m. . The shock was centered approximately 10 miles (16 km) northeast of Santa Cruz on a section of the San Andreas Fault System.

The earthquake was responsible for 63 deaths and over 3,750 injuries. The Loma Prieta segment of the San Andreas Fault System had been relatively inactive since the 1906 San Francisco earthquake until two moderate foreshocks occurred in June 1988 and again in August 1989.

As a result of this event, there were more 916 documented water system pipe breaks. This resulted in the loss of water pressure in the Marina District of San Francisco and difficulty in fighting fires.

<u>Seismic Design Criteria:</u> During the Inland Feeder Project, criteria were developed for new pipelines that cross seismic faults. The refined fault-crossing strategy includes using steel pipelines with welded joints; crossing fault-zones at right angles, and burying the pipes at relatively shallow depth to enable easy access for repair; and locating the pipelines where they can drain into channels or streams if damaged at fault crossings. Metropolitan also began considering the benefits of exceeding minimum code requirements for essential structures.

<u>Seismic Upgrade Program:</u> Dozens of pre-1990 structures were upgraded during this period. The benefit of upgrading seismically vulnerable facilities was demonstrated during the Northridge Earthquake in 1994. Structures that were upgraded at the Jensen plant, which was near the earthquake's epicenter, experienced only minor damage. The only significant damage consisted of rupture of an inlet 84-inch steel pipeline. The Jensen plant was off-line for less than 72 hours while the broken pipeline was repaired, and limited water deliveries were maintained during the repairs. Appendix 4 summarizes damage to Metropolitan infrastructure from the 1971 San Fernando and 1994 Northridge earthquakes.

<u>Local Resources Program:</u> In 1995, Metropolitan established the Local Resources Program (LRP). The LRP combined the Local Projects Program, which provided financial incentives for recycled water projects, with the Groundwater Recovery Program, which provided financial incentives to encourage the development of local groundwater recovery projects. The present LRP has been highly successful in reducing the region's dependence upon imported water.

<u>Diamond Valley Lake (DVL):</u> DVL was completed in 1999 to increase operational flexibility and reliability by providing seasonal storage, drought protection, and dedicated emergency supplies. Seismic resilience was a major factor in both the siting and design of the reservoir. DVL was specifically constructed south and west of the San Andreas Fault, and it was designed to withstand a major event on that fault in order to mitigate for the potential interruption of Southern California's imported water supplies. This 810,000 acre-

foot reservoir, combined with other storage programs, provides a 6-month emergency water supply for Metropolitan's service area.

The M6.7 Northridge earthquake occurred on January 17, 1994, at 4:31 a.m. and had a duration of approximately 10-20 seconds.

The death toll was 57, with more than 8,700 injured. Property damage was estimated to be between $13 and $50 billion. LADWP reported a total of 1,405 pipe repairs and that water pressure had dropped to zero in some areas.

Metropolitan experienced damage at the Jensen Plant including a rupture of an 84" diameter pipeline. Crews worked around the clock and restored service within 72 hours. The ability to roll pipe in the La Verne shops expedited these emergency repairs.

Although Metropolitan's response was very good, a task force was formed to develop recommendations for further improvement (Ref. Report 1087, "Northridge Earthquake Assessment Report").

Special Seismic Risk Assessments: During this period, Metropolitan broadened the scope of seismic risk assessments, from focusing on isolated structures to assessing entire facilities, such as the Diemer plant, and overall systems, such as the CRA. These efforts included seismic vulnerability assessments, facility reliability assessments, and system flexibility studies. These special seismic risk assessments led to several capital projects to structurally upgrade facilities, provided input into Metropolitan's emergency response planning to reduce the time to restore service, and identified options to improve system flexibility to help maintain water deliveries during planned and unplanned outages.

Emergency Response Planning: Following the Northridge Earthquake, Metropolitan revised its Emergency Response Plan and associated programs and established a Member Agency Coordinator function. Metropolitan also began conducting training exercises in coordination with member agencies and other external agencies and three functional exercises based on postulated seismic events were conducted during this period. In addition, the EOC was relocated from the Sunset Headquarters Building to Eagle Rock, and Incident Command Centers (ICCs) were established at each of the water treatment plants. Recognizing that seismic events can impact business functions as well as infrastructure, staff developed a formal Business Resumption Plan. Over time, this evolved into the present Business Continuity Plan (BCP) and IT Continuity Plan (ITP).

Emergency Response Construction Capabilities: In 2008**,** Metropolitan enhanced its ability to respond to emergency events by initiating a long-term project to refurbish and upgrade the La Verne Shops. Metropolitan can roll pipe and conduct simultaneous repairs on two large-diameter pipelines. Retaining in-house fabrication functions is important, as there are few firms in the western U.S. with similar capabilities. In recent years, private firms with machine shop and fabrication capabilities have tended to increase the amount of work outsourced to offshore facilities, instead of retaining it locally. These firms have little ability to respond expeditiously to emergency needs.

Post-2010 Chile, 2011 Christchurch and 2011 Great East Japan Earthquakes (2010-Present)

<u>Seismic Resilience Strategy Defined:</u> The recent earthquakes in Chile, New Zealand, and Japan demonstrated the importance of seismic resilience, and have resulted in extensive discussions among industry experts and public agencies on strategies to achieve greater levels of seismic resilience beyond the conventional measures of prevention and protection. This was particularly true for the 2011 Christchurch, New Zealand Earthquake, although it was the smallest of the three. The reason was the widespread damage that occurred in the downtown section of Christchurch, despite the fact that the infrastructure was designed and constructed in accordance with modern building codes. While the majority of buildings did not fall, and most people were able to exit safely, many of the downtown structures were unsuitable for occupation and had to be demolished. In addition, many of the buried utilities were damaged and had to be abandoned in place. The combined loss of structures and utilities resulted in a long-term reduction to the population within the city.

A M6.3 earthquake occurred in Christchurch, New Zealand on 22 February 2011 at 12:51 p.m. The earthquake was centered 6 miles south-east of the center of Christchurch, which at the time was New Zealand's second-most populous city. The earthquake caused widespread damage across Christchurch, killing 185 people in the nation's fifth-deadliest disaster.

In December 2014, Los Angeles Mayor Eric Garcetti released Resilience by Design which provided recommendations to addresses Los Angeles' greatest earthquake vulnerabilities, including taking steps to secure imported water supplies.

Concurrent with the infrastructure industry's focus on resilience, Metropolitan re-assessed its existing programs and developed a more integrated, comprehensive approach to seismic resilience. One improvement was to incorporate the concept of performance-based design during seismic evaluations. In addition to the evaluation of structures based on design-level earthquakes to prevent damage, performance-based design evaluates the effects of more extreme events to anticipate structural damage. Another improvement was to embrace the significant technological advancements that can improve seismic resilience, including computer modeling techniques, seismic resistant products, and recent industry research. These improvements have allowed Metropolitan to develop an enhanced strategy for seismic resilience moving forward.

During this period, Metropolitan also formed a collaborative Task Force to address the unique vulnerabilities of the major aqueducts that cross the San Andreas Fault. In 2017, Metropolitan fully integrated the various seismic resilience efforts currently underway throughout the organization. The resulting Seismic Resilience Strategy is described in detail in Sections 3 through 7 of this report.

Metropolitan's Comprehensive, Integrated Seismic Resilience Strategy

The enhanced Seismic Resilience Strategy has the following objectives for Metropolitan and for the entire southern California region:

- 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

This strategy is built upon improved collaboration within Metropolitan and formal collaboration with LADWP and DWR, which also import water to Southern California.

Figure 2-4: Detailed Breakdown of Metropolitan's Seismic Resilience Strategy

As shown in **Figure 2-4**, Metropolitan's enhanced Seismic Resilience Strategy includes four components within Metropolitan and a fifth component that involves formal coordination between Metropolitan, LADWP, and DWR.

1. The **Planning component** develops diversified water resources, system flexibility, and emergency water storage through Metropolitan's Integrated Water Resources Plan (IRP) and System Overview Studies. The goal of Metropolitan's IRP is to develop a diverse water supply portfolio that will be able to maintain a reliable water supply under any conditions, including a major seismic event.
2. The **Engineering component** addresses design concepts, vulnerability studies, and seismic resilience projects executed under Metropolitan's Capital Investment Plan (CIP). The Engineering component includes evaluating the seismic resilience of structures, monitoring dams, special seismic assessments, and enhancing pipeline seismic resilience. These efforts are all aimed at improving the seismic resilience of the treatment plants and distribution system through facility upgrades and operational flexibility improvements.
3. The **Operations component** involves Metropolitan's emergency response organization, training exercises, and construction capabilities. Their objectives are to effectively prepare for and respond to emergency events so that impacts to water deliveries are minimized and interrupted deliveries are restored quickly.
4. The **Reporting component** involves documenting the Seismic Resilience Strategy, tracking progress of seismic resilience activities, and annual reporting of near-term goals and recent accomplishments to Metropolitan's Board. This component is aimed at facilitating knowledge transfer, increasing accountability, and improving the transparency of seismic resilience goals and achievements to the Board and member agencies. The reporting component also supports the planning efforts of member agencies by communicating potential outage durations of Metropolitan facilities during emergency events.
5. The **Seismic Resilience Water Supply Task Force component** involves Metropolitan's formal collaboration with DWR, LADWP, the State of California, and other water industry organizations to address the unique seismic vulnerabilities of Southern California's imported water supplies. The two primary objectives of this task force are to 1) enable the agencies to coordinate emergency response efforts, and 2) identify practical mitigation options for reducing the magnitude and duration of disruptions to the region's imported water supplies following a large earthquake on the San Andreas Fault.

SECTION 3 PLANNING COMPONENT

As a supplemental 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 demands during dry and critical periods. However, during the original planning for Diamond Valley Lake (DVL), Metropolitan considered a scenario and a plan to meet demands if imported supplies were interrupted due to a seismic event, including development of a significant increase in storage dedicated to meeting emergencies.

Historically, Metropolitan has provided 50 to 60 percent of the 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 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

Diversified Water Supply Portfolio

Metropolitan has undertaken a number of planning initiatives over the years in order 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.

2015 IRP Update

The 2015 IRP Update was a refinement of Southern California's water management strategy, with seismic resilience continuing to be a key component. The 2015 IRP Update called for increasing the targets for conservation and local supply development and an emphasis on the importance of protecting and maintaining existing local supplies. The more that conservation and local supplies can contribute to the baseline each year, the more imported water Metropolitan can divert into storage to prepare for droughts of unknown duration or potential seismic events. Further developing a diverse water supply portfolio also contributes to increased seismic resilience.

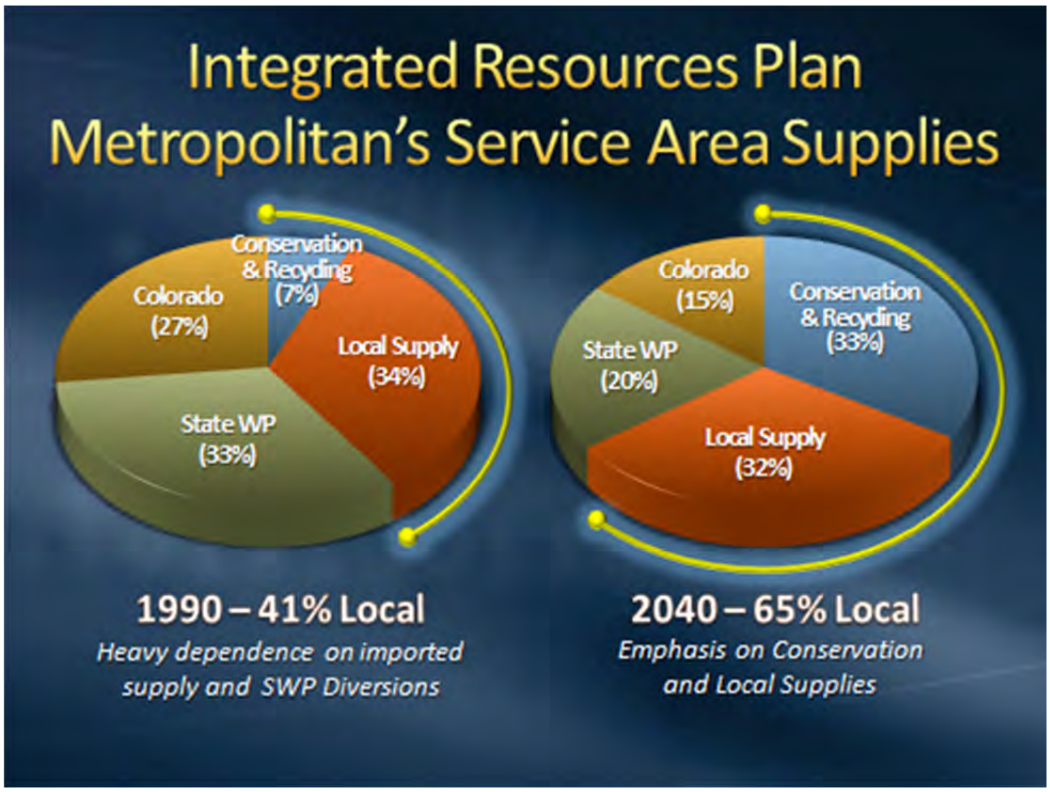


Figure 3-1: Integrated Resource Plan, Metropolitan's Service Area Supplies

Metropolitan's Service Area Supplies under the IRP

In 1990, about 41 percent of regional water demands were met with local resources and conservation. By 2040, about two-thirds will be met by local resources and increased conservation and recycling, as shown in **Figure 3-1**. Metropolitan's strategy is to maintain rather than increase traditional levels of imported supplies. The long-term portfolio approach looks to local solutions to sustain the region's continued growth. Increased flexibility to draw upon a wide range of sources from an ever more diverse water supply portfolio results in greater resilience to the potential impacts of seismic events on Southern California's water supply infrastructure.

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's vast service area 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 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.

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 overall water supply available to each member agency. The level of WSAP reduction implemented would correlate to the severity of the seismic event.

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 planned and unplanned 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 planned and unplanned single-facility outages

Metropolitan has found that for planned and unplanned 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 construction of DVL and the Inland Feeder provided significantly increased water supply reliability through the potential for dramatically increased storage of imported supplies within the service area. These projects increased water supply reliability and system flexibility, and also greatly improved seismic resilience as the storage was purposely located on the coastal side of major faults that are crossed by the SWP, CRA, and Los Angeles Aqueduct (LAA). A significant amount of storage in DVL is dedicated to emergency storage. This water is not used except in emergency conditions such as following a major seismic event. Additionally, the Diemer and Jensen 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.

Emergency Storage

Over the past two decades, Metropolitan has developed a large regional storage portfolio that includes both dry year and emergency storage capacity (summarized in Appendix 5). Storage generally takes two forms: surface reservoirs and groundwater basin storage. In late 2011, heading into the most recent drought cycle, Metropolitan had developed over 5.5 million acre-feet of storage capacity and had successfully stored over 2.7 million acre-feet.

Additionally, Metropolitan has long discussed and executed plans to maintain a reliable supply of water in the face of any type of water supply condition, including following major seismic events that could impact imported water conveyance systems. The development of its diverse resource mix has enhanced the flexibility of Metropolitan's conveyance and distribution system. Metropolitan established criteria for determining emergency storage requirements in the October 1991 Final Environmental Impact Report for the Eastside Reservoir, which is now DVL. These criteria were again discussed in the 1996 IRP. Both of these documents were approved by Metropolitan's Board. Additionally, Metropolitan's emergency storage requirements were summarized in a 2008 Board Report entitled "Water Surplus and Drought Management Plan on water supply and demand as of October 30, 2008."

Emergency storage requirements are based on the potential of a major earthquake causing damage to one or more of the aqueducts that convey Southern California's imported supplies (SWP, CRA, and LAA) into the region. The adopted criteria assume that damage from such an event could render the aqueducts out of service for six months. As a result, Metropolitan has based its planning on a 100 percent reduction in these imported supplies for a period of six months.

Metropolitan's WSDM Plan shortage stages guide Metropolitan's management of available supplies and resources during an emergency to minimize impacts of the catastrophe. This emergency plan outlines that under catastrophic loss of water supply the following actions will be taken:

1. Interruptible water deliveries would be suspended
2. Firm supplies to member agencies would be restricted by a mandatory cutback of 25 percent from normal year retail demand levels
3. Water stored in surface reservoirs and groundwater basins under Metropolitan's program would be made available

4. Full local groundwater production, recycled water, and local surface emergency storage reserve production would be sustained
5. Metropolitan would draw on its emergency storage as well as other available storage

Under the emergency criteria, retail demands would be met through existing surface storage, local production, and storage in surface reservoirs owned and operated by Metropolitan and by DWR. The total amount of storage available for emergency needs in Metropolitan's storage facilities, including DVL, Lake Mathews, and Lake Skinner, is currently 292,100 acre-feet (February 2018). The amount of emergency storage available to Metropolitan in DWR's reservoirs, including Lake Perris, Castaic Lake, Silverwood Lake, and Pyramid Lake, is an additional 334,300 acre-feet (February 2018).

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 development of 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 Southern California to continue water deliveries during the period when imported supply aqueducts are out of service due to damage from a major seismic event. 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.

SECTION 4 ENGINEERING COMPONENT

Metropolitan manages a number of strategies and component studies that evaluate facilities and systems against earthquake hazards. Mitigation options are then developed and executed when practical. These strategies include evaluating the seismic resilience of structures; special seismic assessments that address multiple facilities and systems; and other specialized efforts that address the seismic resilience of dams and reservoirs and the mitigation of geotechnical hazards.

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 in order 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 older structures that were constructed in accordance with earlier codes, and where necessary, to upgrade structures with 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. Additional details are provided in Appendix 6, "Seismic Design Frequently Asked Questions."

Over the past two decades, this effort was primarily aimed at improving the seismic resilience of above-ground facilities and structures constructed prior to 1990. For example, the original pump houses at the five CRA pumping plants were determined to be vulnerable to significant damage in a design-level earthquake. A design-level earthquake is a probable event that is defined by the Building Code as the basis for seismic design of structures. To address this vulnerability, which could have impacted deliveries from the CRA over an extended period, new buttress walls were constructed in 1996.

Construction of new buttress walls at Hinds Pumping Plant

Procedure for Seismic Evaluation of Structures

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 to maximize improvements in seismic resilience of the water delivery system.

Metropolitan's procedure for the seismic evaluation of structures includes the following steps:

1. **Preliminary evaluation of all high-risk structures**

   The preliminary evaluation of existing structures is a high-level assessment to quickly determine if a structure is seismically deficient. Typically, this evaluation involves drawing review, visual inspection, and simplified calculations. If a potential seismic deficiency is identified, the structure is categorized as seismically deficient and the preliminary evaluation is complete.

2. **Prioritization of structures with seismic deficiencies**

   Structures identified as seismically deficient are then prioritized in preparation for a detailed evaluation. Structures built after 1990 were designed and constructed in accordance with the 1988 or later versions of the Uniform Building Code (UBC), which provides reasonable assurance of withstanding a design-level earthquake without catastrophic structural failure. Therefore, structures built before the early 1990's are given priority for the detailed evaluations, with consideration of life safety and the importance of the facility in water deliveries.

3. **Detailed evaluation to develop retrofit options**

   Structures identified with at least one potential seismic deficiency via the preliminary evaluation are thoroughly assessed to confirm any deficiencies. Feasible retrofit options are developed during this step to mitigate the identified deficiencies, and more advanced procedures such as finite element modeling and comprehensive structural calculations may also be applied. The analysis methodology, its results, findings, and recommendations are then summarized in a report that includes rough order-of-magnitude construction costs.

4. **Final retrofit design to strengthen deficient structures**

   The recommendations from the detailed evaluation form the basis for requesting approval from the Board of Directors to proceed with a seismic upgrade project. A project team consisting of design engineers and a project manager considers all feasible retrofit options developed during the detailed evaluation and recommends one option for the final retrofit design. In this process, the project team considers adequacy for seismic resistance, cost, constructability, operational impacts, and environmental impacts to select the preferred option. The selected option is then developed into bidding documents that include detailed design drawings and specifications for the retrofit work.

5. **Periodic reevaluation of strengthened structures**

The seismic design provisions in building codes are constantly evolving, which reflects lessons learned from recent earthquakes and new findings in regional seismicity. Metropolitan periodically re-evaluates its facilities to ensure that system reliability is not compromised due to newly discovered vulnerabilities. Factors that may trigger a re-evaluation of a previously upgraded structure include:

- Substantial increase of seismic hazard level at the site
- New discovery of site seismicity
- New discovery of potential seismic deficiencies in the structure
- Significant deterioration of existing materials in the structure

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 (see **Figure 4-1**). Upgrades of many critical structures have also been completed, including the five pumping plants along the Colorado River Aqueduct, the Jensen Administration Building, and the Lake Mathews Outlet Tower.

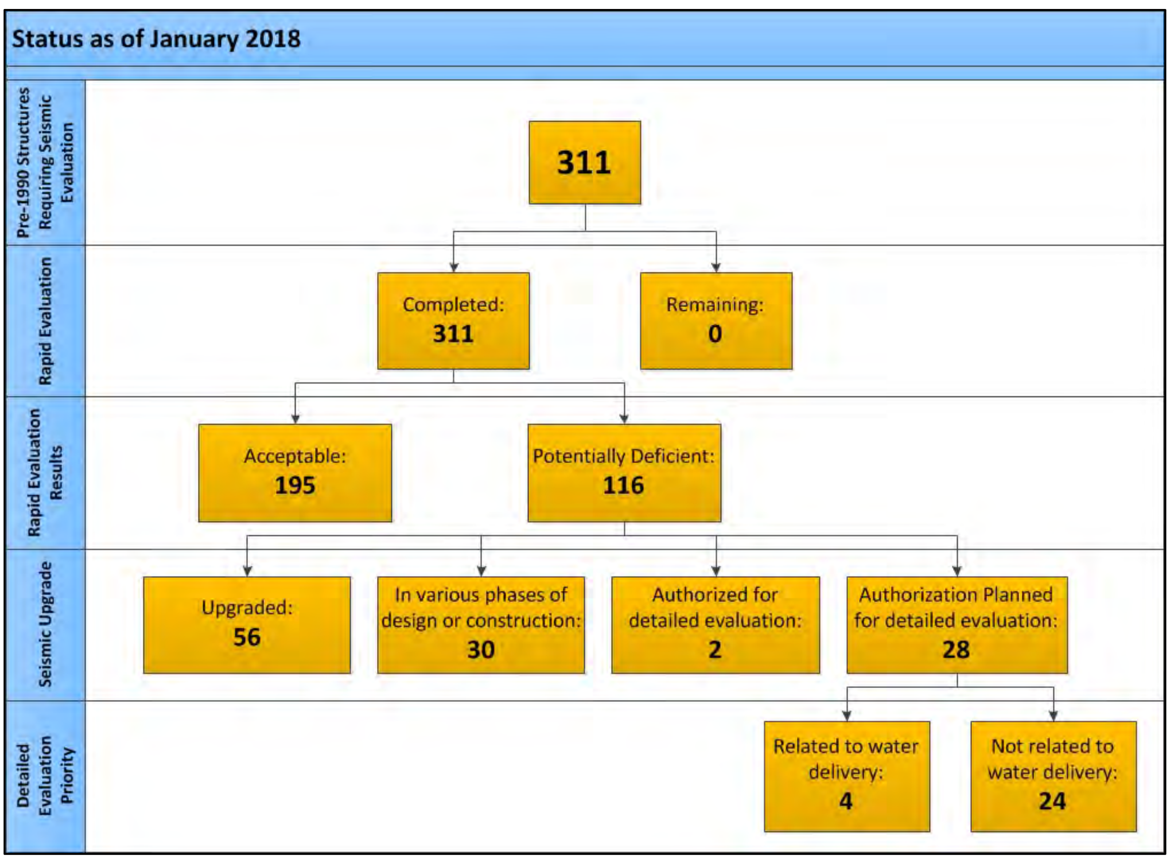


Figure 4-1: Status of Seismic Assessments and Upgrades of Pre-1990 Structures

As shown in the figure, of the 116 structures identified as potentially deficient, 56 have been upgraded and 32 are authorized for study, design or construction. The remaining 28 structures will proceed through Metropolitan's CIP evaluation process to obtain authorization for the detailed evaluations. Since 1998, Metropolitan has invested over $200M in seismic upgrades of its key structures.

Expanded Approach for Achieving Seismic Resilience of 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 UBC1997)

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 an earthquake.

The third item, relating to UBC1997, 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 were 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.

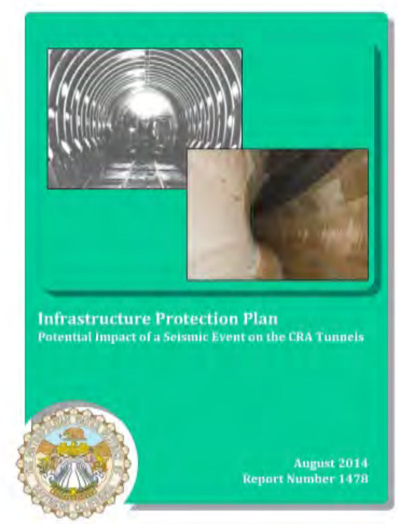
Moving forward, the near-term focus is to complete the detailed evaluations and seismic retrofit projects that have been authorized to date. Long-term goals include:

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

Special Seismic Assessments

Special seismic assessments are performed to complement the original seismic resilience of structures evaluations. These special assessments include seismic vulnerability evaluations, general reliability assessments, and system flexibility studies.

Seismic Vulnerability Evaluations. Seismic vulnerability evaluations identify potential impacts of credible earthquake scenarios on individual facilities and the system as a whole. For these studies, staff review current and readily available seismic hazard data from public, academic, state, and federal sources, as well as input from geotechnical consultants, to screen each facility or system (e.g., the CRA) for its level of exposure to seismic hazards (i.e., surface displacement, ground shaking, liquefaction, and landslides) during a major seismic event. Based on the potential level of exposure and the resulting damage to Metropolitan facilities, the time to restore service are estimated. These studies then evaluate the impact of the damage on Metropolitan's water delivery capability and identify areas with limited backup capability to provide water while the facility is out of service. Improvements that could reduce the loss of service, and/or reduce the time to restore service, are then identified and prioritized.



The 2014 Potential Impact of a Seismic Event on the CRA Tunnels validated historic assumptions regarding potential outage durations for the CRA tunnels.

Findings from these evaluations can lead to capital improvements to strengthen facilities, improve system flexibility, and/or provide input into Metropolitan's emergency response planning to improve the seismic resilience of the distribution system.

To date, Metropolitan has completed over ten seismic vulnerability studies. A few examples are listed below, while a complete list with a brief summary of each study is included in Appendix 7.

- *Seismic Risk Assessment of Local Water Production Facilities in the Service Area of Metropolitan Water District of Southern California,* January 14, 1991, Dames & Moore
- *Probable Maximum Loss Analysis for Metropolitan Water District of Southern California*, September 1998, EQE International
- 2009 Report No. 1335: *Effects of Southern California Seismic Events on Metropolitan Water District Deliveries*
- 2014 Report No. 1490: *Colorado River Aqueduct Seismic Vulnerability Investigations – Summary Report*
- 2017 Report No. 1533: *Seismic Risk Assessment – Conveyance and Distribution System Tunnels*

General Reliability Assessments. The vulnerability of Metropolitan's facilities to damage from major seismic events is also evaluated through general reliability assessments. The objective of these assessments is to examine the vulnerability of facilities to unplanned service interruptions from the following hazards and events:

Seismic activity	Fire
Hydraulic surge	Corrosion
Vehicle impact	Wind-blown projectiles
Equipment malfunction	Third-party construction
Erosion/Scour/Flooding	Vandalism

The assessments are based on compiling data collected from several sources and evaluating the information to identify vulnerabilities that may damage a facility and impact water deliveries. The sources of information include prior reliability studies conducted for the facility; the facility's piping and instrumentation diagrams, electrical single-line drawings and plant layout drawings; interviews with Water System Operations and Engineering Services staff; reviews of corrective maintenance reports, reviews of CIP projects; and field inspections of the facilities.

The general reliability assessments focus on the following when relating to seismic activities:

- Assessing the ability of individual equipment and piping within the facilities to withstand an earthquake
- Reviewing potential soil stability issues that might affect earthquake vulnerability with Metropolitan's geotechnical staff
- Reviewing the ability of existing critical structures (i.e., tanks, treatment basins and pump house buildings) to withstand a seismic event

After identifying potential vulnerabilities to specific hazards and events, staff categorize the vulnerabilities based on the potential service impacts and identify options to mitigate the vulnerability and improve reliability. Mitigation steps include conducting capital projects to rehabilitate, replace, or upgrade equipment and facilities; performing operation and maintenance (O&M) activities for minor equipment modifications; creating procedures for designing, operating or maintaining the facility; and refining Metropolitan's emergency response plan. These options are prioritized based on their potential impact on the operation of the facility and are considered for evaluation and action. The cost and benefit of options that involve capital projects are evaluated through the normal CIP evaluation process.

Metropolitan has completed a total of eight general reliability assessments to date, including assessments of the CRA, all five water treatment plants, the conveyance system, and portions of the distribution system. A few examples are listed below, while a complete list with a brief summary of each study is presented in Appendix 7. As the understanding of earthquake probability and seismic forces continues to increase, these studies will be periodically updated.

- 2006 Report No. 1227: *Distribution System Reliability Assessment*
- 2006 Report No. 1255: *Weymouth Water Treatment Plant Reliability Assessment*
- 2006 Report No. 1297: *Colorado River Aqueduct Reliability Assessment*

System Flexibility Studies. System flexibility studies identify:

1. The impacts of regional facility outages on water deliveries to member agencies
2. Areas with limited flexibility to serve water, which may impact deliveries during an outage
3. Options to improve system flexibility (e.g., interconnections with other agencies, local resource development, or isolation valves).

These studies postulate outages to Metropolitan and DWR facilities, assign a reasonable duration to the outage based on past experience, and then evaluate the impact of the assumed outage on water deliveries through the following steps:

1. Identify service connections affected by an outage
2. Evaluate Metropolitan options to deliver water to the affected service connections

3. Evaluate member agency backup options (e.g., wells, treatment plants, surface storage, interconnections with other agencies) to deliver water to affected service connections
4. Quantify the impact of each outage in terms of loss of retail service to affected service connections, and identify service connections and/or regions with limited or no backup capability
5. Identify options to mitigate the impact of the outage and improve system flexibility to respond to planned and unplanned outages

The results of these studies support member agencies' efforts to improve local system reliability in the event of a planned or unplanned outage of a Metropolitan facility; support joint efforts of Metropolitan and its member agencies in evaluating the reliability benefits of potential projects; and support Metropolitan's efforts to identify options to improve operational flexibility.

Two significant system flexibility studies have been completed to date:

- **System Reliability Study (2006).** This study evaluated the flexibility of Metropolitan's overall distribution system. The study examined the impact of single failures in the system to the ability to deliver water to member agencies and identified existing backup options to deliver water during the outage. Specific types of failures considered in the study included individual facility failures (e.g., the CRA, a treatment plant, a reservoir) and failures in each isolatable segment of the distribution system (e.g., pipelines). Over 250 different postulated events were considered, and the impact on delivery to each service connection was evaluated for each event. The study considered the capabilities both within Metropolitan's system as well as the member agencies' to mitigate impacts of an outage. The study did not, however, consider multiple failures that might be associated with an earthquake, due to the almost unlimited number of combinations of failures that would have to be considered. Metropolitan and member agency discussions regarding this study and local and regional obligations led to a clarification about Administrative Code 4503 "Suspension of Deliveries" that is included in Appendix 8.
- **Mills Water Supply Reliability Study (Report No. 1337).** One of the findings of the 2007 Integrated Area Study was that the supply of raw water to the Mills plant had a lesser degree of redundancy than Metropolitan's other water treatment plants. The Mills Water Supply Reliability Study was undertaken to evaluate conditions that could interrupt the normal raw water supply to the Mills plant, such as earthquakes, and develop options to improve the redundancy and flexibility of supply to the plant.

Seismic Resilience of Dams and Reservoirs

The seismic stability of Metropolitan's dams is safeguarded by a robust and proactive comprehensive dam safety strategy managed by the Safety of Dams Team. The core responsibilities of the Safety of Dams Team are to perform inspections, interpret and analyze collected surveillance and monitoring data, evaluate dam structures and appurtenant works, report the findings, and serve 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, as listed in Table 4-1. There are a total of 24 individual dams/reservoirs, as some of these facilities have multiple dams.

Table 4-1: Current Metropolitan Jurisdictional Dam and Reservoir Facilities

Dam/Reservoir Name	Dam Type
Cajalco Creek Detention Basin	Flood Control
Copper Basin Reservoir	Surface Water Reservoir
Diamond Valley Forebay	Hydraulic Structure
Diamond Valley Lake	Surface Water Reservoir
Diemer Mixing & Settling Basin No. 8	Hydraulic Structure
Diemer Ozone Contactor Basins	Hydraulic Structure
Diemer Treated Water Reservoir	Hydraulic Structure
Garvey Reservoir	Surface Water Reservoir
Gene Wash Reservoir	Surface Water Reservoir
Goodhart Canyon Detention Basin	Flood Control
Lake Mathews	Surface Water Reservoir
Lake Skinner	Surface Water Reservoir
Live Oak Reservoir	Surface Water Reservoir
Mills Reclamation Basin No. 14	Hydraulic Structure
Mills Treated Water Reservoir No. 1	Hydraulic Structure
Mills Treated Water Reservoir No. 2	Hydraulic Structure
Orange County Reservoir	Surface Water Reservoir
Palos Verdes Reservoir	Surface Water Reservoir
Skinner Treated Water Reservoir	Hydraulic Structure
Weymouth Treated Water Reservoir	Hydraulic Structure

Metropolitan's Comprehensive Dam Safety Management Program

Metropolitan's comprehensive dam safety strategy is comprised of six key elements:

1. Regular detailed inspections
2. Surveillance monitoring and performance reporting
3. Cyclical facility assessments
4. Emergency preparedness
5. Inundation map preparation
6. Execution of capital projects

Regular Detailed Inspections

Regular detailed inspections are essential to preserve the integrity of a dam and are necessary for early problem detection and remediation. All Metropolitan dams are regularly inspected by Metropolitan staff at specific intervals using a formal, multilayered process:

- Daily or weekly observations
- Monthly inspections of dam and reservoir facilities with the highest DSOD designated hazard classification, with at least semi-annual inspections of all other facilities
- Detailed mandatory annual inspections conducted in the presence of DSOD staff

Upon completion of the annual DSOD inspections, DSOD prepares and provides a summary inspection report that summarizes their findings and may identify recommended remedial work, which is cataloged as action items that are corrected promptly.

Surveillance Monitoring and Performance Reporting

All Metropolitan dams and reservoirs incorporate instrumentation that measures specific performance parameters such as dam or structural movement, water levels, and seepage, as well as other parameters such as shaking due to earthquakes. Collected data are retained as part of the required annual DSOD inspection report.

In terms of seismic resilience, data from surveillance monitoring and performance reporting contribute to the Cyclic Facility Assessments described below by identifying changes in specific parameters, such as dam or reservoir movement or increased seepage, that may indicate a condition that could affect the ability of the dam or reservoir to withstand an earthquake.

Cyclical Facility Assessments

Cyclic facility assessments were initiated at Metropolitan in 2004 and are generally repeated about every 10 years. These assessments use the most up-to-date data and evaluation criteria to identify potential vulnerabilities in dam embankments, dam structures, foundations, outlet facilities and spillways and develop mitigation options, if necessary. If a potential vulnerability or deficiency is identified, a rehabilitation or remediation project may be included in Metropolitan's CIP.

An example of a facility assessment that evolved into a project under Metropolitan's CIP is the Lake Mathews Outlet Tower. The outlet tower, which is critical for water deliveries to a large portion of Metropolitan's service area, was constructed in 1938 and modified in 1961 to increase its height by 30 feet. A facility assessment conducted in 1994 determined that the modified tower was vulnerable to significant damage from ground shaking. A project was authorized to evaluate and address this vulnerability, resulting in a new seismically resilient Outlet Tower being constructed in 2005.

New and Old Outlet Towers at Lake Mathews (2008)

Emergency Preparedness

Metropolitan has a comprehensive Emergency Action Plan (EAP) for each of its dam and reservoir facilities. The EAP identifies potential emergency conditions that could occur at a dam or reservoir facility and describes procedures to be implemented to minimize loss of life and property damage. EAPs serve to provide guidance to responders, local agencies, and stakeholders in evaluating potential hazards, determining the severity of the emergency, and establishing communication protocols. Required content of dam EAPs are provided in the Federal Emergency Management Agency's (FEMA) Federal Guidelines for Dam Safety, Emergency Action Planning for Dams (FEMA 64, July 2013).

Inundation Map Preparation

Inundation maps illustrate worst-case flooding that would result in the complete draining of a full reservoir. Inundation maps show lateral and longitudinal extent of flooding, flood wave arrival times, maximum flood wave depths, total flooding duration, and peak flood flow rates. Inundation maps are a required component of dam and reservoir EAPs and are used by local emergency response agencies for emergency planning purposes.

Metropolitan's current cycle of inundation mapping updates is planned to be completed by 2018 for all dam and reservoir facilities.

Execution of Capital Projects

Dam and reservoir facility vulnerabilities or deficiencies that are identified during detailed inspections or from cyclical assessments are proposed for rehabilitation or remediation through Metropolitan's CIP. Past examples of facility rehabilitation or remediation projects include the Lake Mathews Outlet Facilities, described earlier, and the Seismic Upgrade of the Diemer Finished Water Reservoir.

Currently, several dam and reservoir related capital projects are in progress, including the final design of the outlet valve replacements at Copper Basin and Gene Wash Reservoirs and the construction of the Palos Verdes Reservoir floating cover replacement and tower seismic upgrades. Planned future projects include floating cover replacements and facility upgrades for the Mills Finished Water Reservoir Nos. 1 and 2 and Garvey Reservoir.

Pipeline Seismic Resilience

Metropolitan's pipelines are exposed to a number of geohazards of varying risk, including fault zone crossings, permanent ground deformation from causes such as liquefaction or landslides, and ground shaking during seismic events. While Metropolitan's pipelines have always been constructed in conformance with standards of practice at the time of design, there haven't been code requirements to address seismic risk. In addition, until recently, there have not been mitigation options for large diameter pipelines.

The photograph on the left shows a pipe joint pullout due to liquefaction from 1995 in Kobe, Japan. (photo courtesy of D. Ballantyne, *Understanding the Seismic Vulnerability of Water Systems*, Regional Water Providers Consortium Board, October 2013)

The photograph on the right shows pipe damage at a fault crossing (photo courtesy of D. Ballantyne, *Understanding the Seismic Vulnerability of Water Systems*, Regional Water Providers Consortium Board, October 2013)

There are currently several seismic resistant pipeline options, such as earthquake resistant ductile iron pipelines with special seismic resistant joints (see **Figure 4-2**), that are becoming available in diameters suitable for use by Metropolitan.

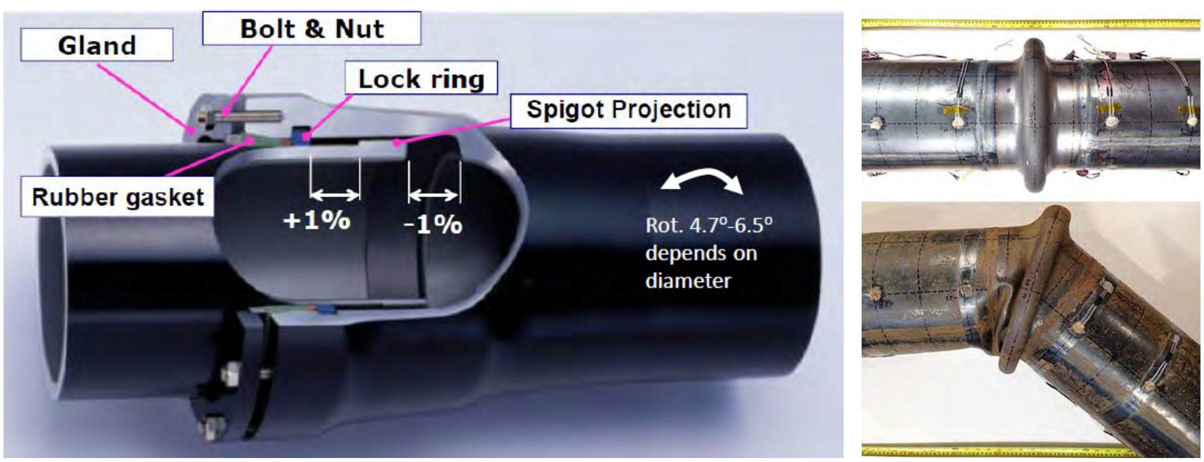


Figure 4-2: Example of Seismic Resistant Pipe (courtesy of Kubota Corp. and JFE)

As mentioned previously, Metropolitan is now formalizing a strategy to achieve significant improvements in seismic resistance of the distribution system over time. This approach takes advantage of up-to-date seismicity data, modern computer modeling techniques, recently developed seismic resistant products, extensive industry research, and updated codes.

The seismic resilience strategy for pipelines has three components:

1. Part 1 – Conducting vulnerability assessments of the existing distribution system
2. Part 2 – Identifying potential mitigation measures for existing pipelines
3. Part 3 – Establishing design and performance criteria for new pipelines and rehabilitation projects

Parts 1 and 2 are described below in more detail. Part 3 for new pipelines will be developed in conjunction with several new large-diameter pipeline projects that are planned over the next 5 to 10 years.

Part 1 –Vulnerability Assessment of Existing Pipelines: Due to the relatively good performance of large-diameter pipelines within Metropolitan's distribution system during previous earthquakes, Metropolitan is focusing on the most vulnerable existing pipelines to establish the need and priority of future mitigation work as well as integrating seismic mitigation into planned rehabilitation programs for aging pipelines. This approach is currently being followed for the PCCP Rehabilitation Program. It is anticipated that there will be relatively few cases where it would be considered cost-effective to upgrade a pipeline solely to enhance seismic resilience.

Vulnerability assessments of pipelines within the distribution system follow the same multi-step approach used for traditional risk assessments. The initial steps entail gathering available geologic, seismologic, and geodetic data, and then identifying seismic hazards along a pipeline route, such as fault zone crossings, liquefaction zones, and landslide hazards. Three simulated earthquake scenarios are considered in the evaluation: a frequent seismic event, moderate event, and a severe event. The hazard assessment provides a bounded solution that includes the expected probable and maximum probable damage for each earthquake scenario.

The resulting damage to the pipeline due to the three design seismic scenarios provides an insight into the corresponding consequences of disruption. These consequences include life-safety impacts, delivery impacts, and societal/environmental impacts.

Preliminary screening is then performed to identify the most vulnerable pipelines that warrant further analysis. Depending on the nature of the seismic hazard, Metropolitan may perform a preliminary assessment using a simplified analysis based on probable ground strain and pipeline material properties. However, in some cases, a more detailed finite element model is required to fully determine the behavior of the pipe and the surrounding support strata under seismic shaking. This comprehensive analysis includes soil-structure interaction, rupture modeling, and permanent pipeline deformation.

For any pipelines that do not meet the performance objectives, mitigation measures are considered. The order and timing of projects to mitigate risks as part of the overall rehabilitation strategy are evaluated and prioritized for inclusion in Metropolitan's CIP.

Part 2 – Mitigation Measures for Existing Pipelines: Where mitigation is recommended to minimize the consequences of service disruption, the general design goals are to design pipe segments and joints that can withstand projected vertical and horizontal movement. In most cases, a simplified analysis will provide sufficient insight into seismic performance; however, in some cases, it may be necessary to analyze the pipeline and connecting structures using a more comprehensive computer model.

Existing continuous welded steel pipe with adequate wall thickness and joint welds typically perform well under significant ground shaking. Where mitigation of existing pipelines is required to achieve acceptable seismic performance, Metropolitan may use specialized earthquake resistant joints as an option. Where these joints cannot achieve acceptable seismic performance, other options may include stiffening of the joints and pipe section; and enlarged vault sections to isolate the pipe from maximum ground deformation. Metropolitan may also evaluate alternate alignment options to relocate existing pipes, if feasible, to avoid areas of known fault crossings or expected permanent ground deformation that may result in significant disruption. Where these options are not feasible and seismic risk is not within acceptable limits, Metropolitan may consider installation of isolation valves or addition of a vault with a removable pipe spool to allow quick insertion of a bulkhead to facilitate shutdown and repair of the damaged section of pipe

Part 3 – Design Guidelines for New Pipelines: The guidelines for new pipelines will be similar in concept to existing pipelines and will be developed in conjunction with several new large-diameter pipeline projects that are planned over the next 5 to 10 years.

SECTION 5 OPERATIONS COMPONENT

Metropolitan is prepared to respond to all types of emergencies through its Emergency Management and Business Continuity Operating Policy A-06. Key elements of this policy include IT Disaster Recovery, Business Continuity and Emergency Response functions. This section focuses on the Emergency Response functions due to specific steps in this area that pertain to seismic resilience.

Emergency Response Organization

Metropolitan maintains a dedicated Emergency Operations Center (EOC) that can be activated at any time to manage Metropolitan's response to a large disaster, including seismic events. The EOC is equipped with multiple modes of communication and coordinates directly with Metropolitan's Operations Control Center (OCC) and Security Watch Center (SWC), as well as with numerous external agencies. For example, the EOC would coordinate with DWR and LADWP, as well as other related agencies, in the event of one or more aqueducts being damaged by an earthquake on the San Andreas Fault, as further explained in the next section.

Metropolitan also has Incident Command Centers (ICCs) located at various facilities. These ICCs can also be activated at any time to manage localized emergencies, and will coordinate directly with the EOC during a major disaster. Metropolitan also has Damage Assessment Teams (DATs) that that can be called upon by the ICCs to conduct investigations at incident sites. The DATs consist of engineers who can assess damage and initiate engineering responses, including recommendations for short-term repairs or work-arounds and potential designs for permanent, long-term repairs.

The Emergency Response Organization (ERO), illustrated in **Figure 5-1**, is comprised of over 200 pre-designated employees who work in the EOC, the ICCs, or in the field during emergencies. ERO staff has completed specialized training that meets State and Federal requirements.

Metropolitan's emergency response structure follows the National Incident Management System (NIMS) and the State of California's Standardized Emergency Management System (SEMS).

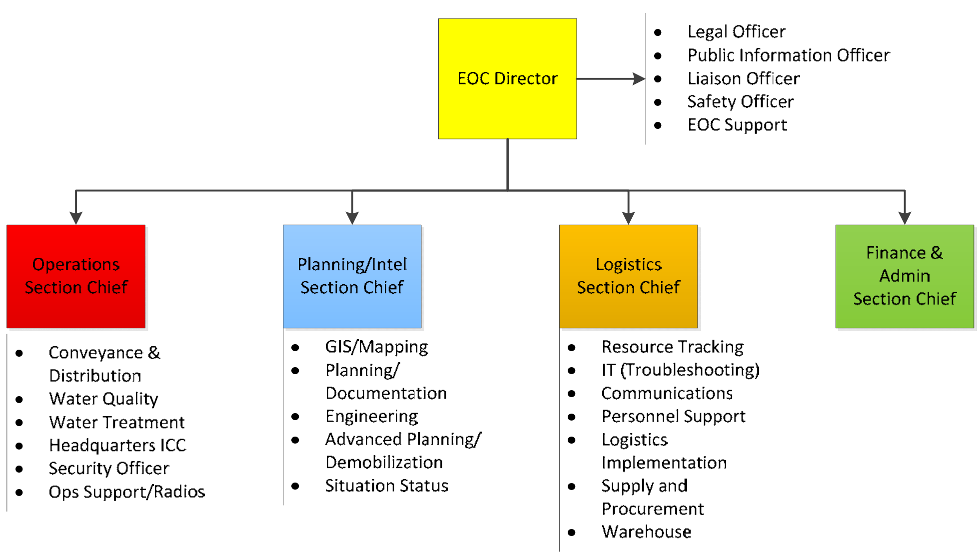


Figure 5-1: Metropolitan's Emergency Response Organization

Photographs from recent emergency exercises at the EOC

Emergency Response Training Exercises

In addition to training emergency response staff on NIMS procedures, Metropolitan regularly conducts emergency response training exercises which have often been based upon a postulated seismic event. Examples include:

- “Resilient Grid“ Functional Exercise, 19 Oct 2017
- “Can you hear me now?” Full Scale Communications Exercise, 08 Apr 2017
- “Desert Shake” Functional Exercise – 04 Nov 2015 (Metropolitan and seven other agencies)
- “Oh Susana!” Functional Exercise – 05 Nov, 2013 (Metropolitan and four other agencies)
- “Golden Guardian” Functional Exercise – 20 Jun 2012
- “California Rolling” Mini Functional Exercise – 08 Oct 2008
- “Hollywood Havoc” Functional Exercise – 04 April 2007
- “Mayhem at Mathews” Tabletop Exercise – 15 Mar 2006 (Metropolitan and four other agencies)

In 2017, Metropolitan completed a five-year exercise plan that allowed all of its member agencies to participate in at least one of Metropolitan’s annual emergency exercises during that period. Metropolitan also conducts approximately 50 tabletop and functional exercises each year. This includes three large-scale emergency exercises per year for the EOC and for each of the 12 ICCs. There are also monthly communication drills (includes Member Agency Response System (MARS) two-way radio, internal Metropolitan radio system, WebEOC updates, mass notification system, and satellite phones) with member agencies, ICCs, Treatment Plant Control Centers, and DWR facilities. These regular exercises, as well as monthly radio and communications tests with member agencies and other outside agencies, help Metropolitan to continually improve its readiness.

Emergency Response Construction Capabilities

Metropolitan maintains the capability to perform rapid repair of damaged facilities such as large pipelines for up to two simultaneous repairs. The machine, fabrication, coating, and valve shops at the La Verne

Shops are used extensively to support system-wide maintenance; to provide emergency services within Metropolitan, for member agencies, and for DWR; and to perform fee-for-service work that supports member agencies and the State Water Project. The fabrication shop can roll pipe on a 24-hour-per-day basis. In 2015, Metropolitan expanded the La Verne Shops to enable the fabrication of two pipe sections up to 12 feet (3.7 meters) in diameter simultaneously, and has been developing standardized pipeline repair drawings and shoring drawings to expedite repair operations.

Metropolitan also maintains stockpiles and materials on hand, and has its own construction equipment and crews ready to mobilize if necessary. Pre-selected urgent repair contractors can also provide additional construction support in case of an emergency. 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.

Pipe being rolled at Metropolitan's La Verne Shops

Metropolitan construction crews

42" x 30" adapter flange being drilled at Metropolitan's La Verne Shops

Stocks of steel plate allow Metropolitan to roll pipe of various diameters and wall thicknesses

SECTION 6 REPORTING COMPONENT

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 Biennial Report

Record Keeping

The Record Keeping component involves tracking progress on key seismic activities and maintaining a detailed record of all investments and expenditures related to seismic upgrade projects.

Key seismic resilience activities include the planning, engineering, operations, and Task Force component near-term goals identified in Section 8. Specific activities include:

- Special planning studies related to seismic resilience
- Seismic evaluations of structures, facilities, and regions
- Designs for seismically upgrading structures/systems and related construction activities
- Emergency response training exercises
- Development of new seismic performance objectives
- Joint efforts with external agencies through the Task Force

For each of these activities, progress will be tracked and reported on at regular intervals. In addition, the cumulative cost of capital investments in seismic upgrade projects will be tracked and reported on annually.

Annual Updates

Staff will update Metropolitan's Board of Directors on an annual basis. The annual update will focus on current seismic resilience issues, recent Metropolitan and Task Force accomplishments, and near-term goals.

Formal Reporting

The biennial report will summarize seismic resilience objectives, goals, and accomplishments; consolidate key reference material; and provide a high-level summary of the various activities related to seismic resilience throughout Metropolitan. Specific areas of emphasis will include:

- Knowledge Transfer: The biennial 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 will be updated every two years.

SECTION 7 SEISMIC RESILIENCE WATER SUPPLY TASK FORCE

The City of Los Angeles has recently increased its focus on seismic risks and public safety. In December 2014, the city released the report, "Resilience by Design," which highlighted Los Angeles' earthquake vulnerabilities and laid out strategies to protect lives; improve the capacity of the city to respond to earthquakes; prepare the city to recover quickly from earthquakes; and protect the economy of Los Angeles and all of Southern California.

A concern noted in "Resilience by Design" is the importance of water infrastructure and the unique dependence of the region upon imported water supplies, all of which cross the San Andreas Fault. The report included a recommendation to fortify the imported water aqueducts by creating a Seismic Resilience Water Supply Task Force (Task Force) with the LADWP, Metropolitan, and DWR.

In August 2015, the three agencies formed the Task Force for the purpose of collaborating on studies and mitigation measures to improve the seismic resilience of imported water supplies to Southern California. The Task Force is comprised of managers and staff from the planning, engineering, and operations functional groups of each agency, and includes executive management on a steering committee. The Task Force also coordinates with other agencies and utilities.

The Task Force created a structure (**Figure 7-1**) that includes functional sub-teams that will focus on aqueduct assessments and mitigation, emergency response, and public relations in the near-term. The Task Force also recognized the benefit of long-term collaboration regarding 'non-aqueduct' assessments and mitigation, and agreed to discuss such issues as they arise.

The initial Task Force goals include:

- Establishing a common understanding about individual agency aqueduct seismic vulnerability assessments, projected damage scenarios, and planning assumptions
- Revisiting historical assumptions regarding potential aqueduct outages due to seismic events
- Discussing opportunities for improving the seismic resiliency of Southern California's imported water supplies through multi-agency cooperation

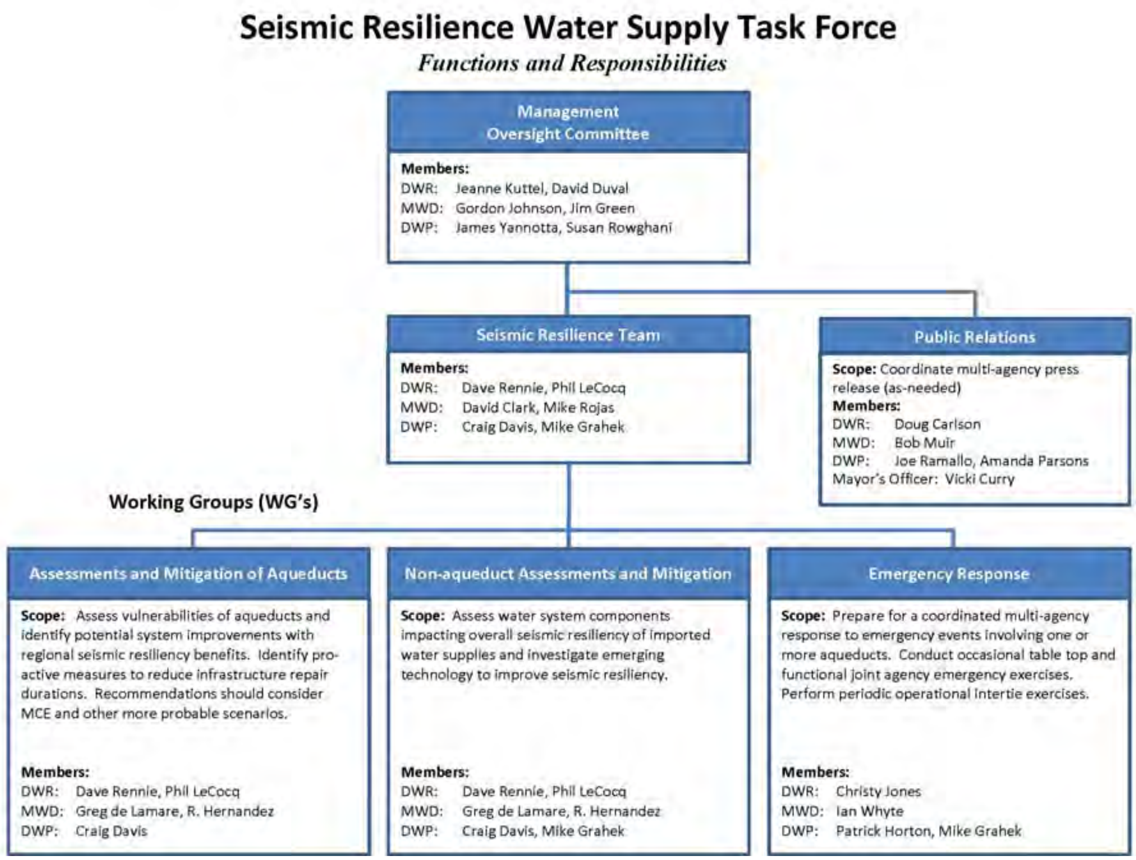


Figure 7-1: Seismic Resilience Water Supply Task Force

One of the initial activities for the Task Force was to conduct a workshop that would allow the three agencies to establish a common understanding about each agency's seismic vulnerabilities; revisit historical planning assumptions; and identify action items that would lead to increased seismic resilience moving forward. The workshop is summarized below.

2016 Aqueduct Workshop

On March 30, 2016, the Task Force held an Aqueduct Workshop at Metropolitan's Headquarters Building in Los Angeles. The purpose of this workshop was to discuss potential damage to Southern California's imported water aqueducts from a major seismic event on the San Andreas Fault. The discussion focused specifically on the Great Southern California ShakeOut Scenario (ShakeOut) of a M7.8 earthquake, developed by the U.S. Geological Survey (USGS) and many partners. The workshop format allowed for a candid exchange of information and ideas between staff from the three agencies, along with LADWP's Seismic Resilience and Sustainability Program's Expert Panel that included experts from industry and academia.

Participants were asked to consider preparations for, and response to, the ShakeOut Scenario from a regional perspective. Specifically, participants were asked, "If all aqueducts were owned and operated by a single agency, then what steps should be taken now to mitigate potential damage, and what would the priority of repairs be following a major seismic event to most rapidly restore imported water deliveries to the region?" This focus on actions that would best serve the region led to productive discussions and practical recommendations for the three agencies to improve the resilience of imported water supplies.

The assembled team concluded that for a M7.8 ShakeOut Scenario event on the southern portion of the San Andreas Fault, the recovery times would exceed historic planning assumptions:

- Restoration of full aqueduct capacities could take more than six months
- Restoration of partial aqueduct flows could take at least two months

The March 30, 2016 Task Force Workshop at Metropolitan's Headquarters Building

When considering this specific scenario from a regional perspective, the participants concluded that residents within Metropolitan's service area would be best served if the three agencies:

- Implement recently identified mitigation projects on the Colorado River Aqueduct and Los Angeles Aqueduct
- Prioritize known vulnerabilities on the Colorado River Aqueduct, Los Angeles Aqueduct, and the State Water Project
- Execute an agreement to allow for a coordinated response to emergency events
- Share resources when responding to emergency events
- Focus initial repair efforts on the State Water Project's West Branch and the Colorado River Aqueduct*

(*This is based on a ShakeOut-type event; it is recognized DWR will also have a priority to serve other customers on the East Branch)

LADWP's Seismic Resilience and Sustainability Program's Expert Panel noted the significance of the nation's largest municipal utility, largest water wholesaler, and largest state-owned water agency joining together to address a major hazard for the first time, and encouraged the Task Force to continue working together long into the future. The assembled team agreed that Southern California could become better prepared for seismic events and that the Task Force should continue to facilitate coordinated vulnerability assessments, evaluate mitigation options, and develop agreements that allow coordinated emergency responses to major seismic events. It was clear that common issues could be studied more efficiently together and there was a consensus for the Task Force to continue to maintain the momentum achieved through this workshop. Although the regional challenge of achieving a greater level of seismic resiliency is significant, the consensus was that it would be achievable through the continued, dedicated efforts of the Task Force.

Future Task Force Activities

To continue the momentum built during the collaborative workshop, the Task Force agreed to conduct conference calls every two months and to initiate a repeating 5-year cycle of planning, executing, and reporting on collaborative goals, activities and accomplishments. This approach is aimed at providing effective management of long-range actions and ensuring task force stability.

The first cycle has included preparation of a detailed report that summarized the 2016 Workshop and identified goals for the period between April 2017 and March 2022. The second cycle will report on progress achieved between 2017 and 2022, and will identify goals for the period between 2022 to 2027.

The high-level goals for 2018 to 2019 are included in Section 8 of this report.

SECTION 8 SEISMIC RESILIENCE PERFORMANCE OBJECTIVES AND NEAR-TERM GOALS

This section summarizes Metropolitan's established performance objectives for the various components of seismic resilience, along with corresponding near-term goals. The goals listed are those that are anticipated to be completed in calendar years 2018 and 2019.

Established Performance Objectives and Near-Term Goals:

- System Level
- Facility Level
- Emergency Response
- Task Force

Other Near-term Goals:

- Establish Additional Performance Objectives
- Develop a Standard Approach for Evaluating Non-Structural Elements
- Enhance Member Agency Planning Efforts
- Seek Funding for Identified Projects
- Support California WaterFix

Established Performance Objectives and Near-Term Goals

Seismic resilience performance objectives are summarized in this section along with the corresponding near-term goals.

System Level

System-level seismic resilience performance objectives and near-term goals focus on two areas: System Flexibility and Regional Supply Interruption/Emergency Storage.

System Flexibility

There are two primary components of system flexibility that contribute to seismic resilience:

1. Operational flexibility - the ability to accommodate short-term changes in regional supply, water quality, or member agency demands, and
2. Delivery flexibility - the ability to maintain deliveries to member agencies during single regional facility planned or unplanned outages.

Metropolitan will continue to develop a demand-driven, flexible regional system aimed at meeting demands, while reducing the impacts of regional infrastructure outages. Regional delivery flexibility improvements will be achieved through demand-driven projects.

System Flexibility Goal	
2019 Goal:	Conduct Rialto Pipeline Alternative Supply Needs study
This study will identify potential near-term and long-term options to meet municipal and industrial (M&I) demands supplied exclusively from the Rialto Pipeline system in the event of a disruption of supplies from the California Aqueduct, East Branch.	

Emergency Storage

Performance Objectives: Metropolitan's objectives for emergency storage include maintaining a six-month supply of water to account for interruption of imported water supplies (assuming a 25% reduction at the retail level).

Emergency Storage Goals	
2019 Goal:	Complete a re-evaluation of Metropolitan's emergency storage needs
This study will re-evaluate Metropolitan's emergency storage requirement based on updated assumptions on potential outage durations for the State Water Project and the Los Angeles Aqueduct. The latest projections for the worst case scenario are that Metropolitan's Colorado River Aqueduct can be repaired within 6 months, LADWP's Los Angeles Aqueduct within about 18 months, the West Branch of the SWP within 6-12 months and the East Branch of the SWP within 12-24 months.	
2019 Goal:	Complete a comprehensive evaluation of Metropolitan's storage programs
This comprehensive evaluation will review all existing storage programs within Metropolitan	

Facility Level

Facility-level seismic resilience performance objectives and near-term goals are categorized based on functionality of facilities: essential facilities related to water delivery; supporting facilities with permanent staff, such as administration buildings; and supporting facilities without permanent staff, such as warehouse facilities.

Essential Facilities (related to water delivery)

Performance Objectives: Performance objectives for essential facilities include maintaining operation with minimum interruption after design-level events and controlling structural damage to facilitate recovery after extreme events.

Essential Facility Goals	
Goal 1:	Complete construction of approved seismic upgrade projects
• Carbon Creek Pressure Control Structure (2018) • Ten Control Structures along the Allen McColloch Pipeline (2018) • Diemer Administration (Control) Building (2019) • Five CRA Pumping Plant Switch Houses (2019)	
Goal 2:	Conduct studies, and complete design of approved upgrade projects
• Define the scope and approach for assessing potential seismic-induced damage to Metropolitan's water conveyance and distribution pipelines (2018) - The purpose of the damage assessment is to estimate the number and severity of pipeline breaks and leaks during major earthquakes, and identify pipelines with the greatest risk for seismic damage. The results of the study will provide input into Metropolitan's emergency response planning activities, and will help prioritize future pipeline seismic resilience enhancements. • Design of seismic upgrade for Weymouth West Wash Water Tank (2018) • Design of seismic upgrade for Diemer West Filter Building (2018) • Complete evaluation of options, design, and award of construction contract to strengthen the CRA Whitewater Tunnel No. 2 (2019) - This work will include strengthening shallow tunnel sections near the portals, improving tunnel access at the west portal, prequalifying tunnel repair contractors, stockpiling steel sets, and pre-designing tunnel repair elements. • Investigate options to improve emergency raw water bypass capabilities at Skinner, Weymouth, Jensen and Mills Water Treatment plants (2019) • Vulnerability study of CRA electric transmission and distribution systems (2019) • Design of seismic upgrade for the original portion of the Water Quality Lab in La Verne and the Weymouth Administration Building (2019)	

Supporting Facilities with Permanent Staff

Performance Objectives: Performance objectives for support facilities with permanently assigned staff include controlling structural damage to prevent casualties and severe injuries under design-level events and maintaining structural stability to prevent catastrophic collapse under extreme events.

Supporting Facilities (with permanent staff) Goals	
Goal 1:	Expedite construction of approved seismic upgrade projects
• Headquarters Building seismic upgrades (award construction contract in 2018)	
Goal 2:	Complete approved studies and seismic upgrade designs
• Seismic upgrade to Field Engineering Building at La Verne (2019)	

Supporting Facilities without Permanent Staff

Objectives: Performance objectives for support facilities without permanently assigned staff include controlling structural damage to facilitate recovery after design-level events and maintaining structural stability to prevent catastrophic collapse under extreme events.

Goals: Metropolitan's near-term goal for improving the seismic resilience of support facilities without permanently assigned staff is to continue exploring opportunities of integrating seismic upgrade work of these relatively minor structures with future capital projects at the facility. At this time, no specific goals have been identified in this area.

Emergency Response

Objectives: Metropolitan's objective is to maintain an effective emergency response organization and support facilities to ensure Metropolitan is prepared to respond to significant earthquakes. Regular training is conducted to ensure staff is prepared for actual events. Metropolitan maintains shop and construction crew capabilities to complete the repair of two simultaneous large diameter pipeline breaks within seven days. This capability is augmented by Metropolitan's ability to re-deploy its contractors and to call upon other agreements to repair four additional large diameter pipe breaks simultaneously within seven days (as well as repair other facility damages). These capabilities ensure Metropolitan is prepared to respond to significant earthquakes.

Emergency Response Goals	
Goal 1:	Prepare and conduct emergency exercises
• Conduct a joint agency workshop to prepare a draft Joint Agency Response Plan (2018) • Conduct high-level training for DWR, LADWP, and MWD staff on the Joint Agency Response Plan (2019) • Run a functional exercise on the Joint Agency Response Plan (2019)	
Goal 2:	Execute a MOU to allow for a coordinated emergency response
• Prepare draft MOU and submit for review (2018) • Secure LADWP, Metropolitan, and DWR approval for the MOU (2019)	

Task Force

Task Force Goals	
2018 Goals:	Collaborative LADWP, Metropolitan, and DWR Goals
• Discuss the applicability of lessons learned from seismic events in Japan, Chile, New Zealand, and Mexico • Compare each agency's approach to conducting seismic assessments • Meet with Southern California Edison (SCE) and Southern California Gas Co. to discuss the potential vulnerabilities of aqueduct power systems • Conduct workshop to explore potential aqueduct interties	
2019 Goals:	Collaborative LADWP, Metropolitan, and DWR Goals
• Establish a leadership structure for a coordinated response to major events • Finalize a three-agency database of available emergency response resources • Conduct a three-agency table top emergency exercise • Develop a ShakeOut Scenario Response and Restoration Plan • Conduct a second three-agency functional emergency exercise that includes energy utilities	

Other Near-Term Goals

Additional seismic resilience goals Metropolitan plans on achieving during 2018 and 2019 include:

1. **Develop a Standard Approach for Evaluating Non-Structural Elements (2019)**

   The Seismic Upgrade Program was expanded from its focus on pre-1990 above-ground structures to include post-1990 structures, partially buried structures, and non-structural components in essential facilities. The existing approach to evaluating pre-1990 structures is also applicable to the post-1990 and partially buried structures. However, a standard approach needs to be developed for evaluating the non-structural components within existing facilities, which involves equipment anchorages and bracing for piping, ducts, and cable trays.

2. **Establish Additional Performance Objectives (2019)**

   Metropolitan intends to establish seismic resilience performance objectives in the following areas:

   a) New pipelines

   b) Retrofit of existing Metropolitan pipelines, typically concurrent with rehabilitation projects

   c) New and existing tunnels

   Metropolitan is now in the process of developing a more comprehensive strategy for incorporating seismic mitigation into the design of its pipelines and tunnels. Although it is possible to clearly define performance objectives for above-ground structures, this process is more complicated for pipelines and tunnels for two reasons: 1) The performance of a pipeline or tunnel subjected to seismic forces is less well-defined than with structures, and 2) The performance needs of specific pipelines, pipeline segments, or tunnels vary widely due to Metropolitan’s supply flexibility and the varied reliance on imported water by member agencies. Metropolitan will explore these issues in greater detail as it moves ahead with major capital programs, including the PCCP Rehabilitation Program. It is expected that by December 2019, Metropolitan will have established an approach for addressing seismic vulnerabilities during pipeline and tunnel rehabilitation projects, and for new pipeline and tunnel design efforts.

3. **Investigate the Potential for Developing a Model to Prioritize Pipeline Rehabilitation (2019)**

   The prioritization model will seek to optimize the sequence of pipeline repairs to achieve the greatest risk reduction for every dollar invested. The prioritization model would take into account multiple risk factors including seismic risk exposure, pipeline condition, consequence of failure in terms of damage to key facilities (e.g., hospital), difficulty of repairs, system flexibility, and cost of repairs.

4. **Enhance Member Agency Planning Efforts (2019)**

   Development of the following documents will support member agency planning efforts regarding new facilities and emergency response programs:

   a) Summary of seismic performance objectives by facility class; examples of recent seismic upgrade projects; and identification of open items

   b) Summary of projected outage durations for Metropolitan facilities under "Operational", "Design", and "MCE" earthquake scenarios

5. **Seek Approval for Detailed Seismic Studies (Ongoing)**

   Under the ongoing Seismic Upgrade Program, Metropolitan will assess the options for seismic upgrades to 28 structures identified as seismically deficient. These projects will be considered for inclusion in Metropolitan's Capital Investment Plan.

6. **Support California Water Fix (Ongoing)**

   Metropolitan will continue supporting the California WaterFix to increase seismic resilience of the Bay-Delta portion of the State Water Project.

Appendix 1

Key Seismic Resilience Achievements

This page intentionally blank.

Metropolitan has made significant improvements in the overall seismic resilience of its water system over the past few decades. These achievements include:

1971	Earthquake Committee formed to assess damage and recommend improvements
1976	Metropolitan's Emergency Response Plan formally adopted
1983	Member Agency Response System (MARS) established
1993	Incident Command Centers (ICCs) established at each treatment plant and a formal engineering response chart adopted for the Damage Assessment Teams (DATs)
1995	Formal Business Resumption Plan developed
1996	Seismic upgrade of CRA Pump Houses completed
1999	Construction of Diamond Valley Lake completed
2004	South slope stability improvements completed at Diemer
2005	Construction of new Lake Mathews Tower completed
2010	Jensen Administration Building seismic upgrade completed
2010	Construction of the Inland Feeder completed
2011	Seismic upgrade of Mills Electrical Buildings 1 & 2 completed
2013	Seismic upgrade of Diemer Finish Water Reservoir completed
2013	Diemer East Wash Water Tank seismic upgrade completed
2014	Seismic upgrade of Weymouth Filter Buildings 1 and 2 completed
2014	CRA seismic assessment confirmed historical assumptions for duration of worst-case outage of the CRA
2015	Seismic upgrade of Jensen Washwater Tanks 1 & 2 completed
2015	Seismic upgrade of Weymouth East Wash Water Tank completed
2015	Task Force formed to enhance seismic resilience of imported water supplies
2017	Seismic upgrade of Diemer East Filter Building completed

Note: Metropolitan has invested over $250M in seismic upgrade projects since 1998.

The California Department of Water Resources has also taken steps to improve the seismic resilience of Southern California's imported water systems, including:

1997	Construction of new Outlet Tower at Silverwood Lake completed
2018	Lake Perris Dam improvements completed

This page intentionally blank.

Appendix 2

Modern Era Earthquakes over M6.3 Within or Near Metropolitan's Primary Service Area

This page intentionally blank.

Southern California has experienced at least six earthquakes within or near Metropolitan's service area and with magnitudes greater than M6.3 during the past hundred years.

Date	Event Location	Fault	Magnitude
April 21, 1918	San Jacinto	San Jacinto	6.7
Mar. 10, 1933	Long Beach	Newport-Inglewood	6.4
Feb. 9, 1971	San Fernando	Sierra Madre	6.5
June 28, 1992	Landers	San Andreas	7.3
Jan. 17, 1994	Northridge	Northridge Thrust	6.7
Oct, 16, 1999	Hector Mine	Lavic Lake Fault	7.1

This page intentionally blank.

Appendix 3

Provision for CRA Uplift

This page intentionally blank.

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

COLORADO RIVER AQUEDUCT

TECTONIC ALLOWANCE ORIGINAL INTENTION INVESTIGATION

1 March 2016

Purpose and Objective

Historic documents have mentioned that the designers of the Colorado River Aqueduct (CRA) incorporated "measures in their engineering designs to minimize the impacts on the flow through the CRA due to future vertical displacements across the key fault traces mapped at that time. **The measures included an additional 0.8 m (2.5 ft) of drop beyond that required by siphon losses at… three fault crossings**" (Report 1484). "In each siphon [Big Morongo and San Andreas] approximately 2.5 feet of additional grade was allowed to provide for adjustment in slope if future movement should occur" (Contract Number 149).

Figure 1 shows the location of each of the siphons in question.

Figure 1
Overview Map

The question was raised regarding the specifics of how this was accomplished. This document will describe investigation into whether this allowance was incorporated, the mechanism by which this allowance was included, summarize historical records suggesting such an allowance, and recommend field investigations which can confirm this analysis.

Observances of Tectonic Allowance

Record drawings for the Colorado River Aqueduct were explored to identify any occurrences or explanation for design Hydraulic Grade Line (HGL) at the Big Morongo Siphon, San Andreas Siphon and Casa Loma Siphon. The first observance of the allowance is found in the hydraulic profiles prepared as a part of the original record drawings of the Colorado River Aqueduct in 1935. Selected copies are included at the end of this document.

A discontinuity is observed in the HGL, dropping by a notated 2.5 feet at the beginning of the Big Morongo Siphon, San Andreas Siphon, and Casa Loma Siphon. The HGL is highlighted in red on Figure 1, with the 2.5-foot drop circled.

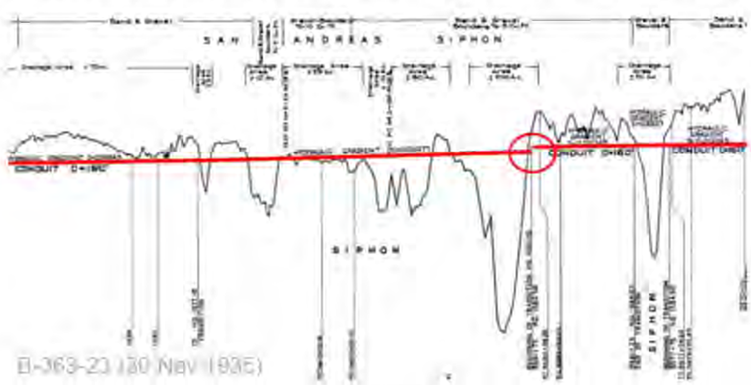


Figure 1
Original 1935 San Andreas Siphon Plan and Profile

A second observance of the allowance is found in the record drawings associated with the late 1950's construction of the second barrel for the CRA siphons (Specification Numbers 504 and 509). As before, selected copies are included at the end of this document. The plan and profiles found in the second barrel siphon record drawings show two parameters corresponding to hydraulic grade at the downstream transition structures, as follows:

- "HG. El.", assumed to be an acronym for Hydraulic Grade Elevation, and assumed to refer to the pressure head at design flow
- "WS El.", assumed to be an acronym for Water Surface Elevation, and assumed to refer to the water surface under free-surface flow conditions at design flow

Figure 2
Big Morongo Siphon Second Barrel Plan and Profile

In the siphon, the HGL is observed to be above the soffit of the pipeline, indicating the pipeline is designed to be under pressurized flow. Upon entering the transition structure, the HGL is below the top of the transition structure walls as free surface flow is designed for.

As shown on Figure 2, the Water Surface Elevation line in the outlet transition structure is depicted 2.5 feet below the Hydraulic Grade Elevation line, as circled in red. For other transition structures, the Hydraulic Grade Elevation line meets the Water Surface Elevation line, as shown on Figure 3 for Thousand Palms Siphon.

A second barrel was not constructed at Casa Loma Siphon according to the original plans, so no corresponding record drawing was identified.

Staff from the Hydraulics team confirmed via calculation that the headloss depicted by the HGL is consistent with the major and minor losses shown in the record drawings for the design flows.

A third observation of the allowance is found in the hydraulic profiles. While not called out numerically as on the previous two sources, the hydraulic profiles depict a slope offset at the Big Morongo and San Andreas Siphons of a much greater magnitude than those observed for other siphons. This is depicted in two figures on the following page.

It is understood that the design philosophy for each siphon was to size the losses across each siphon to maintain the free surface flow HGL across the siphon. This can be graphically observed in Figure 4 as shown by the red dashed line highlighting the HGL matching the canal or conduit slope upstream and downstream of the siphon.

At Big Morongo and San Andreas siphons, an offset of 2.5 feet is observed between the slope upstream of the siphon and the slope downstream of the siphon. Figure 5 highlights this in blue for Big Morongo Siphon.

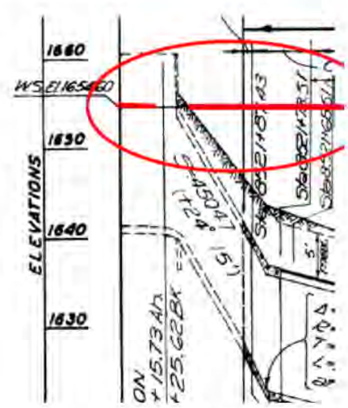


Figure 3
Thousand Palms Siphon Second Barrel Plan and Profile

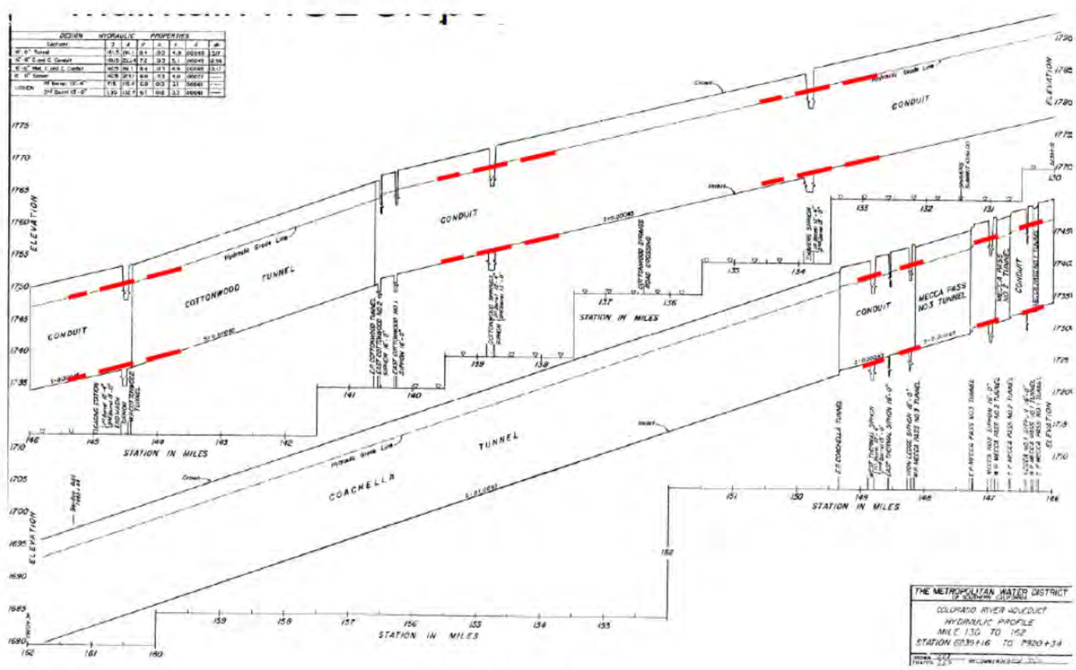


Figure 4
Siphon HGL Slope Consistent with Aqueduct Slope

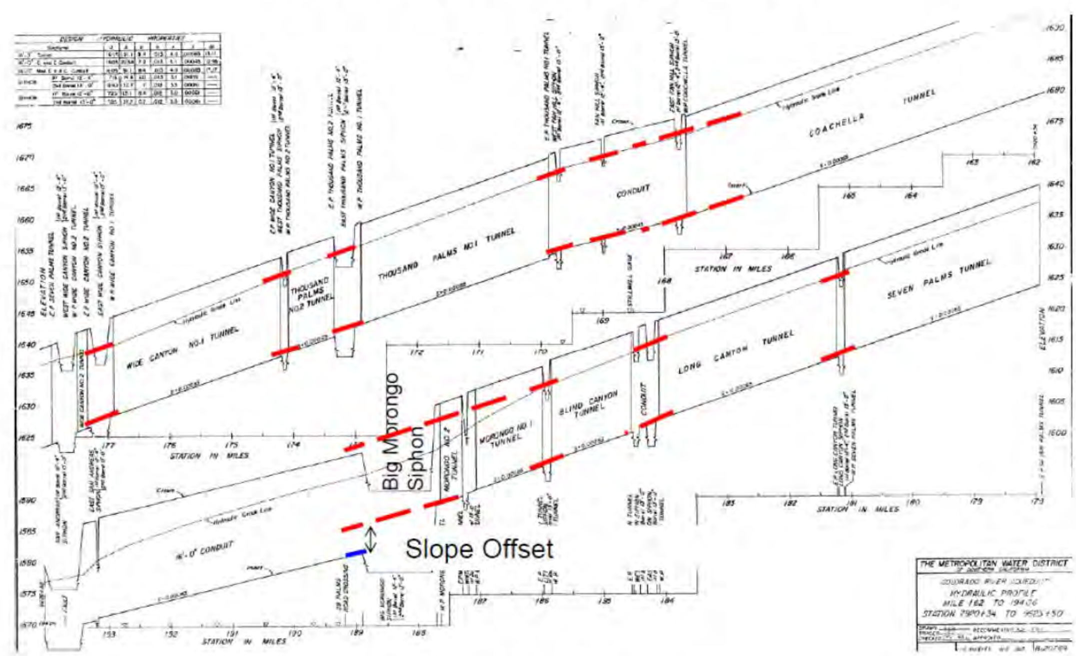


Figure 5
Siphon HGL Slope at Big Morongo Siphon

This last set of observances of the 2.5-foot allowance may provide a suggestion of the designer's thoughts on the effect of the allowance. The Hydraulic Grade Line observed on the profiles gradually drops relative to the invert elevation though the Morongo Number 1 Tunnel and the Morongo Number 2 Tunnel, and in the conduit immediately upstream of the San Andreas Siphon. While dimensions nor elevations are called out on this profile, the depth at the outlet to the Morongo Number 2 Tunnel can be measured on the drawing as 8.9 feet, and the depth at the entrance to the San Andreas Siphon can be measured on the drawing as 7.8 feet.

Previous Surveys

Based on the contract document, construction on Big Morongo Siphon and San Andreas Siphon was started on 5 Feb 1935 and concluded on 16 Sep 1936, with work activities completed by May 1936.

In February and March 1935, a construction staking survey was conducted. Included in the survey notes are an adjustment to the slopes consistent with the markups included in the contract documents (Contract 149). This timing is consistent with the start of construction.

In August 1937, after construction of the CRA, the as-built survey was conducted to set brass caps on the transition structure as permanent benchmarks. Benchmarks established include:

- a manhole at Station 9316+46
- the outlet transition structure for Big Morongo Siphon at Station 9353+15
- the outlet transition structure for East San Andreas Siphon at Station 9581+25 (referred to as "Outlet Siphon" in survey notes)
- the inlet transition structure for San Andreas Siphon at Station 9591+75
- a manhole at Station 9595+00
- the outlet transition structure for San Andreas Siphon at Station 9625+75
- the outlet transition structure for West San Andreas Siphon at Station 9651+75 (referred to as "small siphon" in survey notes)

These are recorded in Field Book 2740. No mention is made within the survey notes of any measurement of invert elevations of the pipeline or transition structure, so any inferences made to the invert elevation require the assumption that the transition structure dimensions are consistent with the planned dimensions appearing on the construction plans (19.17 feet for the Big Morongo Siphon outlet transition structure 18.96 feet for the Big Morongo Siphon inlet transition structure and both San Andreas Siphon transition structures).

In 1998, the Casa Loma Siphon first barrel was surveyed as a part of an as-built survey prepared for construction of concrete encasement between Stations 11073+45 and 11073+93 related to work on the Inland Feeder. The survey notes mention replacement of the pipeline, but do not appear to include any survey of invert elevations.

In 2008, the San Jacinto Diversion Structure, which originated as the inlet transition structure to the Casa Loma Siphon first barrel, was surveyed as a part of establishing NAVD 1988 elevations in the area. While the survey notes do not include invert elevations, they do include the weir elevation, which can be used to estimate the invert elevation based on the record drawings.

In 2014, a settlement study was conducted by Survey at San Andreas Siphon and Big Morongo Siphon to determine the difference in elevation between the inlet and outlet transition structures. The survey only measured the relative difference between the benchmarks set on the inlet and outlet transition structures of each siphon in the August 1937 survey. The difference in elevation between the inlet and outlet structure benchmarks is presented in the table below, suggesting no changes in relative ground movement in the intervening eight decades.

Table 1 1934 and 2014 Survey Comparison

Siphon	May 2014 Survey (feet)	August 1935 Survey (feet)	Difference (feet)
Big Morongo	7.90	7.90	0.00
San Andreas	6.64	6.68	-0.04

Source: Survey Field Book 2740 and Survey Note 1001-29 042

As with the previous surveys, no measurement was made of the invert elevations, so it is not possible to verify that the slope of the canal includes the 2.5-foot slope offset upstream of the siphon directly from survey measurements.

However, using the derived measurements developed as a part of IMDC (ultimately from the design drawings), the slope offset can be calculated. If the difference in elevation between the invert elevations at the inlet and outlet transition structures is 2.5 feet greater than that calculated based on the design slope for the siphon, then the survey data would confirm the tectonic allowance is included in the slope offset. Based on the notes included in the contract document and the slopes appearing on the hydraulic profiles, a slope of 0.00077 was used for design of the lengths of the CRA siphons. The table below presents the calculation, including several other siphons for comparison.

Table 2 Slope Offset Calculation

Siphon Name	Transition Structure Invert Elevation: Upstream (ft-msl '88)	Transition Structure Invert Elevation: Downstream (ft-msl '88)	Drop per Survey (feet)	Drop per Slope (feet)	Slope Offset (feet)
Cottonwood Spring Siphon	1,759.21	1,758.60	0.61	0.46	0.15
End Wash Siphon	1,740.23	1,740.12	0.11	0.45	-0.34
Iron Ledge Siphon	1,729.36	1,728.93	0.43	0.23	0.20
East Thermal Siphon	1,728.27	1,727.90	0.37	0.14	0.23
West Fan Hill Siphon	1,657.67	1,657.03	0.64	0.42	0.22
Thousand Palms Siphon	1,645.53	1,643.93	1.60	1.46	0.14
Whitehouse Canyon Siphon	1,593.82	1,593.27	0.55	0.40	0.15
Big Morongo Siphon	1,591.85	1,584.31	7.54	4.94	2.60
East San Andreas Siphon	1,574.16	1,573.69	0.47	0.27	0.20
San Andreas Siphon	1,573.22	1,566.84	6.38	2.62	3.76

Notes:
(1) Design slope of 0.00077 does not appear on most siphons on most hydraulic profiles, but was checked on the individual plan and profiles for all of the siphons listed in this table

As shown in Table 2, most of the siphons exhibit a deviation in surveyed slope from the design slope of between 0.1 and 0.2 feet. Big Morongo Siphon and San Andreas Siphon slope offsets of more than 2.5 feet each, showing that the slope across each of these siphons is greater than that required to meet the design slope for the siphon of 0.00077. It should be noted that the slope offset for San Andreas Siphon is calculated as 3.76 feet, 1.26 feet greater than the 2.5 feet suggested by the allowance. This may suggest the suggested mechanism for accomplishing the allowance is incorrect, or there may be other factors at play here.

While survey data has not explicitly measured the invert elevations at any point following the construction of these siphons, this calculation is based on the assumption that the siphon transition structures were constructed consistent with the construction plans. If the internal height of the transition structures is in doubt, survey of the invert elevations of the transition structures could be of value.

Field Observations

Given the lack of level sensors along the CRA, Water Supply Operations (WSO) staff have conducted several field investigations of depths along the CRA during periods of constant flow. These field investigations generally consist of one or two staff recording single measurements of depth at several manholes and transition structures between Hinds Pumping Plant and San Jacinto Tunnel.

Under the design flow of 1,605 cfs, the normal depth is designed as 12.96 feet in the most frequently used cut and cover conduit cross-sections, and 13.17 feet in the most frequently used tunnel sections. Figure 1 presents results from the field investigation conducted on 20 March 2013, with flow conditions near design flows.

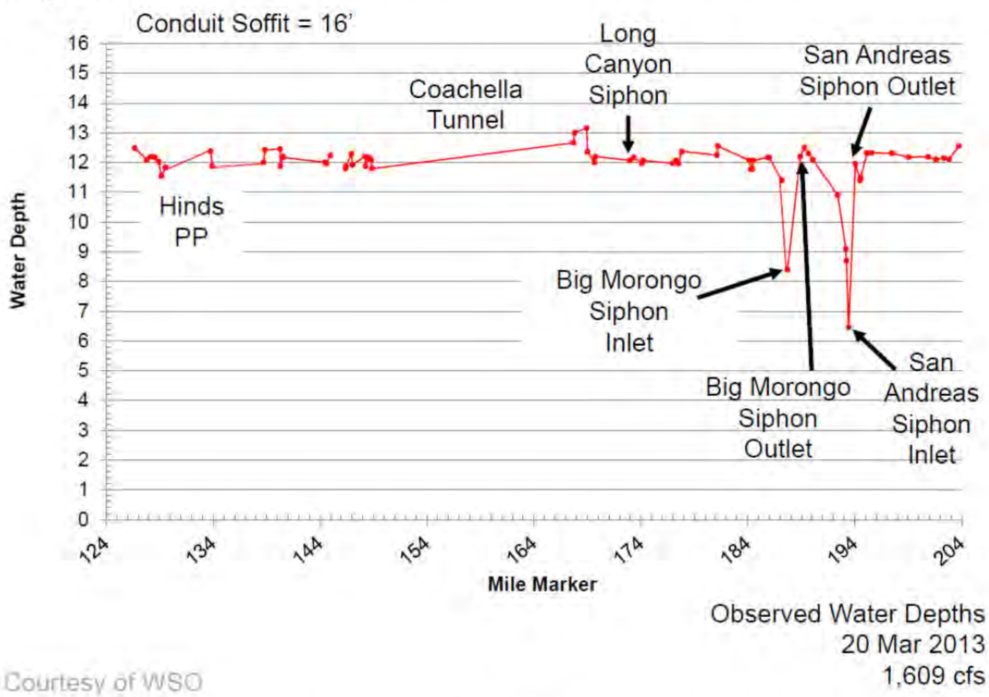


Figure 1
Observed Water Depths at Design Flow

The depth at the San Andreas Siphon and Big Morongo Siphon transition structures consistently stand out with observed water depth lower than the other siphons, dropping to less than 7 feet and less than 9 feet, respectively. These depths are fairly consistent with the depths of 7.8 feet and 8.9 feet observed in the design hydraulic profile discussed at the end of Section 0.

Mechanism

Some possible ideas that could have been incorporated include sizing the diameter of these siphons larger (reducing the headloss across the siphon) or including some type of weir structure.

It is surmised that the mechanism used for incorporating the additional head was to build the inlet transition structure 2.5 feet above the elevation at which the structure would have been constructed without the slope offset. Given that the pressurized pipeline within the siphon can change slope without impacting the hydraulics beyond minor losses, the slope of one of the stretches of pipeline could be raised to achieve a 2.5-foot elevation increase. The contract document suggests this -"The slope given in the hydraulic properties [0.00077] does not include the additional grade allowed to provide for adjustment if future earth movement should take place." (Contract 149)

An exaggerated demonstration of this mechanism is shown in Figure 1. The existing profile of the aqueduct, including the 2.5 foot allowance, is shown in black. A red line, lower at the upstream end of the siphon has been added to shown the 2.5-foot lower starting invert without the allowance. The blue line shows what the initial slope in the siphon would have been in the first pipeline segment without the allowance.

Figure 1
Surmised Design Mechanism

Further, exploring the different versions of the drawings prepared prior to construction suggests the addition of the grade as a slope change. Eight different record drawings are present in EDMS between August and December 1934 (the notice for bids was released 5 December 1934.) These partially correspond to four different construction methodologies and material choices prepared prior to the bid notice (jointed cast-in-place concrete, pre-cast concrete, above ground steel pipe, and buried steel pipe). Ultimately, jointed cast-in-place concrete was selected at the time of the bid notice. The upstream invert elevations of the transition structure in some of the drawings prepared in November 1934 have been raised by 2.5 feet from the August 1934 drawings, with differing slopes (however, each of the differing construction methodologies uses different slopes), with the height of the transition structures maintained between the different drawings. It should also be noted that the 2.5 foot allowance is observed on drawings dating back to 1933, so the allowance was likely planned for prior to 1934.

Assuming the head constraints on the design of the CRA would have been established first at the downstream end (either at the tunnels or of the elevation of Lake Mathews), this would suggest that if the allowance had not been included at each siphon, the CRA upstream of all three upstream siphons could have been designed 7.5 feet lower in elevation, with the lift at Hinds Pumping Plant reduced by 7.5 feet.

Conclusions

In review of record drawings and contract documents associated with the CRA, a tectonic allowance of 2.5 feet of HGL has been included in the design of Big Morongo Siphon, San Andreas Siphon, and the Casa Loma Siphon. Based on the above investigation into this allowance, it is believed that the mechanism for accomplishing the allowance is a slope offset in the invert elevation slope, accomplished by an increased slope in the pressurized pipeline segments within these siphons.

Based on available records, invert elevations have never been surveyed at Big Morongo Siphon, San Andreas Siphon, and the first barrel of the Casa Loma Siphon. Having invert elevation survey data will not prove the mechanism any further than currently shown on record drawings. However, if the internal height of the transition structures is in doubt, survey of the invert elevations of the transition structures could be of value.

In addition, internal inspection of the cast-in-place concrete pipeline and associated joints, as well as internal survey to determine any localized movement, may be desired for non-hydraulic reasons.

Differential survey between the inlet and outlet transition structures would likely be of little value beyond that already provided in 2014. Two additional levels of survey could be conducted—a survey of just the invert elevations of the transition structures, requiring minimal de-watering, and a survey and inspection of the entirety of the siphons, requiring full dewatering.

Estimates of effort for survey of the invert elevations in just the transition structures would be 24 staff hours plus minimal dewatering, and effort for the full siphon survey of the entire length of the two siphons would be 200 staff hours, plus staff for full dewatering.

References and List of Record Drawings

The following table lists record drawings and documents used in preparation of this analysis.

Table 3 Record Drawings and Documents Consulted

Record or ID Number	Record Drawing Type	Siphon	Revision Date
B-363-26	Plan and Profile	Big Morongo	22 Nov 1934
B-363-23	Plan and Profile	San Andreas	30 Nov 1935
B-363-12	Plan and Profile	Casa Loma Siphon	15 June 1934
B-11975	Plan and Profile	Big Morongo	30 Oct 1997
B-11979	Plan and Profile	San Andreas	1 Nov 1956
B-20749	Hydraulic Profile	Multiple, including Big Morongo and San Andreas	1 Aug 1965
B-20748	Hydraulic Profile	Multiple	1 Aug 1965
HR-149	Contract	Big Morongo and San Andreas	5 Feb 1937
FB 2740	Survey Field Book	Big Morongo and San Andreas	12 July 1938
1001 29 042	Survey Notes	Big Morongo and San Andreas	19 May 2014
2037 01 037	Survey Notes	Casa Loma Siphon Number 1	24 August 1998
2039 02 008	Survey Notes	San Jacinto Diversion Structure	5 May 2008
B-1660	Transitions & Sections	San Andreas	21 Nov 1934
B-1663	Transitions & Sections	Big Morongo	22 Nov 1934

Notes:
(1) Since the second barrel was never installed at Casa Loma Siphon, it does not have a

CRA Tectonic Uplift Allowance 8 March 2016

This page intentionally blank.

Appendix 4

Summary of Damage to Metropolitan Infrastructure from Past Earthquakes

This page intentionally blank.

Metropolitan experienced a significant amount of damage to its infrastructure during both the 1971 San Fernando and 1994 Northridge earthquakes. Both of these seismic events primarily impacted the Jensen Water Treatment Plant. Engineering prepared summary reports for both events. The information below represents a convenient summary of what may be found in "Report of Structural Damage to Joseph Jensen Filtration Plant, Earthquake of February 9, 1971" (Report No. 891C), "Historical Documentation of the Jensen Plant Earthquake Disaster of February 9, 1971" (Report No. 909), and "Damage and Repair Report for Joseph Jensen Filtration Plant, Northridge Earthquake of January 17, 1994 (October 1994).

1971 SAN FERNANDO EARTHQUAKE

The San Fernando earthquake struck the greater Los Angeles region in the early morning of February 9, 1971. The thrust earthquake, which had a moment magnitude between 6.5 and 6.7, caused severe damage in the northern San Fernando Valley, with extensive surface faulting to the south of the epicenter. The epicenter was approximately 6.8 miles from the Jensen Plant.

Metropolitan experienced widespread damage at the Jensen Plant. This included a severe break to a 72" Influent Conduit and damage to various structures including the Administration Building, Finished Water Reservoir, Access Tunnel, Mixing and Settling Basins, and Filters.

Following is a summary of the damage to these facilities.

INFLUENT CONDUIT

- Transverse cracks up to ½-in on concrete encasement
- Three joints in the ¼-inch thick steel cylinder separated
- Joint failed and opened up to ¾-inch at the soffit
- Fracture continued thru the top half of the joint
- Much spalling of the mortar lining about 8-inches on each side of the joint
- About 113-feet south of the 72-inch outlet, 75% of the joint failed
- Joint opened up about ¾-inch near the invert and the lining was damaged for about thirty inches each side of the joint
- Entire joint was pulled apart
- Mortar lining was damaged for about 24-inches on each side of the joint
- Considerable spalling and cracking of the lining was evident around the 72-inch outlet
- Lining suffered spalling and cracking approximately 15-feet downstream of the tunnel portal
- Several additional cracks, up to 1/16-inch wide, were observed in the lining
- Two 84-inch and 72-inch welded steel pipelines suffered only minor damage and consisted of cracking of the lining
- Minor cracking at the junction of the 72-inch pipelines and the 12-foot, 6-inch square reinforced concrete box conduit

- The 12-foot wide by 12-foot high reinforced concrete box extending northerly from the main control building had three transverse cracks in the walls and slabs located between Station 5+60 and 6+00;
- Cracks varied in width from 1/32-inch to 1/16 inch;
- 5 Transverse expansion joints in this portion of the influent conduit had separations varying from ½ -inch to 2-inches horizontally, and from ¼-inch to 1-inch vertically.

EFFLUENT CONDUIT

- Severe damage toward the southerly end;
- Differential displacement;
- Complete fracture or shearing.

MAIN CONTROL BUILDING

- Considerable horizontal and vertical displacement throughout; led to multiple non-structural damaged areas throughout building
- Building moved approximately 5-inches to the south and approximately 6-3/4-inches to the east
- There was settlement of 2-inches on the south side of the building causing a slight southeasterly tilt.

BALBOA INLET TUNNEL

- Concrete tunnel lining badly spalled and cracked at a distance approximately 100 feet near the Olive View Fault crossing;

CONNECTING CONDUITS

- Significant damage occurred at expansion joints, intersection of east-west and north-south galleries, and by punching of an embedded pipe into a wall
- Several portions of the structure between expansion joints moved as separated structures, on the three axes of movement, and also moved with twisting (torsional) action on each of the three planes
- In some cases, the joint filler and sealant was compressed and squeezed out of the joint
- Individual working of the structurally separated portions of the structure caused them to pound against each other, thereby resulting in spalling of concrete adjacent to the edges of the expansion joints
- Considerable cracking and some spalling occurred at the intersection of the east-west and north-south 25-foot wide influent conduit and pipe gallery, all were repairable
- Cracks in slabs and walls occurred at the intersection of pipe galleries Nos. 1 and 2 in the north-south influent conduit and pipe gallery, but all were repairable

- The southern end of the east-west pipe that was cast into the west wall of the north-south influent conduit pipe gallery pounded and caused the wall to shatter
- Large amount of movement took place in the overhead piping at the intersection of the east-west and north-south influent conduit pipe galleries
- Movement was in several directions, with pipe having been displaced.

MIXING AND SETTLING BASINS

- Significant damage occurred at expansion joints, and the intersection of the east-west and north-south galleries
- Several portions of the structure between expansion joints moved as separate structures on the three axes of movement
- Some cases, the joint filler and sealant was compressed and squeezed out of the joint;
- The individual working of the structurally separated portions of the structure caused them to pound against each other, thereby resulting in spalling of concrete adjacent to the edges of the expansion joint
- Cracking and some spalling occurred at the intersection of the east-west and north-south influent conduit and pipe gallery
- Cracks in slabs and walls occurred at the intersection of pipe galleries Nos. 1 and 2 in the north-south influent conduit and pipe gallery

FILTERS

- Some vertical and lateral displacement occurred between adjacent beds at some expansion joint locations
- Compressive loads forced expansion joint material out of some joints
- Minor spalling occurred adjacent to some expansion joints
- An apparent lateral thrust from the west caused the wash troughs to pull partly out of the insets
- Wash troughs acting as struts transferred the thrust to the gullet wall, which had not been completely poured, causing the wall to split at the east line of reinforcing bars
- Cracking and spalling in other filter beds occurred at the wash troughs but were minor in nature
- Minor spalling occurred where 16-inch spray header line passes through the wall filter beds
- The west end of the conduit was damaged
- Connection between the used washwater conduit and the 48-inch diameter conduit pulled apart
- Top walkway grid slab cracked diagonally across the northeast corner of filter bed
- Filter control building No. 2 separated from the walkway at the top of the filter beds expansion joint
- Separation varied from ½-inch to 1 ¼-inch at the expansion joint between Filter Control Building No. 2 and the valve and meter structure

- Valve and meter structure settled 1" lower than Filter Control Building No. 2
- Lining on north side of the return washwater line had a spalled area.

CHEMICAL BUILDING

- Severe lateral and vertical motion
- Column anchor bolts either stretched or pulled out of the footing concrete at all six columns
- Column in south wall buckled
- Column at northeast corner bowed out of line
- Diagonal bracing system in exterior walls failed
- Diagonals failed in tension or damaged in compression
- Upper concrete floors and roof were pierced by the diagonal bracing and columns
- Considerable cracking or spalling of slab concrete
- Building frame racked out of plumb, being tilted toward the east
- Metal door and window frames in north wall were racked out of square
- Several siding panels on the north wall broke loose from the framing
- Siding fasteners snapped off or pulled out
- All anchor bolts for the four chemical tanks failed by being sheared, bent or pulled out
- Tanks were not damaged by second floor slab; although marks on tank indicate that 6 to 8 inches of vertical movement took place
- Columns supporting exterior stairway were bent.

BRIDGE AND BOX CULVERT FOR RAILROAD SPUR TRACK

- Vertical crack at the juncture between the north abutment and the wing wall on the west side
- Wall and abutment became offset.

WASHWATER TANK

- Vertical movement of the tank
- Movement caused anchor bolts to either pull out or fail in tension
- Tank slammed down upon the ring wall, resulting in buckling in the upper courses of the tank skin
- Damage to stairway.

FINISHED WATER RESERVOIR

- North Wall:
    - Did not rupture but had 3 continuous horizontal cracks
    - Cracks varied in width from hairline to 1/32 inch and were spaced
    - There were many random vertical and diagonal hairline or large cracks.

- South Wall:
  - Easterly half of the south wall had several vertical and diagonal random cracks
  - Wall between column lines 'B' and 'C' was severely shattered
  - Some earth backfill entered the reservoir thru the wall and roof rupture
  - Random vertical and diagonal wall cracks occurred in the westerly half of the south wall
  - Fracturing and spalling occurred at other locations along the south wall on both the interior and exterior surfaces
  - Lateral offset at crack, particularly where it crossed the wall corbels.
- East Wall:
  - Portion of east wall, north of outlet received extensive damage
  - Bowed inward between the floor and roof slabs
  - Series of continuous horizontal cracks
  - Extensive lengths of spalls and cracks with some fractures occurred at the base of the wall
  - Large vertical crack occurred in the east wall
  - Overflow weir wall was also damaged and laterally offset at a vertical construction joint in the same area
  - East wall, south of the outlet structure, showed some offset and spalling at the floor line
  - Random and vertical cracks occurred at about mid-height
  - East wall of the finished water reservoir was severely fractured and spalled.
- West Wall:
  - Fractured and shattered above the floor slab line;
  - Horizontal displacement of the bottom of this wall occurred at the fracture;
  - Wall shattered for its full height between column 24 and 25.
- Roof
  - Failure plane occurred in the roof slab between column lines B and C
  - Extensive damage to the roof slab occurred adjacent to the drop panel connections;
  - Fracture at the drop panel line was apparent only in the north half of the reservoir
  - Continuous east-west failure occurred in line with the south edge of the roof slab drop panels
  - Roof slab south of this line had a vertical offset approximately 12 inches lower than the roof slab on the north side
  - From column line "0", east to column line "V", spalling was evident only at the west faces of the drop panels
  - Roof slab fractured between column lines "B" and "C"
  - Continuous east-west lines of failure occurred between column lines 3 and 4, 7 and 8, and 24 and 25. These breaks or spalls exposed the reinforcement for the full length of the reservoir roof slab.

- The width of spalling at the construction joint between column lines 24 and 25 varied between 4 feet and 6 feet. During the quake, this joint opened up, allowing for considerable quantities of gravel backfill to fall through from above.
- The roof slab was also severely spalled, shattered and offset vertically at the west edge of the drop panel line adjacent to the east wall
- Spalling also occurred at the west face of the drop panels at line "B" from column line 22, to a point midway between column lines 24 and 25.

RESERVOIR FLOOR

- While floor slab damage was general throughout the structure it was most apparent in the southeast quadrant
- Spalled strip running east-west between column 2 and 3, from a point midway between lines B and C to the east wall
- Spalled strip at the center of the structure, between lines 13 and 14. These spalled strips averaged about 2 feet wide and many of them had vertical offsets upward from the general floor level.
- There were additional spalled construction joints in the north-south direction; however, none of these were as long as the two east-west spalls previously described
- Spalling occurred at the drainage gutters for almost the entire length in both the north-south and east-west directions
- Continuous spalls occurred throughout and between various lines
- Floor cracking occurred midway between lines 14 and 15 in the east-west direction; the south exterior wall drop panels at M-1, N-1 and U-1 spalled in the east-west direction;
- Floor slab cracks located were located as follows:
  - North-south between lines Y and Z; from midway between lines 5 and 6 to a point midway between lines 17 and 18
  - North-south between lines between Z and AA, from a point midway between lines 2 and 3 to a point midway between lines 19 and 20; diagonally across the southeast corner of drop panel W-18
  - North-south between lines P and Q; from a point midway between lines 13 and 14; to column line 15
  - East-west between lines 14 and 15, from a point midway between lines D and E, to a point midway between lines E and F.

BAFFLE WALLS AND COLUMNS

- Damage to the baffle walls consisted of two principal types; cracking or fracturing of the vertical beams and dislodgement and fracturing of the corrugated asbestos cement panels, only one vertical concrete beam collapsed
- The other beams remained standing but were tilted out of plumb
- Many of the other vertical beams were fractured or cracked near the base or in the region slightly above the base
- There were a number of spalls in the cast-in-place concrete projections forming the panel slots on the sides of the circular roof columns
- A large number of the corrugated asbestos cement panels were damaged or completely destroyed. Some of them fell to the floor and were shattered, while others that remained in place were damaged less severely.
- Approximately 73 baffle walls vertical beams sustained cracks, fractures, spilling, etc.
- Damage to the reservoir roof columns varied widely, from hairline cracks to complete fractures
- The damage to any individual column appeared generally to be the same at the top as at the bottom
- The majority of columns were spalled, or otherwise damaged on the east and west sides
- There were two notable exceptions: The first row of columns south of the north wall and the first row of columns north of the south. In these two rows, major damage occurred on the north and south sides
- In all cases, damage to the circular columns appeared to be primarily due to flexure and not to vertical load
- A number of the columns, notably those in the first row east of the west wall, were visibly out of plumb
- The tops of these columns were displaced east. Damage to drop panels and column capitals were generally limited to minor spalls and some cracks, except for several bottom capitals located in the northeasterly quadrant of the reservoir that were fractured or shattered.

RESERVOIR OUTLET STRUCTURE

- Severe and extensive damage;
- Fractures throughout the entire structure.

RESERVOIR INLET STRUCTURE

- Moderate damage;
- Spalled concrete exposing reinforcement.

1994 NORTHRIDGE EARTHQUAKE

In 1994, the Northridge earthquake occurred on January 17, at 4:30 a.m. It had a duration of approximately 10–20 seconds. The blind thrust earthquake had a moment magnitude (M_w) of 6.7. The death toll was 57, with more than 8,700 injured. In addition, property damage was estimated to be between $13 and $50 billion, making it one of the costliest natural disasters in U.S. history. LADWP reported a total of 1,405 pipe repairs and that water pressure had dropped to zero in some areas. The epicenter was approximately 7.3 miles from the Jensen Plant.

Metropolitan had damage at the Jensen Plant and adjacent facilities. Following is a summary of the damage to these facilities:

MAJOR DAMAGE

- Jensen Plant Balboa Influent Conduit
  - 84-in influent pipeline severed approximately 3-in horizontally and 1-in vertically near venturi structure
- East Valley Feeder
  - Pipeline breaks occurred between Odessa and Rinaldi Streets (976+86.70) and Woodley Avenue and Rinaldi Street (957+66.50)
  - Sectionalizing valve damage caused damage to all electrical equipment
  - Street asphalt damage as result of pipe breaks/leaks
- West Valley Feeder No. 1
  - Crack at cut-off wall at Station 1219+10
  - Sectionalizing valve structure damaged, causing damage to all electrical equipment
- Main Electrical Center
- Service Connection CLWA-1T
  - Service connection structure settled and drifted laterally
  - Misalignment of valve assemblies
- Service Connection LA-25
  - Extensive damage at ten pipe joints in the 97-in diameter pipeline and 60-in diameter overflow pipeline; pipe joints spread 1/8” to 3/4”
  - Reinforced box conduit suffered a break and 2” separation; a 6-1/2” separation occurred at the joint where the double box conduit meets the discharge structure
  - Turnout structure moved 6 to 8 inches east
  - Double box conduit moved 3 inches to the east

- Service Connection LA-35T
  - Damage to valve structure and pipe bridge due to differential displacement
- Newhall Tunnel
  - Buckling of steel liner
  - Concrete construction joints opened and closed resulting in sand and water infiltration
  - Bulge on steel liner split at circumferential joint resulting in oil and water infiltration

This page intentionally blank.

Appendix 5

Metropolitan Water Storage Capacity

This page intentionally blank.

Over the past two decades, Metropolitan has developed a large regional storage portfolio that includes both dry year and emergency storage capacity. Storage generally takes two forms: surface reservoirs and groundwater basin storage. Heading into the most recent drought cycle, Metropolitan had developed over 5.5 million acre-feet of storage capacity and had successfully stored over 2.7 million acre-feet. This is a more than 13 times the storage capacity compared to the 1980s, with record quantities of water in reserve. This increase in storage capacity is shown in Figure 5-1.

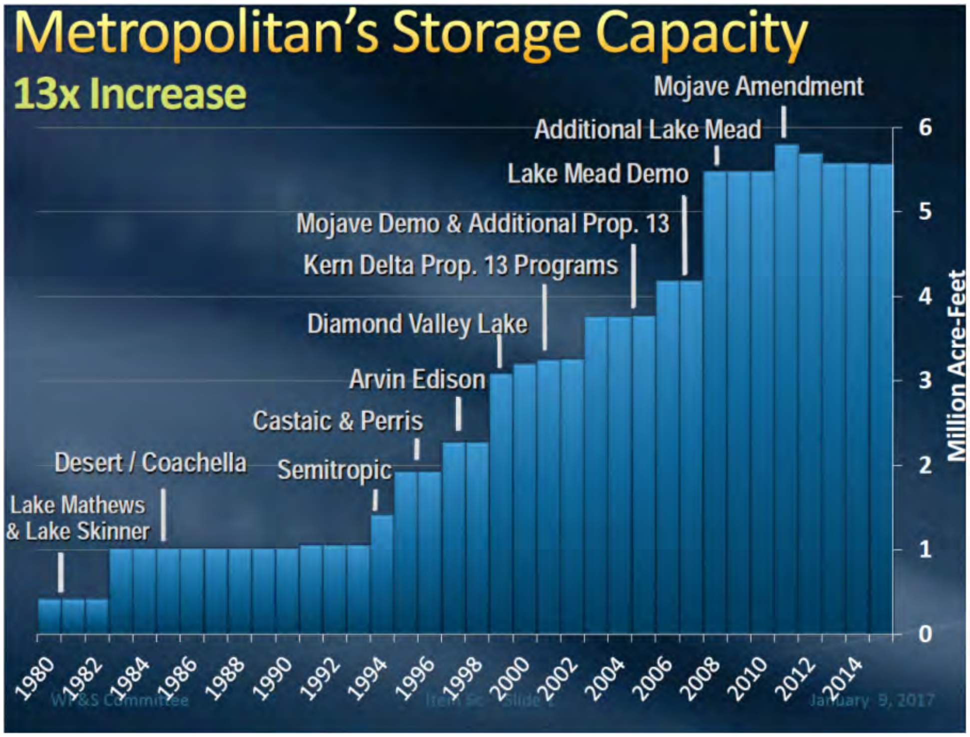


Figure 5-1. Summary of Metropolitan's Storage Capacity Over Time

Some examples of storage resources that have been developed since 1990 include:

- Surface Water Reservoirs:
  - Diamond Valley Lake (810,000 acre-feet)
  - SWP Article 56 Carryover Storage (up to 200,000 acre-feet)
  - Flexible Storage in Castaic Lake and Lake Perris (219,000 acre-feet)
  - Intentionally Created Surplus in Lake Mead (1.5 million acre-feet)
- Groundwater Storage:
  - Member Agency Conjunctive Use Programs (210,000 acre-feet)
  - Semitropic Storage Program (350,000 acre-feet)
  - Arvin-Edison Storage Program (350,000 acre-feet)
  - San Bernardino Municipal Water District Storage Program (50,000 acre-feet)
  - Kern Delta Water District Storage Program (250,000 acre-feet)
  - Mojave Storage Program (390,000 acre-feet)

This page intentionally blank.

Appendix 6

Seismic Design Frequently Asked Questions

This page intentionally blank.

Seismic Design FAQs

September 2017

What are the effects of earthquakes?

- Ground shaking
- Ground rupture
- Liquefaction
- Landslides and avalanches
- Tsunamis

What causes earthquakes?

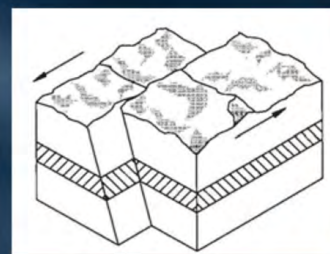
- Slips or rupture of faults
- Movements of tectonic plates
- Volcanic or magmatic activity
- Sudden changes in earth's crust

What is a fault?

- Faults are fractures or discontinuities in large masses of rock, where the rocks on either side have undergone relative displacement
- Faults are planar surfaces, not lines
- Faults can be vertical, horizontal, or at some angle in between
- Faults can be divided into three basic types
  - Strike-slip
  - Thrust
  - Normal
- Strike-slip and thrust most common in So. Cal.

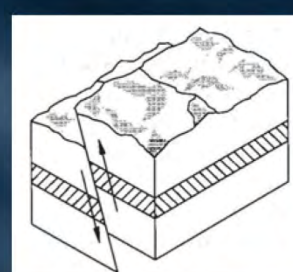
Strike-Slip Faults

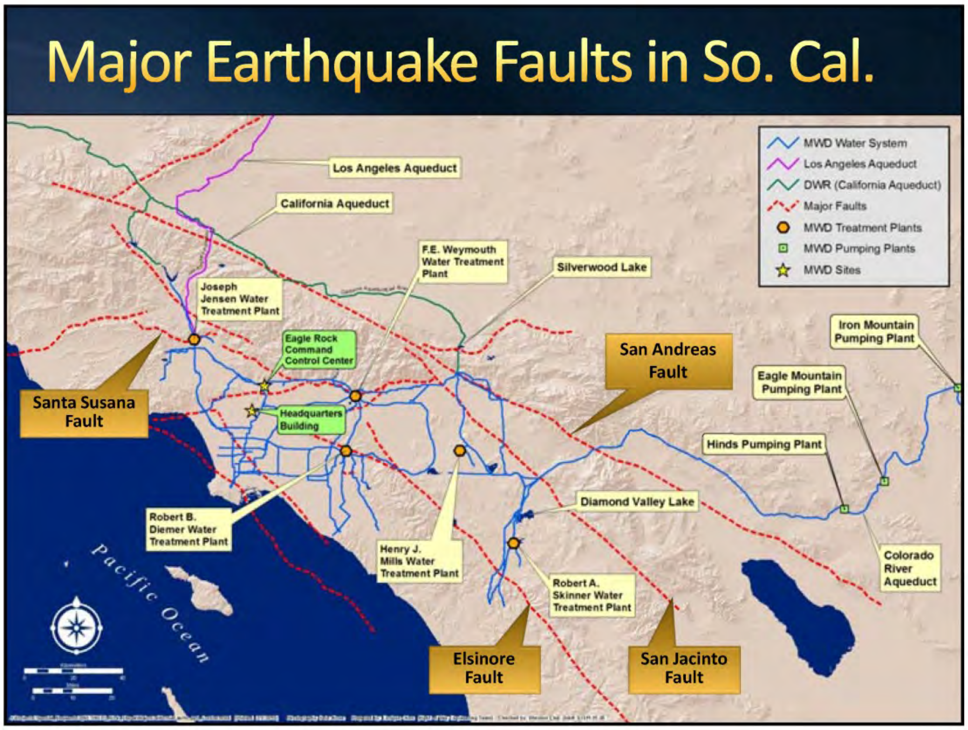
- Faults are primarily vertical or near-vertical
- Movement occurs primarily laterally - one side slides by the other
- Primary examples are the San Andreas and San Jacinto Faults



Thrust Faults

- Faults occur at an angle to the surface
- Movement occurs primarily vertically - one side slides up over the other
- Primary examples are the Santa Susana and Bunker Hill Faults





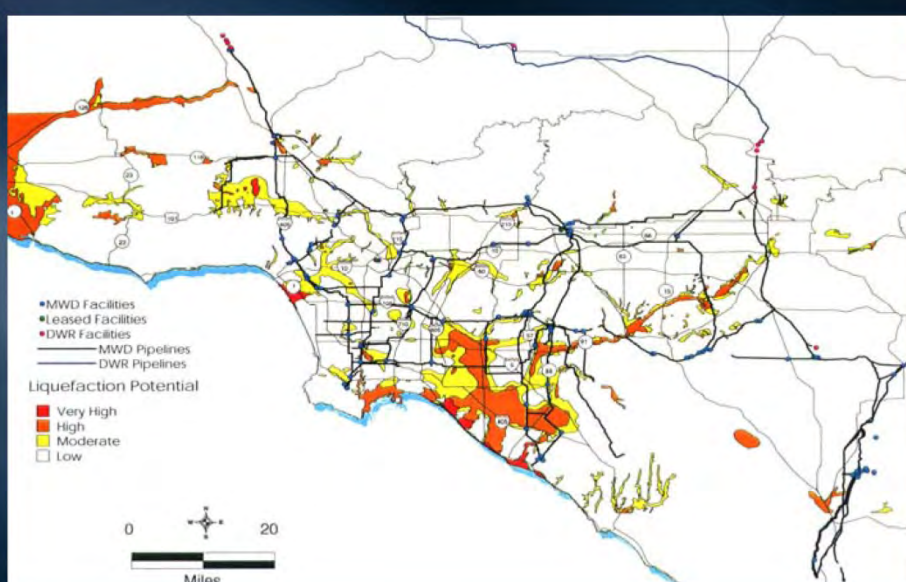
San Andreas Fault

- Fault with the highest probability of generating a major earthquake in So. Cal.
- Potential impact on MWD operation
  - CRA
  - Hinds and Eagle Mountain Pumping Plants
  - Rialto and Inland Feeders
  - East Branch of State Water Project
  - DWR's Santa Ana Pipeline

Liquefaction

- What is liquefaction?
  - A process by which water-saturated soils temporarily lose strength and act like liquid
- Factors needed for liquefaction
  - Loose or low density sandy soils
  - Shallow ground water
  - Strong ground shaking

Liquefaction Susceptible Zones in So. Cal.

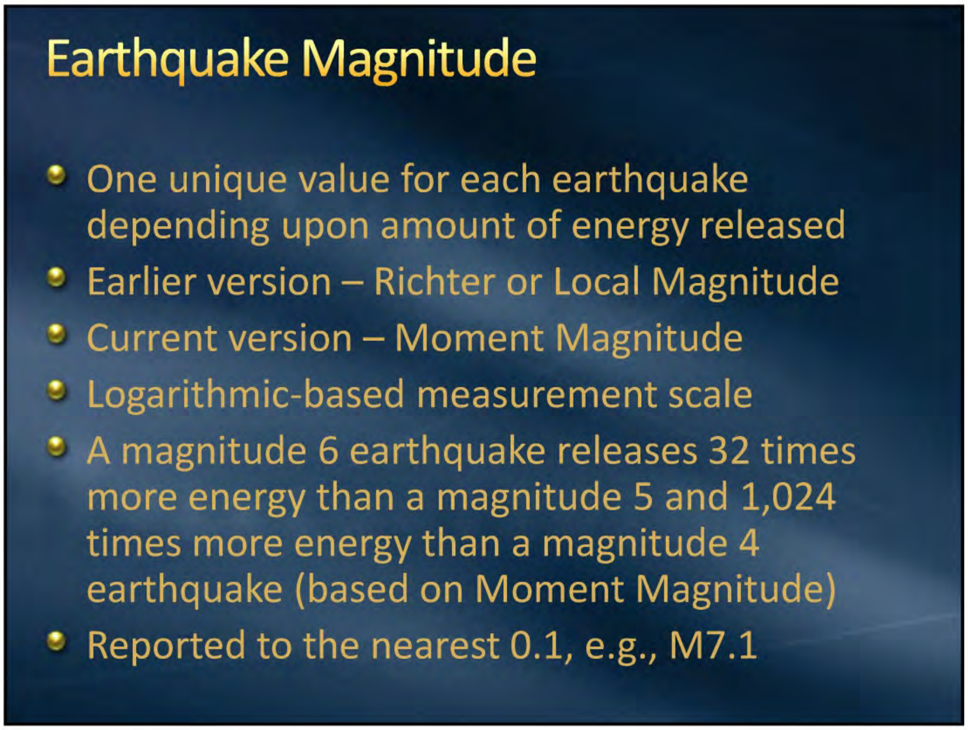


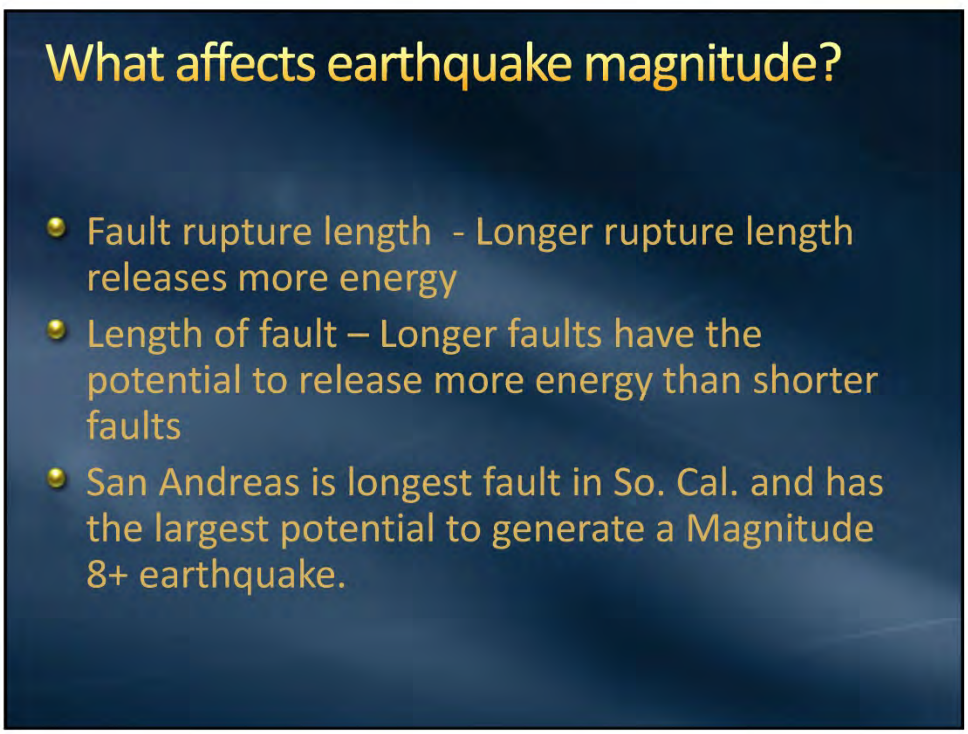
How to measure earthquakes?

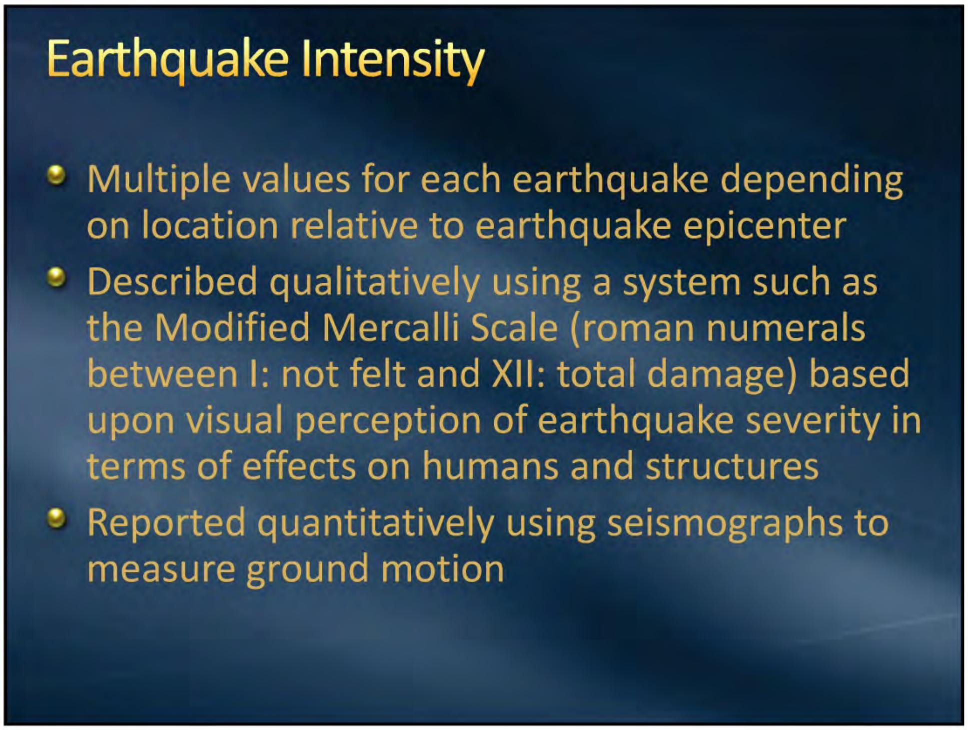
- Earthquake Magnitude
  - Describes size of earthquake
  - Unique value for each earthquake
  - Quantitative value based upon amount of released energy
- Earthquake Intensity
  - Describes effect of earthquake
  - Multiple number of values for every earthquake
  - Qualitative description or quantitative measurement of ground or structural response to earthquake

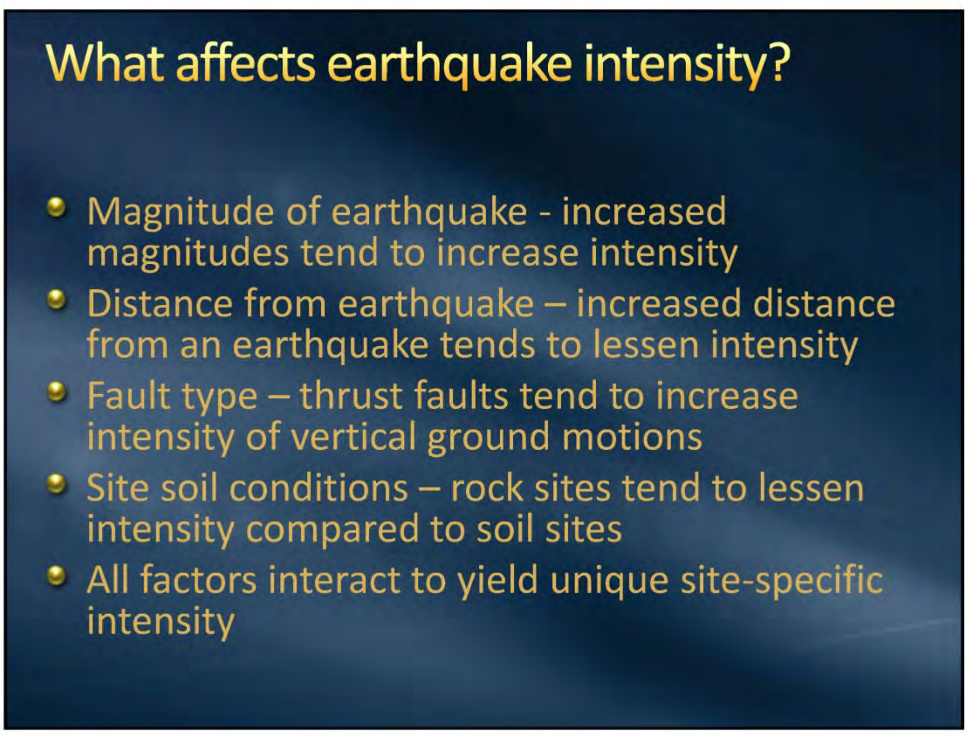
Definitions

- Maximum Credible Earthquake
  - Largest earthquake that is physically capable of occurring on a fault
- Peak Ground Acceleration (PGA)
  - Maximum acceleration measured at ground surface during the course of earthquake motion
- %g
  - Acceleration expressed as a percentage of the force of gravity
- Maximum Considered Earthquake Ground Motion
  - Smaller of the probabilistic ground motion (2% probability of exceedance in 50 years), and the deterministic ground motion (Maximum Credible Earthquake occurring on the controlling fault)


Earthquake Magnitude
One unique value for each earthquake depending upon amount of energy released
Earlier version – Richter or Local Magnitude
Current version – Moment Magnitude
Logarithmic-based measurement scale
A magnitude 6 earthquake releases 32 times more energy than a magnitude 5 and 1,024 times more energy than a magnitude 4 earthquake (based on Moment Magnitude)
Reported to the nearest 0.1, e.g., M7.1


What affects earthquake magnitude?
Fault rupture length - Longer rupture length releases more energy
Length of fault – Longer faults have the potential to release more energy than shorter faults
San Andreas is longest fault in So. Cal. and has the largest potential to generate a Magnitude 8+ earthquake.


Earthquake Intensity
Multiple values for each earthquake depending on location relative to earthquake epicenter
Described qualitatively using a system such as the Modified Mercalli Scale (roman numerals between I: not felt and XII: total damage) based upon visual perception of earthquake severity in terms of effects on humans and structures
Reported quantitatively using seismographs to measure ground motion


What affects earthquake intensity?
Magnitude of earthquake - increased magnitudes tend to increase intensity
Distance from earthquake – increased distance from an earthquake tends to lessen intensity
Fault type – thrust faults tend to increase intensity of vertical ground motions
Site soil conditions – rock sites tend to lessen intensity compared to soil sites
All factors interact to yield unique site-specific intensity

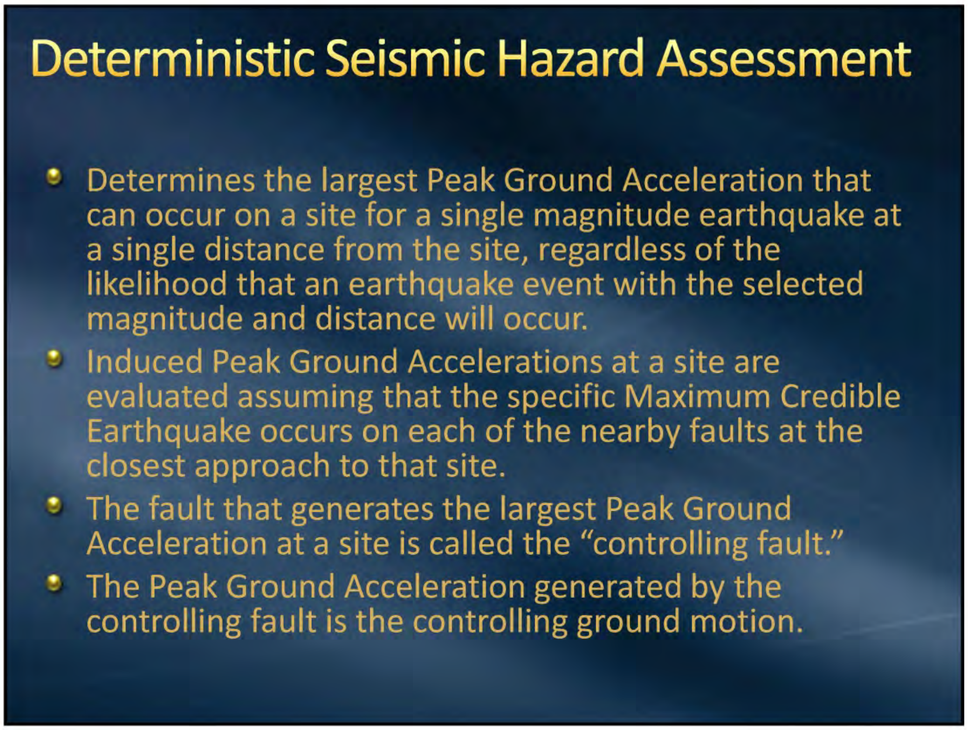
Comparison of Magnitude Scale and Intensity Scale

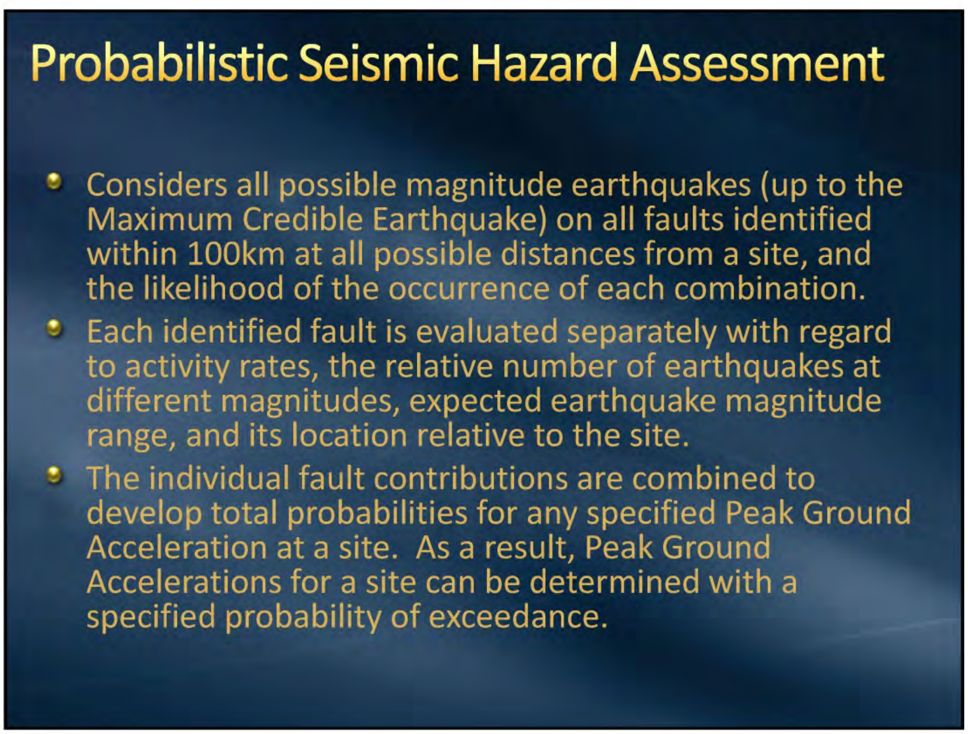
Richter Scale	Modified Mercalli Intensity Scale	Perception of Earthquake Intensity*
2	I-II	Detected only by instruments
3	III	Felt indoors
4	IV-V	Felt by most people; slight damage
5	VI-VII	Felt by all; damage minor to moderate
6	VII-VIII	Everyone runs outdoors; damage moderate to major
7	IX-X	Major damage
8+	X-XII	Major to total damage

***Measured at epicenter**

How are earthquake magnitude and intensity used in design?

- Earthquake magnitudes are not specifically used in design
- Designs are based upon resisting predicted earthquake intensities (quantified by peak ground accelerations stated to nearest 0.01 or %g)
- Earthquake magnitudes and several other factors are used to estimate earthquake intensities for design


Deterministic Seismic Hazard Assessment
Determines the largest Peak Ground Acceleration that can occur on a site for a single magnitude earthquake at a single distance from the site, regardless of the likelihood that an earthquake event with the selected magnitude and distance will occur.
Induced Peak Ground Accelerations at a site are evaluated assuming that the specific Maximum Credible Earthquake occurs on each of the nearby faults at the closest approach to that site.
The fault that generates the largest Peak Ground Acceleration at a site is called the “controlling fault.”
The Peak Ground Acceleration generated by the controlling fault is the controlling ground motion.


Probabilistic Seismic Hazard Assessment
Considers all possible magnitude earthquakes (up to the Maximum Credible Earthquake) on all faults identified within 100km at all possible distances from a site, and the likelihood of the occurrence of each combination.
Each identified fault is evaluated separately with regard to activity rates, the relative number of earthquakes at different magnitudes, expected earthquake magnitude range, and its location relative to the site.
The individual fault contributions are combined to develop total probabilities for any specified Peak Ground Acceleration at a site. As a result, Peak Ground Accelerations for a site can be determined with a specified probability of exceedance.

Current Building Code Seismic Design Requirements

- Maximum Considered Earthquake (MCE) Ground Motion
  - Probabilistic: Ground motion with 2% probability of exceedance in 50 years
  - Deterministic: Ground motion generated by Maximum Credible Earthquake occurring on the controlling fault(s)
  - Smaller ground motion determined by these two methods governs design
  - Deterministic approach usually governs in So. Cal.
- A Regular Facility is designed for 2/3 of MCE Ground Motion to achieve Life Safety performance
- An Essential Facility is design for a higher performance
  - Building codes establish the minimum seismic design criteria, and building owners can choose to design for a higher performance
- Building codes do not apply to facilities under Cal. Division of Safety of Dams (DSOD) jurisdiction

Examples of Regular and Essential Facilities

Facilities	Description	Examples
Regular	Normal occupancy	•Commercial buildings •Residential buildings •Manufacturing facilities
Essential	High occupancy/Special occupancy	•Schools •Hospitals •Jails, detention facilities •Public utility facilities •Hazardous material storage facilities • Fire and police stations • Emergency shelters • Aviation facilities

Based on IBC 2009, ASCE 7-05

Examples of Design Peak Ground Acceleration in Recent Codes

Codes	Year in Effect in Cal.	Design Peak Ground Acceleration (PGA)+		
		Weymouth	USHQ	Skinner
UBC 1994	1995	0.4g	0.4g	0.4g
1994 Northridge Earthquake - Resulted in codification of the near-source effect*				
UBC 1997	1998	0.52g	0.4g	0.4g
Seismic hazard map updated to reflect the adoption of Maximum Considered Earthquake Ground Motion as the basis of structural design				
IBC 2009	2010	0.71g	0.59g	0.4g

+The listed PGA values are based on generic seismic hazard maps included in the codes. A site-specific analysis may result in different values.
*Other factors such as frequency contents and shaking duration will result in adverse effect on structures that cannot be captured by PGA along. The effect is more pronounced when the site is close to earthquake epicenter, and accounted for by amplifying PGA.

How to define seismic performance of structures?

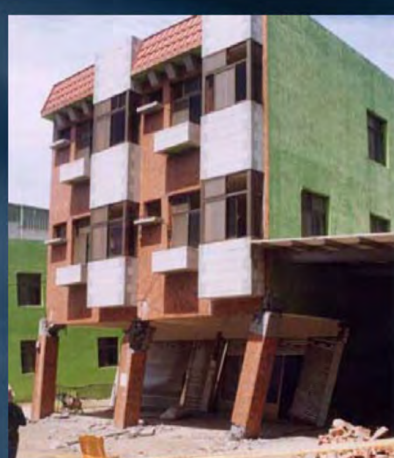
Structural Performance Level*	Expected Performance	Post-Earthquake Assessment
Immediate Occupancy	• Limited structural damage • Safe to occupy immediately after earthquake with minor repair	Green
Life Safety	• Significant structural damage; no imminent risk of collapse • Occupants would safely evacuate from the building • Not safe to occupy w/o major repair. Repair may be economically impractical.	Yellow or Red
Collapse Prevention	• Extensive structural damage and on verge of partial or total collapse • Building is likely damaged beyond repair both technically and economically	Red

*As defined in ASCE 41-06 Seismic Rehabilitation of Existing Buildings

Example of life safety performance

1999 Chi-Chi (Taiwan) Earthquake

Example of collapse prevention performance



1999 Chi-Chi (Taiwan) Earthquake

What's the expected seismic performance of a structure meeting current code requirements?

- Regular Facilities
  - The objective is to allow safe evacuation of occupants (Life Safety), instead of focusing on prevention of structural damage
- Essential Facilities
  - The objective is to allow continuous operation of the building (Immediate Occupancy) with limited structural damage
- The expected performances are for the design earthquake (2/3 of MCE Ground Motion)

Does the building code require existing structures to be upgraded to the current code requirements?

- No, but there are a few exceptions
- Exceptions
  - Type of structural system known to have significant inherent deficiencies: unreinforced masonry or block wall structures
  - Structures required for post-earthquake disaster response: hospitals and emergency response centers
  - Extensive addition/alternation
- Owners can reduce seismic risk with voluntary upgrades

What's the acceptable seismic performance level for an existing structure, as it may not meet the current code requirements?

- Depending on post-earthquake functions of the building, the owner may choose the desired performance level
  - Immediate Occupancy
  - Life Safety
  - Collapse Prevention
- Non-building structures (reservoirs, tanks...) are designed based on consensus standards and guidelines (e.g. ASCE, ASME, AWWA...)
  - Operational
  - Prevention of uncontrolled release of contents

What seismic performance are specified in MWD's seismic design criteria?

Building Type Structures				
Importance Designation	**Essential Facilities**		**Regular Facilities**	
	New	**Existing**	**New**	**Existing**
Building Code and Industry Standards	CBC ASCE 7	CBC ASCE 41	CBC ASCE 7	CBC ASCE 41
Design Intent Per Code/ Standard Language	Provide a larger margin against collapse in MCE and remain operational in Design Earthquake (2/3 MCE)	Enhanced performance against life safety in Design Earthquake	Collapse prevention in MCE and prevent life threatening damage in Design Earthquake	To achieve life safety in Design Earthquake
Metropolitan Seismic Design Objective	To remain operational following a major seismic event	Intended to maintain occupancy immediately following a major seismic event	May experience significant damage, but would prevent life threatening injury or casualty following a major seismic event	May experience significant damage, but would prevent life threatening injury or casualty following a major seismic event

What seismic performance are specified in MWD's seismic design criteria? (Cont.)

Water Containing Structures				
Importance Designation	**Essential Facilities (Related to Water Delivery)**		**Regular Facilities (Not Related to Water Delivery)**	
	New	**Existing**	**New**	**Existing**
Building Code and Industry Standards	CBC ASCE 7 ACI350 AWWA D100 API 650	CBC ASCE 41 ACI350 AWWA D100 API 650	CBC ASCE 7 ACI350 AWWA D100 API 650	CBC ASCE 41 ACI350 AWWA D100 API 650
Design Intent Per Code/ Standard Language	Provide a larger margin against failure in MCE and require a higher level of liquid tightness to maintain serviceability in Design Earthquake (2/3 MCE)	Not differentiated.	Prevent catastrophic failure in MCE and prevent uncontrolled release of liquid in Design Earthquake	Not differentiated.
Metropolitan Seismic Design Objective	To remain operational following a major seismic event	To remain operational or can be restored quickly following a major seismic event	May experience significant leak and require dewatering to repair, but would prevent uncontrolled release of liquid following a major seismic event	May experience significant leak and require dewatering to repair, but would prevent uncontrolled release of liquid following a major seismic event

Appendix 7

Summary of Previous Metropolitan Seismically Induced Damage Studies

This page intentionally blank.

The impact of earthquakes on Southern California and on Metropolitan's system has been the subject of several previous internal and external assessments:

Seismic Risk Assessment of Local Water Production Facilities in the Service Area of Metropolitan Water District of Southern California, **January 14, 1991, Dames & Moore.** This is a comprehensive report on the effects of a major earthquake on the Southern San Andreas Fault. The report has various models for estimating damage and concludes that there could be hundreds of local water pipelines damaged, loss of power, etc. Metropolitan feeders that are vulnerable to damage were identified, and the report estimates that Metropolitan service will be lost for 6 months or less. The report also predicts significant damage to ground water wells.

Probable Maximum Loss Analysis for Metropolitan Water District of Southern California**. September 1998, EQE International.** This report was prepared to assess the potential monetary loss associated with several earthquake scenarios. This report highlighted the potential for widespread damage resulting from an earthquake. The study did not address the impact on deliveries or system recovery.

Assessment of Frequency of Recovery Plan and Extreme Events within the Metropolitan Water District Service Area, **December 2001, Geomatrix Consultants.** This report was prepared to aid in the evaluation of hazards under the System Reliability Plan (see next report). This report evaluated the probability of earthquakes of two levels of severity within Metropolitan's service area. The first was a moderate (strong) earthquake similar to the Northridge earthquake (M6.7) and the second was an extreme event, on the order of M7.5. The report provided information on the probability of these earthquakes both within each of Metropolitan's operating regions and within the service area as a whole. The scope of the report did not include evaluating the impact on service or time for recovery.

Distribution System Reliability Assessment, (Report No. 1227), **December 2006, Metropolitan Facility Planning staff.** This report evaluated the reliability of the distribution system. In addition, a separate section of the report dealt with the vulnerability of Metropolitan's facilities to various initiating events. The report addressed the probability of failures in the system due to various random causes including earthquakes. It utilized information from the Geomatrix study to estimate the probability of seismically induced failures. Estimates for the recovery time from the various events were provided.

Facility Reliability Assessments, **2006, Metropolitan Facility Planning staff.** Reliability assessments were conducted by Metropolitan of the five treatment plants and the Colorado River Aqueduct. These assessments evaluated the susceptibility of individual facilities to a series of hazards such as fire, flooding, and earthquakes. Earthquakes were identified as one of the highest risk hazards because of the potential to cause numerous simultaneous failures. The reliability assessments identified structures that had not been updated to the latest seismic criteria. As part of the Seismic Upgrade Program, these structures have been evaluated. Where necessary, capital projects were initiated to upgrade the facilities to the most recent building codes. Completed Facility Reliability Assessments are listed below:

- *Diemer Water Treatment Plant Reliability Assessment, (Report No. 1225),* 2006
- *Skinner Water Treatment Plant Reliability Assessment, (Report No. 1246),* 2006
- *Weymouth Water Treatment Plant Reliability Assessment, (Report No. 1255),* 2006

- *Mills Water Treatment Plant Reliability Assessment, Report No. 1269,* 2006
- *Jensen Water Treatment Plant Reliability Assessment, Report No. 1280,* 2006
- *Colorado River Aqueduct Reliability Assessment, Report No. 1297,* 2006

***System Reliability Study,* 2007, Metropolitan Facility Planning staff.** This study evaluated the reliability of the entire system. This study examined the impact of single failures within the system on the ability to deliver water to member agencies and identified existing backup options. The failures considered included individual facilities as a unit (e.g., a treatment plant or a reservoir). For pipelines, the study considered a failure in each isolatable segment of the line. The impact on deliveries to each service connection was identified and over 250 different events were studied. The study considered capabilities within Metropolitan's system, as well as the member agencies', to mitigate the failures. This study did not consider multiple failures that might be associated with an earthquake due to the almost unlimited number of combinations of failures that would have to be considered.

Golden Guardian 2008. In November 2008, under the auspices of the USGS, Caltech and Earthquake Research Associates, a major disaster drill was conducted in Southern California. The drill was based on a magnitude 7.8 earthquake on the San Andreas Fault (Golden Guardian Exercise). The preliminary studies conducted as part of the exercise indicated that major damage is expected. The impact on water systems was one of the areas of focus for the drill and the related studies. The studies concluded that in areas impacted heavily, water service could be lost for six months.

***Potential Effects of Southern California Seismic Events on Metropolitan Water Deliveries (Report No. 1335)*, January 2009, Metropolitan Facility Planning staff.** This report provided a perspective on the magnitude of damage that could result from moderate and extreme earthquakes, the corresponding potential impacts on Metropolitan water deliveries, and estimated time frames for restoring service. The report also offered recommendations for reducing the potential impacts of certain significant seismic events.

***Mills Water Supply Reliability Study (Report No. 1337),* Metropolitan Facility Planning staff.** The Mills study was prepared in response to findings of the Integrated Area Study, which identified risks to the raw water supply to the Mills plant. The study evaluated alternatives to improve the reliability and redundancy of the raw water supply to Mills. A capital project has been initiated to implement one of the options.

***Potential Impact of a Seismic Event on the CRA Tunnels (Report No.* 1478), August 2014, Metropolitan Facility Planning staff.** This is the first report of a comprehensive study of the seismic vulnerability of the CRA. Five companion reports (Metropolitan Report Numbers 1470, 1484, 1485, 1490 1558) are described below. This study evaluated the vulnerability of CRA tunnels to damage from a major seismic event, provided a perspective of the level, extent and type of seismic damage that could be imposed on CRA tunnels, and estimated the time frame to restore service. The results of the study showed that most of the CRA tunnels are expected to perform well following a large seismic event. Of all the CRA tunnels, only the area near the west portal of the San Jacinto tunnel would be subject to liquefaction, but this area would be easily accessible. The area above the west portal of the San Jacinto tunnel could also be subject to seismically induced landslides, but a project was completed in 1998 to mitigate the potential damage from a landslide at the portal. For the remainder of the tunnels, the potential to experience heavy damage from landslide or rockfalls is negligible. Despite traversing a highly seismic area, there are only three instances of the CRA tunnels crossing a known active fault: Whitewater Tunnel No. 2, Thousand Palms Tunnel No. 2, and Wide Canyon Tunnel No. 2. Of these three tunnels, Whitewater Tunnel No. 2 would likely experience the most significant displacement from a fault rupture.

For ground shaking, while a number of the tunnels could experience high levels of shaking based on estimated Peak Ground Acceleration (PGA), most of these tunnels are deep and constructed in hard rock, which is beneficial for their performance during an earthquake. However, approximately 4.2 miles of tunnel were identified as having a high potential of experiencing heavy damage from the Maximum Considered Earthquake (MCE). These are areas that have shallow cover (e.g. near portals) and experience high PGA values. It should be noted that the entire 4.2 miles would not be expected to be damaged from a single earthquake, but rather there would be isolated areas of damage with those identified tunnel sections. A CIP has been submitted to further investigate the vulnerability of these tunnel sections and to identify options to mitigate the risk.

The Whitewater Tunnel No. 2 was identified as having the greatest cumulative seismic risk. The tunnel is crossed by the Garnett Hills segment of the San Andreas Fault which, from the San Gorgonio Pass Seismic Event Vulnerability Study (Report No. 1484; 2014), could experience up to a 12 foot horizontal and 3 foot vertical offset from a rupture of the San Andreas Fault approximating the MCE. The tunnel could also experience very high levels of shaking from the MCE, and was constructed in compacted sands and gravels, which could negatively impact the performance against the shaking.

For the purpose of estimating repair times, a worst-case damage scenario was developed for the Whitewater Tunnel No. 2, and a tunnel repair workshop was conducted to get a realistic understanding of repair methods and repair times (reference Report No. 1485).

***Colorado River Aqueduct – San Gorgonio Pass Seismic Event Vulnerability Study (Report No. 1484),* July 2014, GeoPentech.** This study evaluated the potential for horizontal and vertical deformation following a large seismic event within the San Gorgonio Pass area. To assist in the study, a team of geoscientists experienced in assessing the potential for fault displacements along the southern San Andreas Fault System in the area of the San Gorgonio Pass was assembled under GeoPentech, Inc. The study incorporated the most recent information available regarding the seismicity of the area including: geology, geodesy, seismicity, paleoseismology, and tectonics.

The information gathered during the course of the study was used to develop a 3-dimensional deformation model of the San Gorgonio Pass area using Coulomb 3.3 (San Gorgonio Pass Model). The model was developed to estimate the surface fault displacement and deformation that would occur along and near the CRA within the San Gorgonio Pass as a result of future seismic events. The results of the San Gorgonio Pass Model were compared to current geologic and geomorphic data, which showed a reasonable reflection of the natural conditions of the area, validating the results of the model.

The MCE for the southern San Andreas Fault would be a rupture originating near the Salton Sea around Bombay Beach and extending through the San Gorgonio Pass up to between Wrightwood and Three

Points. Based on available geologic data, the most likely event on the San Andreas Fault to rupture in on the Garnett Hills Fault, which is a strand of the San Andreas Fault system located in the San Gorgonio Pass. Results from the San Gorgonio Pass Model indicate that an earthquake approximating the MCE for the Southern San Andreas Fault System could result in a horizontal offset of approximately 12 feet and a vertical deformation of approximately 3 feet at the Garnett Hills Fault crossing of the CRA. The vertical deformation would extend over the CRA for approximately 60 miles.

The seismic event would result in uplift along the longitudinal profile of the CRA with three separate peaks, with the last peak occurring at or near the Whitewater Tunnel No. 2 and resulting in a cumulative upward deformation of approximately 3 feet. This upward deformation of the CRA would reduce the flow carrying capacity of the aqueduct. An accompanying probabilistic rupture hazard analysis of the San Gorgonio Pass (Report No. 1470) showed that the above deformation occurring at the CRA crossing has a return period of approximately 750 years.

***The Colorado River Aqueduct San Gorgonio Pass Seismic Event Vulnerability Study – Hydraulic Analysis, (Report No. 1558),* September 2014, Metropolitan Facility Planning and Hydraulics staff.** This study documents a detailed hydraulics analysis that evaluated the impact of a seismically induced vertical uplift of the CRA alignment over a length of approximately 60 miles, based on the uplift profile from the San Gorgonio Pass Seismic Event Vulnerability Study (Report No. 1484). The analysis showed that despite the uplift, Metropolitan would be able to continue flowing approximately 1300 cubic feet per second, approximately 80 percent of design flow, through the aqueduct after initial rapid repairs are completed. The analysis assumed free surface flow with a 3-foot minimum freeboard, the same as the current aqueduct design. Minor pressurization of the system could allow for some additional flow if required. The analysis also assumed that repairs to the CRA following the earthquake maintained the design cross sections and friction of the non-damaged CRA sections, and that no repairs were done to reestablish the grade.

***Probabilistic Rupture Hazard Analysis of CRA at San Gorgonio Pass (Report No. 1470),* October 2014, Metropolitan staff.** This report is a supplemental report to Report No. 1484, "Colorado River Aqueduct – San Gorgonio Pass Seismic Event Vulnerability Study." The report documents the results of a probabilistic rupture hazard analysis of the CRA where it crosses the Garnett Hills segment of the Southern San Andreas Fault in the San Gorgonio Pass. The analysis showed that the projected 3-foot vertical and 12-foot horizontal surface deformation at the CRA crossing in the San Gorgonio Pass has a return period of approximately 750 years.

***Colorado River Aqueduct Seismic Vulnerability Investigations – Summary Report (Report No. 1490)*, December 2014, Metropolitan Facility Planning staff.** This report briefly summarizes the results of the CRA seismic vulnerability studies (Reports 1478, 1484, 1485 and 1558).

***Seismic Risk Assessment – Conveyance and Distribution System Tunnels (Report No. 1533),* March 2016, GeoPentech and Metropolitan Facility Planning staff.** This study evaluated the seismic risk of the 41 tunnels within Metropolitan's Conveyance and Distribution System to heavy damage during a future maximum considered earthquake (MCE) event that would adversely impact water deliveries to member agencies while the tunnel is out of service for repairs. The study was completed through a two part process. Part 1 screened each of the 41 tunnels and identified tunnels that were vulnerable to one or more seismic hazard, and could result in a loss of service to the member agencies (i.e., no backup capability) if flow through the tunnel is disrupted. Tunnels that met both criteria in Part 1 were deemed a potential seismic risk to Metropolitan's water delivery reliability and were pushed through to Part 2 of the process. Part 2 further evaluated each of the potential high-risk tunnels identified in Part 1 and numerically ranked each tunnels degree of seismic risk in order to identify which tunnel(s) may pose the greatest risk to Metropolitan's water delivery capability.

This page intentionally blank.

Appendix 8

Administrative Code Section 4503 "Suspension of Deliveries" and 9/21/06 IAS Clarification

This page intentionally blank.

§ 4503. Suspension of Deliveries.

(a) Whenever repairs or maintenance of the District's system, in the opinion of the Chief Executive Officer of the District, shall require suspension of delivery of water at any point or points, such delivery may be suspended without liability on the part of the District; provided, that except in cases of emergency, as determined by the Chief Executive Officer, notice of such suspension of service shall be given to the affected member public agency in advance of such suspension. Metropolitan will make a concerted effort to notify and work with member public agencies regarding all scheduled interruptions. The District will schedule non-emergency interruptions for the low demand months of the year, typically October through April, in coordination with the member public agencies.

(b) Each member agency shall have sufficient resources such as local reservoir storage, groundwater production capacity, system interconnections or alternate supply source to sustain a seven-day interruption in Metropolitan deliveries based on annual average demands. If a member public agency has been provided with a sixty (60) day notice of when an interruption in service is to occur, the member public agency shall be responsible for and reimburse direct costs, excluding labor costs, incurred by Metropolitan in the event that a scheduled non-emergency interruption of up to seven days is postponed or cancelled at the request of the member public agency as a result of insufficient local resources, and the District agrees to such cancellation or postponement. Direct costs shall be determined by Metropolitan's Chief Executive Officer, in consultation with the affected member agency. These direct costs shall be applied to the member public agency's water invoice following cancellation or postponement of the shutdown.

(c) Except in cases of emergency, the District, working with the member agencies, will produce a shutdown schedule each September for the annual shutdown season from October through April. The District will also develop a three-year shutdown schedule, which will give notice of the proposed shutdowns greater than seven days at least one-year in advance.

(d) Replenishment Service certifications will be adjusted for the reduction of credits that are accrued due to shutdowns that are greater than seven days. No adjustments will be made for shutdowns seven days or less unless the member agency provides a service to the District by serving another member agency in-lieu of District deliveries during a shutdown even if the shutdown is seven days or less.

Section 322.4 based on Res. 7260 – May 12, 1970, amending Res. 3896 – August 18, 1950; amended by M.I. 33642 – March 10, 1981. Section 322.4 repealed and Section 4503 adopted by M.I. 36464 – January 13, 1987, effective April 1, 1987; amended by M.I. 42278 - February 11, 1997; paragraph amended by M. I. 44812 - March 12, 2002; paragraph amended by M. I. 45943 – October 12, 2004; paragraphs assigned (a), (b), (c), & (d) designations and amended by M. I. 45988 – November 9, 2004.

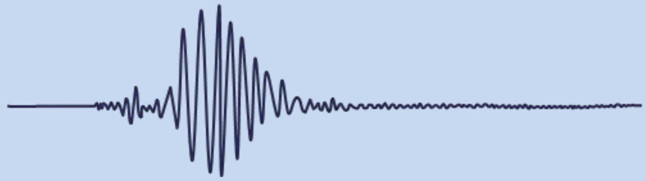
2007 Integrated Area Study (IAS) Clarification

1. Original intent
    a. Communicated that MWD's system is interruptible
    b. Protected MWD from liability claims for required shutdowns
    c. Illustrated commitment to minimizing impacts
        i. Advanced notice & coordination
        ii. Non-emergency outages only during low flow months
    d. Required member agencies to make provisions for outages
        i. 7-day supply of average annual demands
        ii. No enforcement – no penalty

2. Updated text & interpretation
    a. Recognized changing conditions
        i. Increased member agency dependence upon MWD
        ii. Many agencies in non-compliance
        iii. Increased difficulty in storing treated water
    b. Revised requirement for member agency outage provisions
        i. Capability to sustain 7-day interruption (not limited to supply)
        ii. Penalty added for cancellation or postponement of outage

3. IAS clarification
    a. MWD planned outages are required to maintain long-term reliability
    b. Unplanned MWD outages may also occur
    c. Intent of 4503 was to encourage agency provisions for planned and unplanned outages
    d. Compliance not enforced (beyond interference with planned outages)
    e. Member agencies responsible for decisions regarding provisions for unplanned outages
    f. Regional flexibility improvements achieved through demand-driven LRP & IAS projects

REPORT



SEISMIC RESILIENCE REPORT

2020 UPDATE

The Metropolitan Water District of Southern California

700 N. Alameda Street, Los Angeles, California 90012

Report No. 1551-1

February 2020

Seismic Resilience Report 2020 Update

Prepared By:

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

Report Number 1551-1
February 2020

Prepared under the direction of:

John Bednarski	Chief Engineer

Prepared by:

Albert Rodriguez	Engineering Services

Reviewed by:

Deven Upadhyay	Assistant General Manager/Chief Operating Officer
Brent Yamasaki	Water System Operations
Catherine Stites	General Counsel
Tobin Tellers	Engineering Services
Cash Spradling	Engineering Services
David Clark	Engineering Services
Arlene Arita	Engineering Services
John Shamma	Engineering Services
Howard Lum	Engineering Services
Grace Chan	Water Resources Management
Kevin Donhoff	Water Resources Management
Jack Safely	Water Resources Management
Ian Whyte	Water System Operations
Greg de Lamare	Engineering Services

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.

Publication History:

Initial Release (First Biennial Report No. 1551)	*February 2018*
2020 Update (Report No. 1551-1)	*February 2020*

Cover Photo: Test setup for large diameter seismic-resilient ductile-iron pipe to be used on Metropolitan's Casa Loma Siphon

CONTENTS

This Page Intentionally Left Blank

EXECUTIVE SUMMARY

In February 2018, the Metropolitan Water District of Southern California (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 purpose of the update is to document revisions to Metropolitan's Seismic Resilience Strategy, document seismic-resilience-related studies completed since publication of the 2018 Report, list the achievements related to the seismic performance objectives and near-term goals identified in the 2018 Report, and communicate new performance objectives and goals that will further increase the seismic resilience of Metropolitan's system.

Since the publication of the 2018 Report, Metropolitan has initiated multiple studies that will improve planning for earthquake response. Completed studies include an evaluation of Metropolitan's emergency storage requirements and an evaluation of the susceptibility of the conveyance and distribution pipelines to liquefaction. Staff is also nearing completion of an assessment of the potential damage to the conveyance and distribution pipelines from different earthquake events.

In the last two years, Metropolitan has also completed construction for seismic upgrades to 17 structures. Additionally, Metropolitan substantially completed the initial round of seismic evaluations for above-ground structures constructed pre-1990, which in general pose an elevated seismic risk. Evaluation of above-ground structures built post-1990 has been initiated as well as evaluation of hydraulic structures (e.g., reservoir outlet towers) to assess their seismic risk when compared to current design practices.

Finally, Metropolitan conducted over 100 emergency response exercises, workshops, and seminars since February 2018, including two large functional exercises. These exercises help to ensure that Metropolitan staff is prepared for when an eventual earthquake occurs. Metropolitan also started a new five-year exercise plan in 2019 that will allow all of its member agencies to participate in at least one of Metropolitan's annual emergency exercises during the next five years.

Overall, Metropolitan has achieved many of the near-term goals that were proposed in the 2018 Report and is continuing the efforts to complete the few items that are still outstanding. The strategy outlined in the 2018 Report to develop the seismic resilience of the system is an ongoing process that will continue to evolve and adapt as new information becomes available.

Staff recommends changing the frequency of written update reports from its current two-year cycle to a frequency of a written report every five years, with the next written report to the Board in 2025. Staff will continue to provide annual oral updates on Metropolitan's Seismic Resiliency Strategy to the Board.

This Page Intentionally Left Blank

SECTION 1 PURPOSE

The Metropolitan Water District of Southern California (Metropolitan) owns and operates a complex conveyance, storage, treatment, and distribution system that serves a 5,200-square-mile service area within an active seismic region. Over its approximate 90-year history, Metropolitan has been proactive in mitigating seismic risk posed to the system, as well as improving its ability to maintain or quickly restore water deliveries following a major earthquake.

In February 2018, Metropolitan published *Report No. 1551, Seismic Resilience First Biennial Report* (2018 Report), which summarized Metropolitan's historical approach to mitigating seismic risk and defined the organization's current Seismic Resilience Strategy and the core components of that strategy. The report also identified performance objectives and near-term goals of the Seismic Resiliency Strategy. The 2018 Report is available on Metropolitan's website using the link below:

http://mwdh2o.com/PDF_About_Your_Water/SRS%20Report%201551_Final_030518A_Submit_Reduced.pdf

The *2020 Seismic Resilience Report Update* is a supplement to the 2018 *Seismic Resilience First Biennial Report*. The purpose of the update is to document recent revisions to Metropolitan's Seismic Resilience Strategy regarding emergency storage requirements, document seismic-resilience-related studies completed since publication of the 2018 Report, and list the achievements related to Metropolitan's Seismic Resilience of Structures Program, emergency response planning, and the seismic performance objectives and near-term goals identified in the 2018 Report. The report also identifies new performance objectives and goals that will further increase the seismic resilience of Metropolitan's system.

This Page Intentionally Left Blank

SECTION 2 BACKGROUND

Seismic Risk

Southern California is crossed by numerous faults of varying levels of activity that are capable of generating large earthquakes and causing widespread damage. The 2018 Report listed six earthquakes that occurred within or near Metropolitan's service area in southern California since 1900 - four strong earthquake events (M6.0 – 6.9) and two major earthquake events (M7.0 to M7.9).

In 2019, two significant earthquakes events occurred in the region. On July 4, 2019, a M6.4 earthquake occurred near Ridgecrest, approximately 122 miles north/northeast of Los Angeles. Then on July 5th, a M7.1 earthquake occurred in the same vicinity. While the earthquakes caused major damage to Ridgecrest and the surrounding communities, the earthquakes only caused mild shaking in the Los Angeles region due to the distance from the epicenter. However, these earthquakes are a reminder that earthquake risk is always present and that the region must take steps to prepare and respond.

A map showing significant (M6.3 and greater) earthquakes that have occurred in the southern California region since 1900 is provided in Appendix A.

Seismic Resilience Strategy

Metropolitan's Seismic Resilience Strategy is comprised of four components that encompass the various functions that promote the organization's seismic resilience objectives.

Planning – Developing and maintaining a diversified water portfolio, system flexibility, and emergency storage 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

Metropolitan's Seismic Resilience Strategy was described in detail in the 2018 Report, and the overall structure of the strategy is unchanged. A detailed breakdown of Metropolitan's Seismic Resilience Strategy is provided in Figure 2-1. The figure provides an overview of the comprehensive actions taken to mitigate impacts from large earthquakes, to quickly respond following an earthquake event, and to provide transparency regarding seismic risk and preparedness.

As shown in Figure 2-1, 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 Department of Water Resources (DWR), and the Los Angeles Department of Water and Power (LADWP) to improve the seismic resilience of the imported water supply aqueducts.

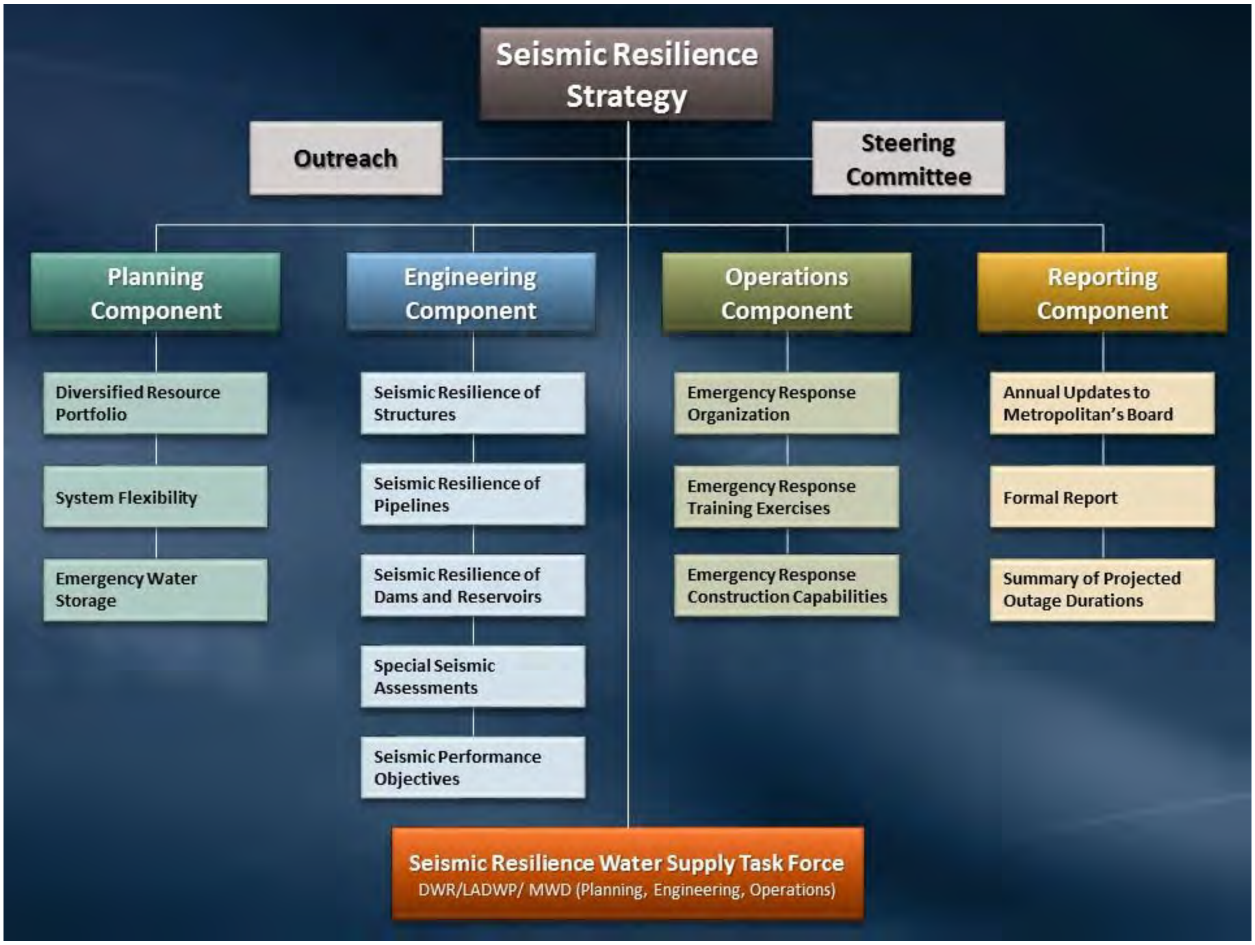


Figure 2-1: Detailed Breakdown of Metropolitan's Seismic Resilience Strategy

SECTION 3 SEISMIC RESILIENCE STRATEGY UPDATES/REVISIONS

Planning Component

Emergency Storage

Beginning in February 2018, Metropolitan and its member agencies convened a workgroup to evaluate regional storage, including the size and management of Metropolitan's emergency storage program. The goal of the emergency storage program evaluation was to update the emergency criteria and develop a revised methodology to determine emergency storage needs. The methodology and recommendation of the workgroup were described 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[1].

The update of the emergency criteria was based on 1) newly revised potential outage durations for the region's imported water supplies – the Colorado River Aqueduct (CRA), the Los Angeles Aqueduct, and the State Water Project east and west branches – following a seismic event, and 2) a revisit of retail water demand and locally available supplies within the service area. The revised outages were developed as part of the Seismic Resilience Water Supply Task Force. The workgroup took into account the capabilities of member agencies when identifying reduction of retail water demand and local production during an emergency outage of imported supplies. This is a critical change in that the previous storage calculation assumed 100 percent local production during the outage period.

Diamond Valley Lake

The new emergency storage criteria considered various combinations of local demand reduction and supply production to develop an envelope of scenarios designed to prevent a shortage during an outage. Based on the range of potential scenarios, the workgroup recommended 750,000 acre-feet for the emergency storage program target, an increase from the previous planning target of 630,000 acre-feet.

The emergency storage is assumed to be distributed among the available capacities of existing Department of Water Resources and Metropolitan surface reservoirs located on the coastal side of the San Andreas Fault. Since member agency demands for supplemental water will be met through deliveries of supplies from storage, evaluation of spatial distribution of storage and most effective operation of the

[1] The Metropolitan Water District of Southern California, Water Planning and Stewardship Committee, Board Item 9-3, "Update of Metropolitan's Emergency Storage Objective," May 2019. http://www.mwdh2o.com/WhoWeAre/Board/Board-Meeting/Board%20Archives/2019/05-May/Letters/064883968.pdf

distribution system will be accomplished as part of Metropolitan's continued efforts and coordination within Metropolitan's storage portfolio evaluation or other regional planning processes.

System Flexibility

In July 2019, Metropolitan's Board of Directors authorized an amendment to the Administrative Code to enable delivery of member agency water supplies in Metropolitan's system in an emergency subject to the General Manager's approval[2]. The amendment is an effort to enhance water delivery reliability after a serious emergency in which 1) Metropolitan is unable to make deliveries to a member agency due to physical damage to Metropolitan's system resulting from a natural disaster or other emergency and 2) there are no alternate means for Metropolitan or the member agency to provide service to an area without the use of a portion of Metropolitan's system. The Administrative Code change clarifies the conditions of these emergency deliveries in a proactive way, instead of a reactive way in response to damaged infrastructure following a natural disaster or serious emergency.

Engineering Component

Seismic Resilience of Structures

Metropolitan has developed an ongoing program for evaluating and upgrading its above-ground facilities with the goal of protecting life safety and critical infrastructure to minimize water delivery interruptions following a seismic event. The initial round of evaluations focused on structures that were deemed likely to be more susceptible to damage from earthquakes – buildings constructed prior to 1990. Structures built after 1990 were constructed in accordance with the 1988 or later versions of the Uniform Building Code, which provides reasonable assurance of withstanding a design-level earthquake without catastrophic failure. The program procedure for the seismic resilience of Metropolitan's above-ground structures was described in the *Seismic Resilience First Biennial Report* and the program status as of January 2018 was provided. Since publication of that report, an additional 17 seismic upgrades have been completed. Figure 3-1 provides the overall status for the pre-1990 structures as of November 2019. Of the 311 pre-1990 structures identified, 63 percent were found to be acceptable and 37 percent (116 structures) potentially deficient following the rapid evaluation process. Of the 116 structures, 85 have either been seismically upgraded or are in design or construction. The remaining are largely structures that are not related to water delivery.

The program for seismically upgrading the above-ground structures is meant to be a continuous program, with the intent of reevaluating structures periodically. Structures found to be acceptable during the initial evaluation round may undergo a reevaluation, if warranted by new information such as a significant increase in seismic design force or displacement due to code revisions or newly discovered ground conditions, damage of structural components, severe material deterioration, and/or changes of occupancy.

[2] The Metropolitan Water District of Southern California, Engineering and Operations Committee, Board Item 8-4 "Authorize Amendments to the Administrative Code Regarding Deliveries of Member Agency Supplies in Metropolitan's System in an Emergency; the General Manager has determined that the Proposed Action is Exempt or Otherwise Not Subject to CEQA", July 2019. http://www.mwdh2o.com/WhoWeAre/Board/Board-Meeting/Board%20Archives/2019/07-July/Letters/07092019%20BOD%208-4%20B-L.pdf

As shown in Figure 3-1, evaluation of the pre-1990 structures related to water delivery has been substantially complete and the deficient structures are being addressed. Following the 1994 Northridge earthquake, and subsequent earthquakes in Taiwan, Japan, and New Zealand, substantial research in seismic design and code revisions has taken place. Post-1990 structures may or may not meet the current seismic performance standards, which has prompted Metropolitan to expand the seismic evaluation to post-1990 structures, a process which was initiated in early 2019 to further improve its seismic resilience. Twenty-six structures have been identified as part of the post-1990 structure list. Rapid evaluations have been completed on six structures, and none have been identified as seismically deficient.

As Metropolitan begins its evaluation of the post-1990 above-grade structures, staff is also initiating a process to identify and systematically evaluate below-ground structures such as vaults and manholes. Similar to the evaluation of above-ground structures, the prioritization of these facilities will consider potential impacts to water delivery and potential for loss of life.

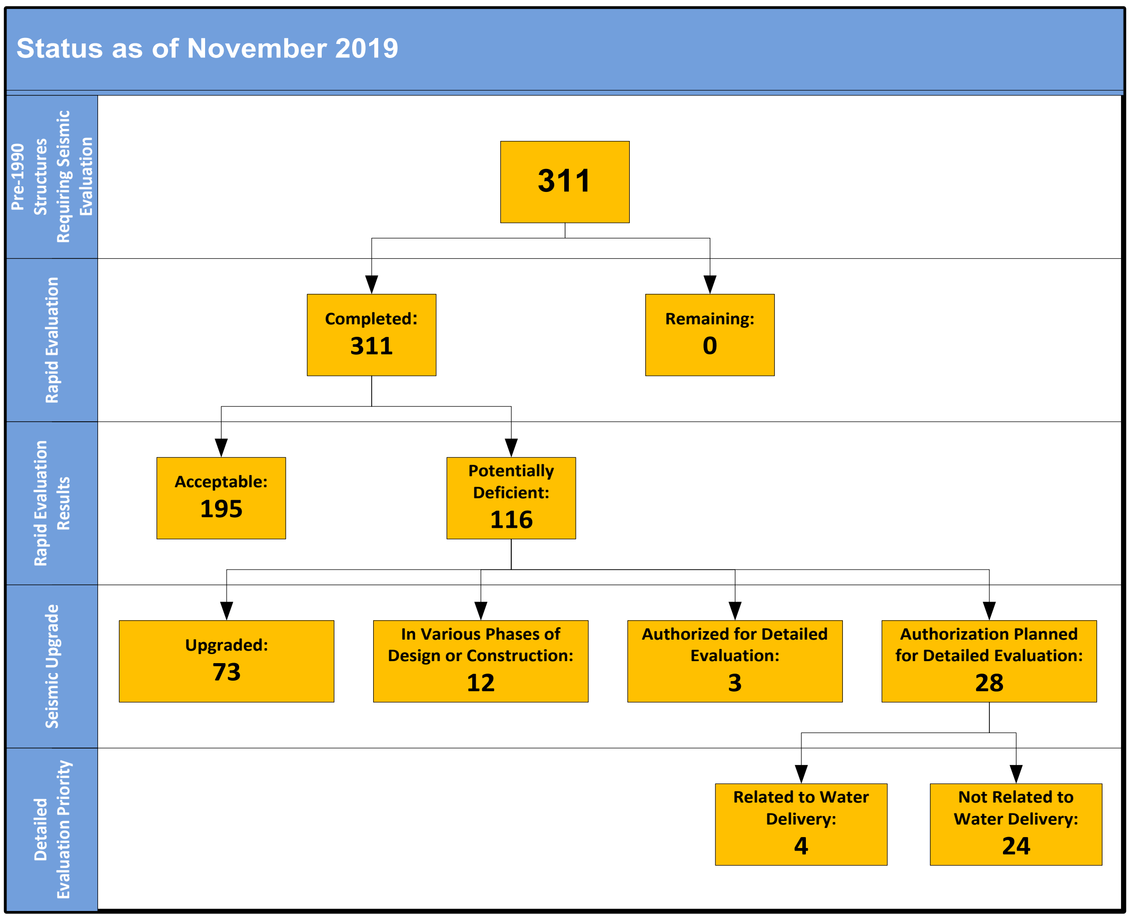


Figure 3-1: Status of Seismic Assessment and Upgrades of Pre-1990 Structures

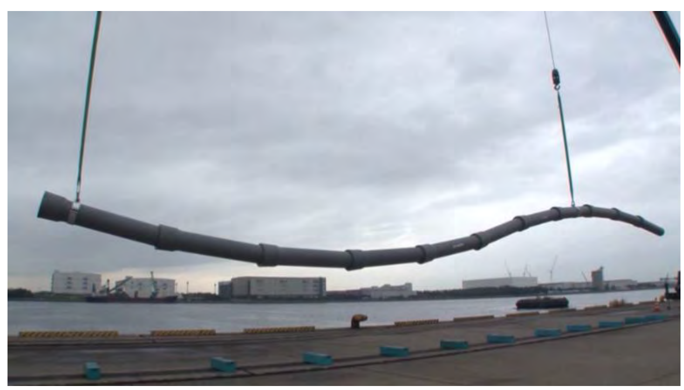
Seismic Resilience of Pipelines

Metropolitan's pipelines have been constructed in conformance with standards of practice at the time of design. Historically, there have been very few prescriptive code requirements for seismic design of pipelines. Only recently have there been developments in mitigation options for large diameter pipelines, including improved techniques to analyze the response of structures and pipelines within the ground from shaking, increased post-earthquake data collection of ground motions and damage observations, and demonstrated performance of earthquake-resistant pipeline products.

In keeping with the goals of the Seismic Resilience Strategy, Metropolitan is developing seismic design criteria for new pipelines based on current state of practice, geotechnical and seismicity criteria, operating conditions, and asset management strategies. The planned design approach for new pipelines will be to establish performance criteria, identify seismicity and ground conditions along the alignment, and design the pipeline to resist damage from ground shaking and deformation. Specialized pipe joints and sections can be designed to accommodate ground deformation from fault displacement or liquefaction. For existing pipelines, seismic resilience will be incorporated as a component of pipeline rehabilitation projects. Metropolitan will evaluate each upgrade individually to balance risk, performance, and cost. See the Seismic Performance Objectives in this section for more information on the pipeline seismic design.

Metropolitan is in the early years of a 20-year program to rehabilitate its prestressed concrete cylinder pipelines (PCCP), which, at 163 miles, makes up approximately 20 percent of Metropolitan's conveyance and distribution system. The initial phase of the program will focus on the Second Lower Feeder, which will be upgraded with an interior steel liner. The new steel lining and the welded joints are designed to improve the seismic performance of the pipeline. For Reach 9 of the Second Lower Feeder, Metropolitan is investigating alternatives for realigning the portion of the pipeline that crosses the Newport-Inglewood Fault. One alternative being evaluated is to use specialized large-diameter earthquake-resistant steel pipe to accommodate fault displacement while maintaining structural integrity of the pipe for water conveyance.

Following this strategy, Metropolitan is completing the final design for rehabilitation of the Casa Loma Siphon Barrel No. 1 on the CRA in 2020. The Casa Loma Siphon Barrel No. 1 crosses the San Jacinto Fault Zone and is subject to long-term subsidence-induced deformation from groundwater pumping. The project will replace 800 feet of the existing 148-inch diameter concrete pipeline with two parallel barrels of 104-inch diameter earthquake resistant ductile iron pipe (ERDIP). The ERDIP joints are designed to accommodate ground displacements without failure, which will allow for uninterrupted service following a major earthquake.



Earthquake-Resistant Pipe

Seismic Resilience of Dams and Reservoirs

Metropolitan's ongoing strategy for managing the safety of its 24 dams includes five major components: (1) Detailed Inspections; (2) Monitoring & Reporting; (3) Facility Assessments; (4) Emergency Action Plans, including Inundation Maps; and (5) Capital Projects for dam improvements and upgrades.

Consistent with the goals of the Seismic Resilience Strategy, Metropolitan performs cyclical assessments of its facilities that include: 1) developing dam seismic performance criteria based on current state of practice, geotechnical and seismicity criteria, and operating conditions, 2) selecting design or safety evaluation earthquakes, 3) characterizing ground motions, 4) analyzing seismic performance of the dams and foundations, and 5) evaluating structural adequacy of dam appurtenant structures for earthquake loading.

Finally, Metropolitan has an ongoing Dam Safety Initiatives Program that has initiated several plans to improve Metropolitan's dam seismic safety and earthquake readiness. These initiatives are being coordinated with the California Division of Safety of Dams (DSOD) and Office of Emergency Services and include the following:

- Ongoing preparation of Emergency Action Plans, including inundation maps
- Performing training exercises at the dam site to test processes during a seismic event
- Providing training and guidance on overall dam safety
- Reviewing operation and maintenance methods for reservoir drawdown and operations after a seismic event
- Updating guidelines and procedures on protection against seismic risk
- Establishing a strong communications system on seismic information
- Performing structural strengthening of dams, including rehabilitation and improvement of spillways and inlet/outlet towers such as Lake Skinner Outlet Tower
- Improving dam safety instrumentation, monitoring, and reporting capabilities

Special Seismic Assessments

Metropolitan conducts studies to further the organization’s understanding of the vulnerability of the 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. Recently completed and ongoing studies are described below.

Completed Study:

> ***Report 1625 - Liquefaction Susceptibility Mapping for the Metropolitan Water District of Southern California’s Feeder System*** **(Carollo Engineers, Inc., 2019)**. The liquefaction susceptibility mapping study provides a relative scale of liquefaction susceptibility of deposits along Metropolitan’s conveyance and distribution system, given sufficient earthquake ground motions. Existing liquefaction maps available from the California Geological Survey provide a conservative overview of potentially liquefiable areas without any delineation for relative susceptibility. Areas are marked as either liquefiable or not liquefiable. The study utilized available geologic mapping data as well as publicly available groundwater data to map the relative liquefaction susceptibility of Metropolitan’s conveyance and distribution pipelines for historical high and modern (1999 to 2019) groundwater depths providing five levels of relative scaling of susceptibility from very high to very low. The results of the study will be used to identify specific locations that may be targeted for future site-specific detailed liquefaction analyses, help prioritize pipeline replacement projects, and assess alternative pipeline alignments.

Studies currently underway:

Earthquake Damage Assessment of Metropolitan Water District Conveyance and Distribution Feeder System **(ABS Consulting, Inc.).** The study utilizes proprietary modeling software to estimate the potential number of pipeline breaks that may occur from various extreme earthquakes such as a Magnitude 7.8 earthquake on the South San Andreas Fault. The damage assessment model takes into account pipeline material and joint type, distance from earthquake source, and regional geologic conditions when developing the damage estimate. The results of the study will provide input into Metropolitan's earthquake emergency response planning and training activities, and help prioritize future pipeline seismic resilience enhancements. Anticipated completion is March 2020.

Seminars and Workshops

Metropolitan has recognized the importance of providing awareness of the seismic hazards and risks to Metropolitan, its member agencies, and sub-agencies and encouraging a transfer of knowledge of assessment and mitigation strategies to reduce seismic risk. Metropolitan ensures that risk awareness and knowledge transfer are promoted through active participation at various workshops.

In October 2019, Metropolitan co-hosted with LADWP the 11th Water System Seismic Conference. The conference is a bi-annual event that brings together utility, consulting, and academic professionals from the United States, Japan, and Taiwan to share knowledge in research, design practices, and construction technologies to prepare for and respond to seismic events. Conference topics included emerging design techniques, innovative construction practices, seismic damage assessments, seismic mitigation measures, and emergency response and recovery. In addition to co-hosting the conference, Metropolitan staff delivered four presentations on the organization's seismic resilience efforts. The papers and authors are listed in Appendix B.

Metropolitan Chief Engineer Providing Opening Remarks at 11th Water System Seismic Conference

In December 2019, Metropolitan co-sponsored the Earthquake Resilience Workshop for Water and Wastewater Utilities in Southern California. The workshop was a partnership with the United States Environmental Protection Agency and local utility and emergency management organizations to provide guidance and information to drinking water and waste water utilities to enhance their ability to enhance their resilience approach.

Staff also presented Metropolitan's seismic strategy and goals at the Member Agency Managers Meeting in August 2019. Staff described the various activities that Metropolitan conducts to understand the seismic risk and improve the overall resilience of the system. They also used the opportunity to promote the defense-in-depth approach to seismic resilience for the member agencies. This approach is a layered strategy of system hardening, emergency water supply diversification, and increased system flexibility, including potential interties between member agencies.

Seismic Performance Objectives

Structures

Metropolitan's facilities are categorized as either an essential facility or regular facility, depending on performance requirements of the structure in accordance with code requirements. The structures are then designed or rehabilitated to meet the design criteria specified in the applicable seismic codes.

Essential facilities are those that are required for Metropolitan's core business-water delivery. All structures that are directly or indirectly related to water conveyance, storage, treatment and distribution are considered essential. Additionally, structures that contribute to Metropolitan's business continuity are also considered essential. The performance objective for an essential facility is to allow for continuous operation of the structure with limited damage after a maximum considered seismic event. These essential facilities are designed or improved to allow for immediate occupancy or continuous operation after a major seismic event. As an owner/operator of essential lifeline facilities, Metropolitan's water-related facilities will remain functional for disaster relief and fire suppression following a seismic event.

For regular facilities, the objective is to allow safe evacuation of occupants with possible structural and non-structural damage. The performance objective is to ensure life safety and prevent collapse of the structure. A facility designed as a regular facility may require significant repair following a major seismic event.

Pipelines

Metropolitan's conveyance and distribution pipelines are considered essential pipelines that are required for post-earthquake response and recovery. The pipelines are intended to remain functional and operational during and following a maximum considered earthquake. No uncontrolled release of a substantial amount of water is permitted under this design scenario.

Metropolitan continuously improves its techniques to analyze the response of pipelines to a seismic event to improve its assessment and prediction of earthquake damage to these facilities. Post-earthquake data of ground motion and damage information are used to improve earthquake resilience design methodologies. The data collected is used in advanced seismic pipeline analysis that relies on finite element techniques for soil-structure 3d modeling. Innovation in the development of earthquake-resistant pipeline products contributes to better seismic performance.

For new pipeline seismic design, the performance objective is to ensure the pipeline, pipe joints, and pipe-to-structure connections are capable of resisting the seismic shaking resulting from earthquake wave propagation without permanent damage. As the pipeline crosses known earthquake faults, the system will be designed to accommodate the maximum anticipated ground movement from fault displacement using specialized joints or pipe sections. Automatic shutoff valves may be added on either side of the fault to increase system flexibility.

For existing pipeline seismic design, a comprehensive risk assessment of the system using the latest seismicity and pipeline fragility data will be performed. The vulnerabilities of each pipeline segment will be used to determine the priority and schedule of seismic rehabilitation. Seismic resilient design to resist shaking and accommodate fault displacement will be incorporated as components of the rehabilitation program. Each upgrade will be evaluated individually to balance risk, consequence, performance, and cost to define an economical long-term approach.

Operations Component

Emergency Response Training Exercises

In addition to training emergency response staff on National Incident Management System procedures, Metropolitan regularly conducts emergency response training exercises which have often been based upon a postulated seismic event.

Recent examples include:

- "ShakeOut" Full-Scale Emergency Operations Center (EOC)/Incident Command Post (ICP) Exercise, October 17, 2019
- "Joint Infrastructure Security Exercise"- Tabletop Exercise with various Federal, State, and Local emergency management partner agencies- April 10, 2019
- "Operation Nomad"- Functional EOC/ICP and member agencies, November 14, 2018

In 2019, Metropolitan started a new five-year emergency exercise plan that will allow all of its member agencies to participate in at least one of Metropolitan's annual emergency exercises. The first of these exercises was a tabletop exercise for the Orange County member agencies on August 29, 2019, which focused on a hypothetical incident at the Diemer Water Treatment Plant.

Metropolitan has conducted over 100 exercises since February 2018. This included two large functional emergency exercises for the EOC and multiple tabletop exercises, workshops, and seminars for the 12 Incident Command Posts located at the water treatment plants, conveyance and distribution facilities, and other strategic locations in Metropolitan's service area.

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.

Emergency Response Capability

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 addition, Metropolitan has upgraded its satellite phones to ensure communication ability following a seismic event and is in the process of installing high frequency radios at all Incident Command Posts (formerly Incident Command Centers) and the Emergency Operations Center.

Reporting Component

Formal Report

The interval for development of a formal report will be changed to every five years from the original two-year interval. Increasing the time interval between report updates will allow for a full Capital Investment Plan cycle to complete and for projects to move through concept, design, and construction.

Seismic Resilience Water Supply Task Force

The Seismic Resilience Water Supply Task Force (Task Force) is a collaborative effort involving Metropolitan, DWR, and LADWP to improve the seismic resilience of the imported water supplies to southern California. Following a major earthquake that disrupts the imported water supplies, the agencies would coordinate resources to repair the imported water supply aqueducts to ensure that deliveries are restored as quickly and to as many people as possible.

In March 2018, Metropolitan, DWR, and LADWP convened an aqueduct workshop to discuss lessons learned from recent large earthquakes in New Zealand, Japan, and Mexico; share each agency's approach to conducting seismic assessments; and discuss potential interties that may assist with recovery of water supply to the region. The group also had initial discussions on development of an emergency response plan specific to the Task Force.

Seismic Resilience Water Supply Task Force Aqueduct Workshop – March 2018

The Task Force also conducted two tabletop emergency exercises in 2018 and 2019. These exercises were used to give substance to some of the ideas in the Joint Agency Emergency Response Plan (ERP).

Metropolitan, DWR, and LADWP are developing a Water Mutual Assistance Agreement (WMUA), which will formalize the Task Force and define the reporting and accounting requirements for mutual assistance following a major seismic event that impacts imported water supplies. A draft of the Joint Agency ERP has also been completed. The Joint Agency ERP will be finalized along with the WMUA. The plan defines the scenarios that would trigger the deployment of the Multi-Agency Coordination Group, which enhances the collaboration in operation, reporting, and plan maintenance.

This Page Intentionally Left Blank

SECTION 4 SEISMIC RESILIENCE NEAR-TERM GOALS

Status of 2018 Listed Goals

The 2018 Seismic Resilience First Biennial 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.

System Level Goals

Goal	Conduct Rialto Pipeline Alternative Supply Needs Study
Status: Metropolitan completed an initial study to identify the near-term and long-term emergency supply needs for member agency demand from the Rialto Pipeline. The Rialto Pipeline is exclusively supplied from the California Aqueduct East Branch and is susceptible to extended disruption from an earthquake on the San Andreas Fault. The study also identified options to meet emergency supply needs. Metropolitan is currently working with member agencies to expand on the emergency supply options.	

Goal	Complete a Re-evaluation of Metropolitan's Emergency Storage Needs
Status: Metropolitan, in coordination with member agencies, completed a re-evaluation of Metropolitan's emergency storage needs and presented the recommendations to increase storage from 630,000 acre-feet to 750,000 acre-feet to Metropolitan's Board in May 2019. A description of the emergency storage re-evaluation is provided in Section 3.	

Goal	Complete a Comprehensive Evaluation of Metropolitan's Storage Programs
Status: Metropolitan, in coordination with member agencies, will complete the 2020 Integrated Water Resources Plan (IRP). Metropolitan will use newly developed demand and supply forecasts to analyze its entire supply portfolio, including all storage programs, in assessing regional reliability.	

Facility Level Goals

Goal	Complete Construction of Approved Seismic Upgrade Projects
Status: Construction has been completed for the listed projects. • Carbon Creek Pressure Control Structure • Ten Control Structures along the Allen-McColloch Pipeline • Diemer Administration Building • CRA Pump Plants Switch Houses (Five Buildings) • Weymouth West Wash Water Tank	

Goal	Conduct Studies, and Complete Design of Approved Upgrade Projects

Status:

- Assessment of potential seismic-induced damage to Metropolitan's water conveyance and distribution pipelines

  Studies to estimate damage from shaking and at fault crossings from large earthquakes and liquefaction susceptibility of pipelines are in progress with an estimated completion date of March 2020. See Special Seismic Assessments under Section 3.

- Seismic upgrade for Diemer West Filter Building

  Completed design and construction of seismic upgrades is ongoing with an estimated completion date of December 2020.

- Complete evaluation of options, design, and construction contract to strengthen CRA Whitewater Tunnel No. 2

  Preliminary design is underway.

- Investigate options to improve emergency raw water bypass capabilities at treatment plants

  Study is ongoing.

- Vulnerability Study of CRA electric transmission and distribution systems

  Completed CRA Electric Transmission System Towers Reliability Study, which considered seismic vulnerability in addition to other hazards.

- Seismic Upgrade of Water Quality Lab in La Verne

  Project is currently in design.

- Seismic Upgrade of Weymouth Administration Building

  Project is currently in design.

- Seismic Study of Lake Skinner Outlet Tower

  Completed voluntary seismic assessment of the tower which considered current dam safety criteria

<u>Emergency Response Goals</u>

Goal 1:	**Prepare and Conduct Emergency Exercises**

Status:

- Conduct a joint agency workshop to prepare a draft Joint Agency Response Plan
- Conduct high-level training for DWR, LADWP, and Metropolitan staff on the Joint Agency Emergency Response Plan
- Run a functional exercise on the Joint Agency Emergency Response Plan

  Metropolitan conducted joint agency tabletop exercises to develop the Joint Agency Emergency Response Plan in 2018 and 2019. The functional exercise will be conducted following finalization of the Joint Agency Emergency Response Plan.

Goal 2:	**Execute MOU to Allow for Coordinated Emergency Response**

Status:

- Prepare draft Memorandum of Understanding (MOU) and submit for review
- Secure LADWP, Metropolitan, and DWR approval for the MOU

  The Joint Agency Mutual Assistance Agreement is in the final stages of review and is expected to be signed off by all three parties in the near future.

Seismic Task Force Goals

2018 Goals:	**Collaborative LADWP, Metropolitan, and DWR Goals**

Status:

- Discuss the applicability of lessons learned from seismic events in Japan, Chile, New Zealand, and Mexico

  The organizations continue to incorporate lessons-learned from seismic events, including the July 4, 2019, M 6.4 and July 5, 2019, M 7.1 events in Ridgecrest, California

- Compare each agency's approach to conducting seismic assessments

  In development of the Joint Agency Emergency Response Plan, the organizations provided detailed presentations of their seismic assessments and the underlying assumptions to their anticipated damage and outage durations.

- Meet with Southern California Edison (SCE) and Southern California Gas Co. to discuss the potential vulnerabilities of aqueduct power systems

  Metropolitan held discussions with staff from SCE and shared information on the respective systems and seismic vulnerabilities.

- Conduct workshops to explore potential aqueduct interties

  DWR and LADWP continue to investigate the potential for constructing an intertie between the State Water Project East Branch and the Los Angeles Aqueduct.

2019 Goals:	**Collaborative LADWP, Metropolitan, and DWR Goals**

Status:

- Establish a leadership structure for a coordinated response to major events

  The leadership structure for a coordinated response is described in the Joint Agency Emergency Response Plan

- Finalize a three-agency database of available emergency response resources

  Updating list of emergency response resources for 2020

2019 Goals:	Collaborative LADWP, Metropolitan, and DWR Goals (cont'd)
Status: • Conduct a three-agency tabletop exercise *Metropolitan hosted a tabletop exercise in October 2019.* • Develop a ShakeOut Scenario Response and Restoration Plan *The ShakeOut Scenario is identified as one of the triggers that would initiate the Joint Agency Emergency Response Plan.* • Conduct a second three-agency functional exercise that includes energy utilities *Conducted a functional emergency exercise at the Robert B. Diemer Water Treatment Plant with local Sheriff and Fire Departments, SCE, City of Yorba Linda Emergency Services, Yorba Linda Water District, Orange County Emergency Management, and the Water Emergency Response of Orange County.*	

Other Near-Term Goals

1. Develop a Standard Approach for Evaluating Non-Structural Elements:

   Metropolitan is in the process of studying industry standards applicable to Metropolitan and collecting approaches taken by other agencies.

2. Establish Additional Performance Objectives for new pipelines, retrofit of pipelines, and new and existing tunnels:

   Metropolitan is now designing new pipelines and tunnels and retrofitting existing pipelines and tunnels in accordance with current standards and incorporating additional seismic mitigation measures wherever practicable.

3. Investigate the Potential for Developing a Model to Prioritize Pipeline Rehabilitation:

   This is being addressed through the Asset Management efforts, with input from recent seismic studies on risk from potential damage from shaking, fault rupture, and liquefaction.

4. Enhance Member Agency Planning Efforts Regarding New Facilities and Emergency Response Programs:

   The Member Agency Managers Workshop was used to present the Seismic Resilience Strategy and objectives and Seismic Task Force findings.

5. Seek Approval for Detailed Seismic Studies

   This is an ongoing effort. As Metropolitan completes the rapid evaluations of the Post-1990 structures, detailed studies will be recommended for those structures found to be potentially deficient.

6. Support the Delta Conveyance Project (part of the former proposed California WaterFix Project)

Metropolitan will continue to support the Delta Conveyance Project to increase the seismic resiliency of the Bay-Delta portion of the State Water Project.

2020 Update Near-Term Goals

The following section lists new near-term goals that will further Metropolitan's objective of seismic resilience. These goals are anticipated to be completed before the next update in 2025.

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	

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.	

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	

Goal	Complete Design of Approved Seismic Upgrade Projects
• Weymouth Administration Building Seismic Upgrade and Building Improvements • La Verne Water Quality Lab and Field Engineering Building Seismic Upgrades and Building Improvements • CRA Whitewater Tunnel No. 2 Seismic Upgrades • Lake Mathews Disaster Recovery Facility Seismic Upgrades • Upper Feeder San Gabriel Tower Seismic Upgrade • Weymouth Inlet Channel Structural Upgrades	

Goal	Seismic Upgrade of Below Ground Structures
• Initiate evaluation of below-ground structures. Identify and list all structures. Develop a prioritization system for evaluation.	

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	

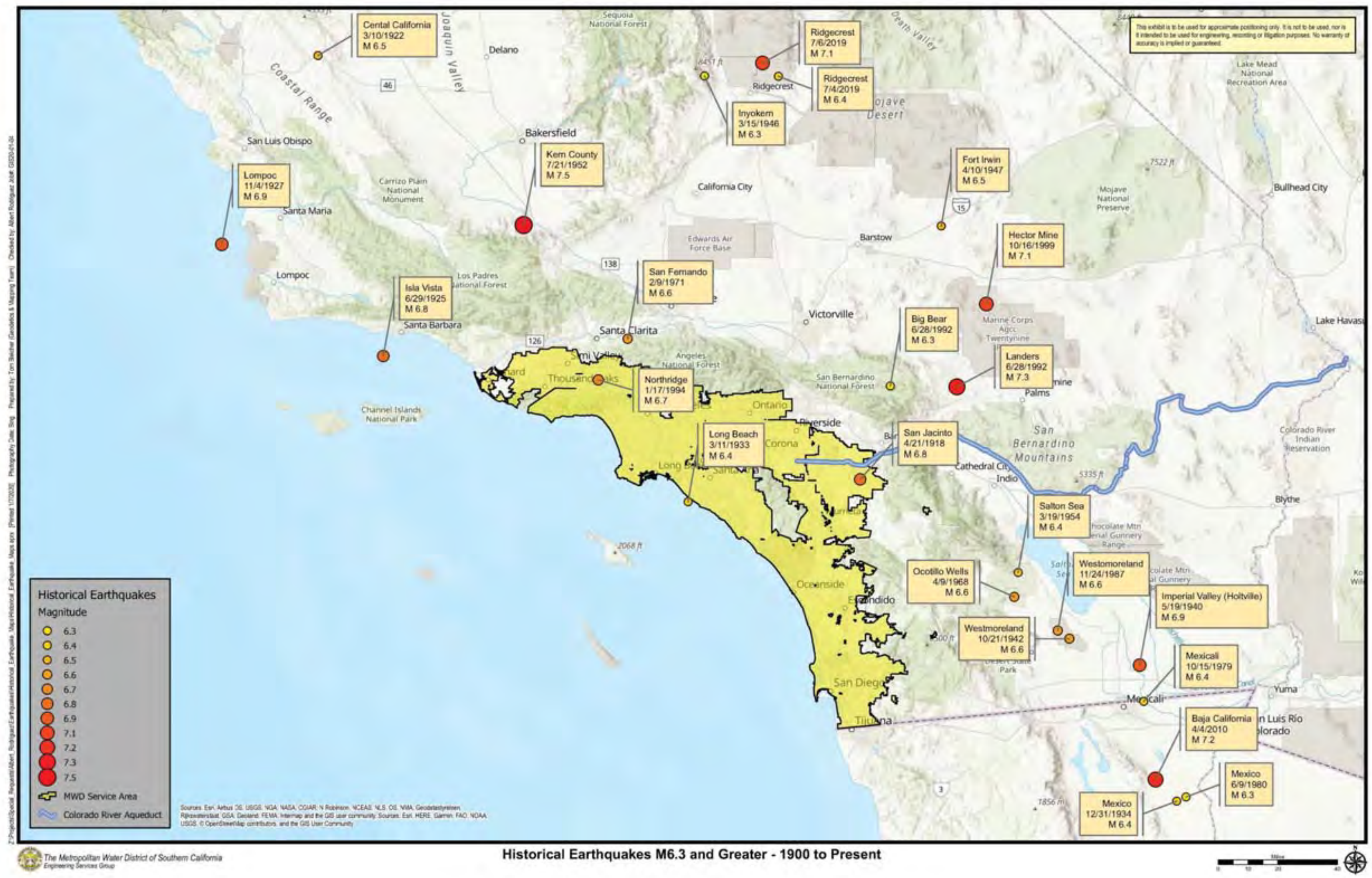
Other Near-Term Goals

- Promote to member agencies the Defense-in-Depth approach to seismic resilience as recommended in *Report 1335 – Potential Effects of Southern California Seismic Events on Metropolitan Deliveries* (January 2009).
- Continue to gain and share knowledge about seismic resilience through participation in workshops and conferences.
- Complete rapid evaluations for post-1990 above-grade structures.

This Page Intentionally Left Blank

Appendix A – M6.3 or Greater Earthquakes in Southern California Region - 1900 to Present

This Page Intentionally Left Blank



Historical Earthquakes M6.3 and Greater - 1900 to Present

This Page Intentionally Left Blank

Appendix B – List of Metropolitan Staff Seismic Conference Papers

This Page Intentionally Left Blank

Metropolitan Staff Papers Presented at the 11th JWWA/WRF/CTWWA Water Seismic Conference

Brainard, Andrew (2019), "Evaluation of Welded Joints in Steel Pipelines by Finite Element Modeling", P*roceedings of the 11th JWWA/WRF/CTWWA Water Seismic Conference*, October 9-11 2019, pp. 42-53.

Beikae, Mohsen (2019), "Monte Carlo Simulation of Probabilistic Rupture Hazard Analysis for Lifelines Crossing Active Faults", *Proceedings of the 11th JWWA/WRF/CTWWA Water Seismic Conference*, October 9-11 2019, pp. 107-119.

Chai, Winston (2019), "Seismic Rehabilitation of Upper Feeder Pipeline Santa Ana River Crossing – An Example of Metropolitan's Seismic Upgrade Program", *Proceedings of the 11th JWWA/WRF/CTWWA Water Seismic Conference*, October 9-11 2019, pp. 1-12.

Peng, Tao (2019), "Mitigation of Fault Displacement and Ground Subsidence for Large Diameter Pipeline", *Proceedings of the 11th JWWA/WRF/CTWWA Water Seismic Conference*, October 9-11 2019, pp. 217-228.

Appendix 10

METROPOLITAN'S ENERGY INTENSITY INFORMATION, INCLUDING CONVEYANCE AND DISTRIBUTION GENERATION

Appendix 10
METROPOLITAN'S ENERGY INTENSITY INFORMATION

Introduction

The Metropolitan Water District of Southern California is a wholesale water agency that distributes water to its 26 member agencies. These agencies receive treated and untreated water through Metropolitan's 830 miles of interconnected pipelines. There are over 400 service connections to the 26 member agencies located throughout Metropolitan's 5,200 square mile service area.

Metropolitan has always recognized the relationship between water and energy. In addition to being one of the original contractors for power from Hoover Dam in 1937, Metropolitan also paid for half of the cost of the Parker Dam power plant. The energy Metropolitan receives from these facilities provides greenhouse gas (GHG)-free electricity for pumping along the Colorado River Aqueduct. Metropolitan's conveyance and distribution system is also designed to minimize pumping. Imported supplies flow by gravity through Metropolitan's treatment plants and distribution system to the member agencies.

Water-Related Energy Use in California

The Water-Energy Nexus (W-E Nexus) recognizes that water supplies and energy supplies are interrelated. Water supplies require energy for heating and cooling, but also for transporting, treating and disposing. Likewise, energy supplies require water for cooling, fuel extraction and processing and hydropower production.

State agencies, water districts, and other stakeholders began to study the important link between energy and water in the 2000s. Since then, it has been widely reported that California's "Water Sector" uses 19 percent of the state's electricity and 32 percent of the state's natural gas not used for power generation.

The original source for these facts is the California Energy Commission's 2005 "California's Water – Energy Relationship" report (CEC-700-2005-011-SF, Nov. 2005[1]). In the report, the CEC analyzed energy use data for 2001 and disaggregated the 19 percent into urban water supply, wastewater treatment, customer end uses, and agriculture. Based on the CEC's analysis, approximately 3 percent of California's electrical use in 2001 was associated with urban water agency conveyance, treatment, and distribution. Customer end-uses such as the heating and cooling of water represented 11.1 percent. Another 0.8 percent was attributed to wastewater treatment and 4.2 percent was associated with agricultural uses. Table A.10-1 presents the water related energy use in California adapted from the 2005 CEC report.

The 3.8 percent of electricity associated with urban water supply and wastewater treatment represent the "embedded energy" in water.

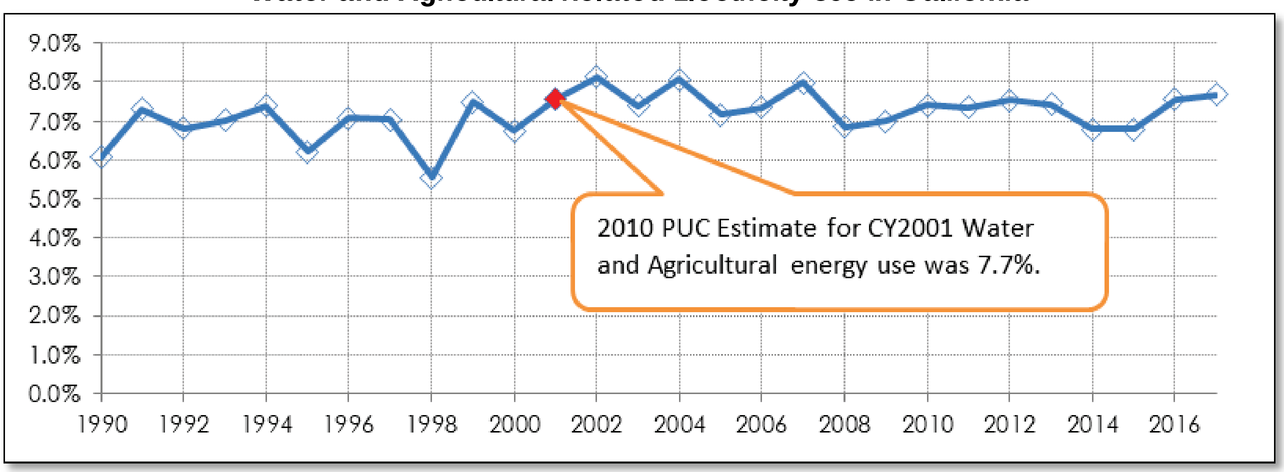
[1] https://www.energy.ca.gov/2005publications/CEC-700-2005-011/CEC-700-2005-011.PDF

Table A.10-1
Water Related Energy Use in California[2]

	Electricity (Gigawatt-hour)	Natural Gas (Million Therms)
Urban Water Supply	**7,554**	**19**
Wastewater Treatment	2,012	27
Urban End Users	27,887	4,220
Agricultural Total	10,560	18
Total Water Sector Use	**48,013**	**4,284**
Total California Use	**250,494**	**13,571**
Urban Water Supply	**3.0%**	**0.1%**
Wastewater Treatment	0.8%	0.2%
Urban End Users	11.1%	31.1%
Agricultural Total	4.2%	0.1%
Total Water Sector Use	**19.2%**	**31.6%**

In 2010, the California Public Utilities Commission (PUC) reevaluated water-related energy use and estimated that 7.7 percent of the State's electricity was used for urban water supply, wastewater treatment, and agricultural-related pumping and treatment.[3] This is close to the CEC report estimate for those three sectors. While water-related electricity use varies from year to year, it has fluctuated between 6 percent and 8 percent over the past 30 years, as shown in Figure A.10-1.

Figure A.10-1
Water and Agricultural Related Electricity Use in California[4]



[2] "California's Water – Energy Relationship" report (CEC-700-2005-011-SF, 2005)
[3] Embedded Energy in Water Studies Study 1: Statewide and Regional Water-Energy Relationship (Public Utilities Commission, 2010, page 58)
[4] CEC: California Energy Consumption Data Base: http://ecdms.energy.ca.gov/

In response to California's GHG emission goals, Metropolitan and many other water utilities are taking steps to reduce water-related energy use and emissions. This includes increasing energy recovery in conveyance and distribution systems, developing renewable energy projects, performing energy studies, auditing facility energy usage, and other related actions. Additionally, the conservation programs administered by Metropolitan and the member agencies save embedded energy along with the energy associated with customer end uses. Section 3.8 contains a description of Metropolitan's energy sustainability initiatives and proposed Climate Action Plan.

Metropolitan's Energy Intensity

Under CWC 10631.2(a), urban water management plans "Shall include any of the following information that the urban water supplier can readily obtain:"

1. An estimate of the amount of energy used to extract or divert water supplies.
2. An estimate of the amount of energy used to convey water supplies to the water treatment plants or distribution systems.
3. An estimate of the amount of energy used to treat water supplies.
4. An estimate of the amount of energy used to distribute water supplies through its distribution systems.
5. An estimate of the amount of energy used for treated water supplies in comparison to the amount used for nontreated water supplies.
6. An estimate of the amount of energy used to place water into or withdraw from storage.
7. Any other energy-related information the urban water supplier deems appropriate.

This section provides Metropolitan's energy intensity information according to these guidelines. Due to the mixing of water supplies before and after treatment, Metropolitan's complex distribution system, and the large number of service connections, Metropolitan provides system-wide energy intensity values. As operational conditions change from month to month and year to year, Metropolitan's energy use and energy intensity also vary.

Metropolitan's operational control includes the Colorado River Aqueduct (CRA) but does not include the State Water Project (SWP). However, excluding upstream embedded energy from the SWP would not represent an accurate estimate of the energy embedded in Metropolitan's water supplies. To avoid potential misinterpretation of the data provided, this Appendix reports Metropolitan's energy intensity information <u>with</u> upstream SWP embedded energy.

Metropolitan's energy intensity for the water it provides to its member agencies is broken down into the following functions and described below:

- Source
- Conveyance
- Treatment
- Distribution
- Storage

Source

The water Metropolitan receives comes from two sources: (1) the California Department of Water Resources' (DWR) State Water Project, and (2) the Colorado River. The energy required to extract or divert water from these sources is reported in conveyance.

Conveyance

The energy requirements from the two conveyance systems supplying Metropolitan's water have been combined, along with the volume of water delivered, into a single weighted energy intensity value. This method provides an energy intensity estimate which can then be used by other water agencies and stakeholders. As the blend of water from the SWP and the Colorado River changes each year, the total energy consumption for conveyance also varies.

Metropolitan's energy intensity for conveyance also accounts for consequential and non-consequential hydropower. Consequential hydropower is hydropower produced as the sole result of a water demand or use. Non-consequential hydropower is hydropower produced as the result of some combination of water demand deliveries and releases for other purposes such as flood control. The non-consequential hydropower from Hoover Dam and the SWP's Hyatt-Thermalito Complex are discussed in the following sections.

Colorado River

Metropolitan conveys water from the Colorado River through its Colorado River Aqueduct (CRA). The water is pumped through five pumping plants to reach Metropolitan's service area. The nominal energy intensity of water conveyed through the CRA is 2,000 kWh/AF.

There are no recovery generating plants along the CRA. However, the water that Metropolitan pumps from the Colorado River has been released from Lake Mead through the Hoover Dam generators. Metropolitan receives 27.1 percent of the energy produced at Hoover. This energy is used to power the CRA pumps. The production rate (kWh/AF) at Hoover depends on several factors, including the elevation of Lake Mead. The USBR updates this value monthly. Metropolitan incorporates its share of the energy produced at Hoover in the calculation of the CRA conveyance energy requirement.

State Water Project

Metropolitan is a contractor for water from DWR's SWP. The SWP uses a combination of natural and man-made systems to move water from Lake Oroville on the Feather River in northern California, through the Sacramento/San Joaquin River Delta (Delta), and into the California Aqueduct for delivery to Southern California and other regions. DWR conveys water through the California Aqueduct using a series of pumps and hydroelectric generators. Metropolitan receives water from DWR through the West Branch of the California Aqueduct at Castaic Lake and from the East Branch of the California Aqueduct at several locations in San Bernardino and Riverside Counties.

The California Aqueduct's net energy intensity for the water received from the West Branch is 2,580 kWh/AF and for the East Branch it is 3,236 kWh/AF. These values are the nominal pumping requirements of the SWP pumps (Banks, Dos Amigos, Buena Vista, Teerink, Chrisman, Edmonston, Oso, and Pearblossom) less the nominal generation values from the West and East Branch recovery generating plants (Warne, Castaic, Alamo, Mojave, and Devil Canyon). These values exclude pumping and generating at the San Luis Gianelli Plant.

The SWP also produces power at its Hyatt-Thermalito complex (HTC) near Lake Oroville and the Feather River in northern California. DWR releases water from Lake Oroville which flows through the HTC hydro generators and produces power for the SWP. State Water Project Contractors, including Metropolitan, pay for the HTC based on their share of the SWP's Variable Operation, Maintenance, Power and Replacement (OMP&R) Component of the Transportation Charge. To determine the benefit Metropolitan receives from the HTC generation in calculating the Energy Intensity of SWP conveyance, this same OMP&R share (percentage) is used with the total generation from the HTC. From 2004 through 2018, Metropolitan's share of the HTC costs has ranged from 60.2 percent to 74.3 percent. A multi-year average percentage has been used to reduce the year-to-year volatility of this factor and calculate the non-consequential energy included in Metropolitan's conveyance energy intensity. Table A.10-2 presents the 2018 conveyance energy intensity with upstream SWP embedded energy.

The SWP contract has specific provisions on how and when to account for various water deliveries and the associated costs. This will result in differences between the SWP billing values and the amount of water delivered to Metropolitan from the SWP.

Table A.10-2
2018 Conveyance Energy Intensity with Upstream SWP Embedded Energy

	With SWP Embedded Energy
Net Energy Use (kWh)*	3,050,621,000
Water Conveyed (AF)	1,588,958
Energy Intensity (kWh/AF)	1,919.9

* Accounts for non-consequential hydropower generation of 94,161,800 kWh from Hoover Dam on the Colorado River and 861,900,000 kWh from the Hyatt-Thermalito Complex on the State Water Project.

Treatment

Metropolitan operates five treatment plants to provide potable water to its Member Agencies. The estimated amount of energy used to treat water supplies has been calculated by dividing the annual amount of energy consumed at the plant sites by the amount of water treated. In order to meet water quality regulations, Metropolitan has retrofitted its treatment plants to use ozone, rather than chlorine, as the primary disinfectant during treatment (chlorine and ammonia are added after filtration for a disinfection residual in the distribution system). Metropolitan generates ozone on-site at each treatment plant. The ozone generation process has increased the energy required for treating Metropolitan's supplies. Table A.10-3 presents the treatment energy intensity for 2018.

Table A.10-3
2018 Treatment Energy Intensity

	2018
Energy Use (kWh)	53,608,000
Water Treated (AF)	769,398
Energy Intensity (kWh/AF)	69.7

Metropolitan has also installed solar energy at three of its treatment plants with a combined capacity of five megawatts. The electricity generated by these facilities meets between 15 percent and 20 percent of the energy demands of those plants. Solar energy is added to the grid power used at each plant to estimate a total energy intensity value. In 2018, Metropolitan generated 10,409,000 kWh of solar energy from these facilities, reducing the electricity purchased from the grid and its associated GHG emissions.

Distribution

Due to the high elevations at which Metropolitan receives water from the SWP and CRA conveyance facilities, minimal pumping (and electricity use) is needed to distribute treated and untreated water to its Member Agencies. Gravity, not electricity, drives water supply deliveries through most of Metropolitan's distribution system.

In addition, Metropolitan has 16 recovery hydroelectric generating plants located throughout its distribution system. The generators produce electricity from the water flowing through the pipelines. These plants generate more power than is consumed from distribution pumping. Without the hydroelectric generators, embedded energy in the water would be reduced at facilities called pressure control structures and the potential for energy production would be lost. The energy used in the pumping plants and produced by the generators has been netted, with the result divided by water deliveries to calculate the distribution energy intensity.

Weather variation has a significant impact on distribution system energy intensity. In dry years with low SWP deliveries, Metropolitan generates less distribution system hydropower and may need to increase pumping to deliver CRA supplies throughout the region. Table A.10-4 presents the distribution system net energy intensity for 2018.

Table A.10-4
2018 Distribution System Net Energy Intensity

	2018
Pumping (kWh)	4,753,000
Hydropower Generation (kWh)	-239,699,000
Net Distribution Energy Use (kWh)	-234,946,000
Water Delivered (AF)	1,540,022
Energy Intensity (kWh/AF)	-152.6

Storage

Metropolitan maintains significant storage facilities and programs both inside and outside its service area. However, Metropolitan does not use any energy for storage programs under its "span of control." Water is delivered by gravity flow. External water storage and recovery are managed by other parties and are often transacted through exchange arrangements. Water delivered to Metropolitan from these storage programs is accounted for in conveyance energy intensity.

Metropolitan's Annual Energy and Energy Intensity

Energy and energy intensity information is provided for each of the non-zero processes listed above: Conveyance; Treatment; and Distribution. As noted previously, these values vary from year to year due to operational changes and differences in water supply availability. An estimated overall energy intensity is provided for untreated and treated water deliveries for 2018 and for a six-year average in the tables below. Both estimates account for non-consequential hydropower. Table A.10-5 presents the treated and untreated water energy intensity for year 2018. Table A.10-6 presents the average treated and untreated water energy intensity for 2013 through 2018. Figure A.10-2 shows Metropolitan's energy use for 2013 through 2018 and highlights the impacts of hydrological conditions on Metropolitan's energy use.

Table A.10-5
2018 Treated and Untreated Water Energy Intensity

	With SWP (kWh/AF)
Conveyance*	1,919.9
Treatment	69.7
Distribution	-152.6
Total Treated	1,837.0
Total Untreated	1,767.3

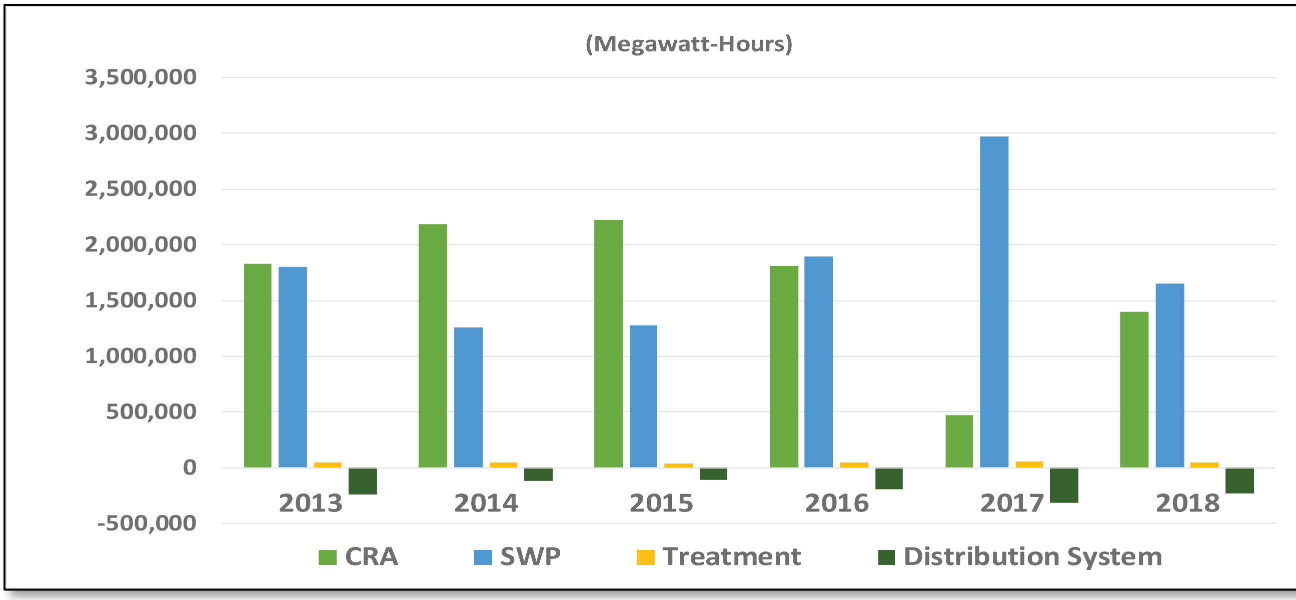
*Accounts for hydropower generation from Hoover and Hyatt/Thermalito

Table A.10-6
Average Treated and Untreated Water Energy Intensity (2013 – 2018)

	With SWP (kWh/AF)
Conveyance*	1,928.0
Treatment	57.0
Distribution	-121.9
Total Treated	1,863.0
Total Untreated	1,806.0

*Accounts for hydropower generation from Hoover and Hyatt/Thermalito

Figure A.10-2
Variations in Metropolitan Energy Use (2013-2018)



Greenhouse Gas Emissions

Metropolitan voluntarily reports its GHG emissions from all sources to The Climate Registry (TCR). TCR implements a GHG registry for California entities and develops protocols for GHG reporting. The data provided in TCR's registry is publicly accessible and transparent. Metropolitan's annual GHG data and those for many other water agencies are available through TCR's CRIS website[5]. To guarantee data quality, TCR requires published GHG information to be audited by a certified verification expert. Metropolitan has been auditing and reporting its annual GHG emissions to TCR since 2005.

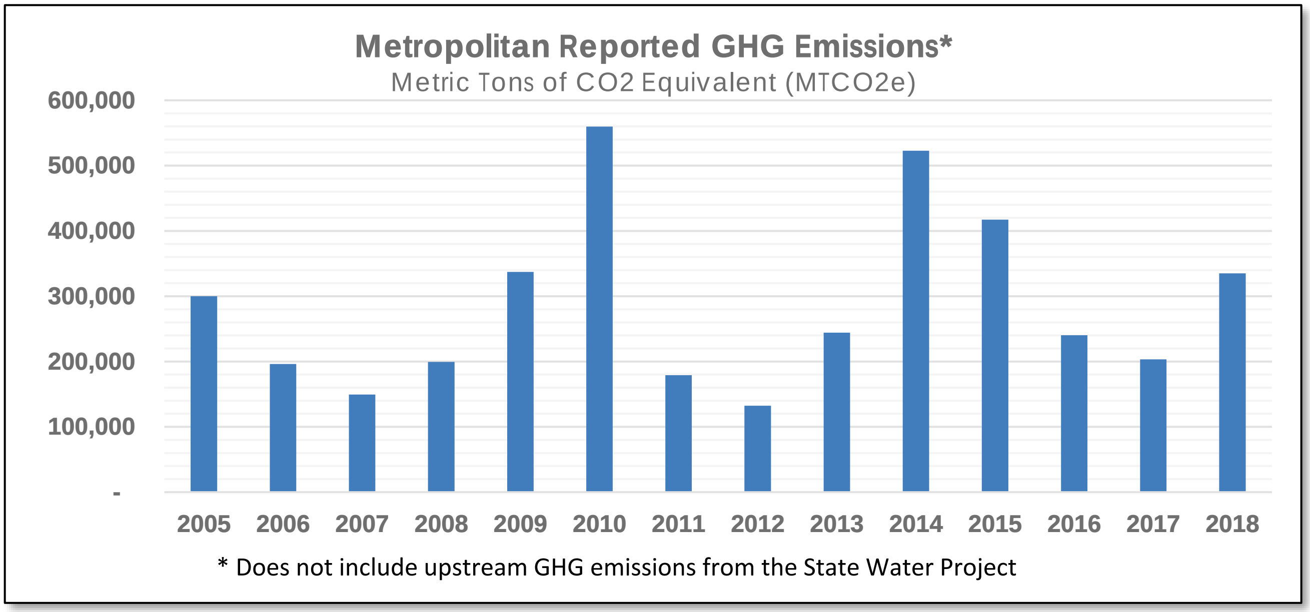
As with energy intensity, Metropolitan's GHG emissions vary due to hydrology. Over 95 percent of Metropolitan's GHG emissions are derived from electricity use, primarily from the CRA. In dry years, Metropolitan purchases additional grid electricity to accommodate higher CRA deliveries and uses more energy for distribution system pumping. The combination of higher electricity use coupled with higher GHG emission factors for purchased electricity cause Metropolitan's GHG emissions to spike in dry years. The opposite is true in wet years. Lower CRA deliveries are met with zero-carbon electricity from Hoover and Parker dams. In recent years, Metropolitan's GHG emissions have swung from 522,600 tons of CO2e emitted during the record low SWP allocation year in 2014 to 203,400 tons of CO2e emitted during the record wet year in 2017. Metropolitan's 10-year average of 317,100 tons of CO2e includes two dry-year/wet-year cycles.

[5] The Climate Registry CRIS GHG Database: https://www.theclimateregistry.org/tools-resources/reporting-toolkit/cris-resources/

Unlike Metropolitan's embedded energy described above, Metropolitan's reported GHG emissions do not include upstream SWP emissions. Metropolitan is participating in TCR's new Water-Energy Nexus GHG Registry and will be able to provide additional GHG metrics in the future.

The California Air Resources Board (CARB) tracks state-wide GHG emissions from all sources on an annual basis[6]. Compared to CARB's GHG inventory, Metropolitan's CO2e emissions represented 0.12 percent of the state's total emissions in 2014 and 0.05 percent in 2017. Additional information on Metropolitan's GHG emissions and Climate Action Plan are contained Section 3.8. Figure A.10-3 presents Metropolitan GHG emissions for 2005 through 2018.

Figure A.10-3
Metropolitan GHG emissions



DWR Required Water-Energy Nexus Table: Process Approach

Table A.10-7 contains Metropolitan's required Water-Energy Table for CY2018 using the Water Supply Process Approach in Table O-1A.

The table shows Metropolitan's energy intensity with upstream SWP embedded energy and non-consequential generation included.

Note that Metropolitan uses an alternative approach for calculating total or system-wide kWh/AF. Metropolitan's approach adds the energy intensity of the individual components to derive a system-wide total, where the required table divides the total net energy use by total deliveries. As a result, the system-wide kWh/AF total described in Table A.10-6 varies slightly from DWR's required Table A.10-7. Metropolitan also incorporates non-consequential hydropower production in its energy intensity calculations.

---

[6] https://ww2.arb.ca.gov/ghg-inventory-data; California's GHG emissions were 444.7 million tons of CO2e in 2014 and 424.1 million tons of CO2e in 2017, the latest year available.

Table A.10-7 (Table O-1A for Year 2018): Water Supply Process Approach Including Upstream State Water Project Energy Use

Urban Water Supplier: ***Metropolitan Water District of Southern California***

Water Delivery Product (If delivering more than one type of product use Table O-1C)

Wholesale Potable Deliveries

Table O-1A: Recommended Energy Intensity - Water Supply Process Approach

Enter Start Date for Reporting Period: 1/1/18

End Date: 12/31/18

☑ Is upstream embedded in the values reported?

	Water Volume Units Used	Urban Water Supplier Operational Control							
		Water Management Process						Non-Consequential Hydropower (if applicable) See Narrative Below	
		Extract and Divert	Place into Storage	Conveyance	Treatment	Distribution	Total Utility	Hydropower	Net Utility
Volume of Water Entering Process	acre feet	0	0	1,588,958	769,398	1,540,022	1,540,022	0	1,540,022
Energy Consumed (kWh)	N/A	0	0	3,050,621,051	53,607,943	-234,945,839	2,869,283,155		2,869,283,155
Energy Intensity (kWh/vol.)	N/A	**0.0**	**0.0**	**1919.9**	**69.7**	**-152.6**	**1863.1**	**0.0**	**1863.1**
				MWD method: process additive			**1837.0**		

Quantity of Self-Generated Renewable Energy

10,409,000 kWh

Data Quality *(Estimate, Metered Data, Combination of Estimates and Metered Data)*

Combination of Estimates and Metered Data

Data Quality Narrative:

Assumes Colorado river energy intensity at 2,000 kWh/AF; SWP East Branch at 3,236, and SWP West Branch at 2,580.
Energy use for the treatment and distribution processes are metered. Non-consequential hyrdopower is calculated from metered data.
Detailed descriptions of the methodology are contained in the appendix.

Narrative:

This table incorporates upstream State Water Project conveyance deliveries, energy use, consequential and non-consequential energy generation from Hoover Dam and the SWP Hyatt-Thermalito Complex.
Including upstream SWP imbedded energy represents the applicable energy intensity of Metropolitan's water supplies as delivered to its Member Agencies.

Metropolitan uses an alternative method for calculating overall energy intensity by adding the processes to derive a total utility value as described above.
Using Metropolitan's additive methodology, the total utility energy intensity for treated water would be 1,837 kWh / AF instead of 1,863 kWh / AF in the table above

Total non-consequential hydropower included in 2018 conveyance: 956,021,000 kWh
- Hoover Dam non-consequential hydropower: 94,162,000 kWh
- Hyatt-Thermalito non-consequential hydropower: 861,859,000 kWh

Metropolitan delivers both treated and untreated water to its member agencies.

Glossary

Water-Energy Nexus: The recognition of the link between water supplies and energy supplies

Energy Intensity: A measure of the energy required to deliver, or process water expressed in kilowatt hours per acre-foot (kWh/AF)

Embedded Energy: The amount of energy required to deliver water supplies from a source to a delivery point. Also expressed in kilowatt hours per acre-foot (kWh/AF).

Greenhouse Gas Intensity: a measure of the overall greenhouse gasses required to deliver or process water, expressed in GHG/AF.

Hydropower: Renewable energy produced by water powering a turbine to produce electricity.

Water Sector: The water sector in the W-E Nexus is broadly defined to include customer end-uses of water such as heating or cooling; pumping and treating urban and agricultural water supplies; and wastewater disposal.

Consequential Hydropower: Hydropower produced as the sole result of a water demand or use. An example would be a hydropower recovery plant on an aqueduct that generates power as demands dictate flows in the aqueduct.

Non-consequential Hydropower: Hydropower produced as the result of some combination of water demand and other requirements such as flood releases or environmental flows.

The Climate Registry: A California non-profit organization tasked with managing a voluntary GHG registry for the State as well as implementing a voluntary GHG registry specifically for water-related GHG emissions.

This page intentionally left blank.

Appendix 11

QUANTIFYING REGIONAL SELF-RELIANCE AND REDUCED RELIANCE ON WATER SUPPLIES FROM THE DELTA WATERSHED

Appendix 11
METROPOLITAN'S
REDUCED DELTA RELIANCE REPORTING

A.11.1 Background

Under the Sacramento-San Joaquin Delta Reform Act of 2009, state and local public agencies proposing a covered action in the Delta,[1] prior to initiating the implementation of that action, must prepare a written certification of consistency with detailed findings as to whether the covered action is consistent with applicable Delta Plan policies and submit that certification to the Delta Stewardship Council.[2] Anyone may appeal a certification of consistency, and if the Delta Stewardship Council grants the appeal, the covered action may not be implemented until the agency proposing the covered action submits a revised certification of consistency, and either no appeal is filed, or the Delta Stewardship Council denies the subsequent appeal.[3]

An urban water supplier that anticipates participating in or receiving water from a proposed covered action such as a multi-year water transfer, conveyance facility, or new diversion that involves transferring water through, exporting water from, or using water in the Delta should provide information in their 2015 and 2020 Urban Water Management Plans (UWMPs) that can then be used in the covered action process to demonstrate consistency with Delta Plan Policy WR P1, Reduce Reliance on the Delta Through Improved Regional Water Self-Reliance (WR P1).[4]

WR P1 details what is needed for a covered action to demonstrate consistency with reduced reliance on the Delta and improved regional self-reliance. WR P1 subsection (a) states that:

(a) Water shall not be exported from, transferred through, or used in the Delta if all of the following apply:

> *(1) One or more water suppliers that would receive water as a result of the export, transfer, or use have failed to adequately contribute to reduced reliance on the Delta and improved regional self-reliance consistent with all of the requirements listed in paragraph (1) of subsection (c);*
>
> *(2) That failure has significantly caused the need for the export, transfer, or use; and*
>
> *(3) The export, transfer, or use would have a significant adverse environmental impact in the Delta.*

WR P1 subsection (c)(1) further defines what adequately contributing to reduced reliance on the Delta means in terms of (a)(1) above.

(c)(1) Water suppliers that have done all the following are contributing to reduced reliance on the Delta and improved regional self-reliance and are therefore consistent with this policy:

> *(A) Completed a current Urban or Agricultural Water Management Plan (Plan) which has been reviewed by the California Department of Water Resources for compliance with the applicable requirements of Water Code Division 6, Parts 2.55, 2.6, and 2.8;*

---

[1] Water Code, § 85057.5; Cal. Code Regs. tit. 23, § 5001.
[2] Water Code, § 85225; Delta Plan, App. D.
[3] Water Code, §§ 85225.10-85225.25; Delta Plan, App. D.
[4] Cal. Code Regs., tit. 23, § 5003.

(B) Identified, evaluated, and commenced implementation, consistent with the implementation schedule set forth in the Plan, of all programs and projects included in the Plan that are locally cost effective and technically feasible which reduce reliance on the Delta; and

(C) Included in the Plan, commencing in 2015, the expected outcome for measurable reduction in Delta reliance and improvement in regional self-reliance. The expected outcome for measurable reduction in Delta reliance and improvement in regional self-reliance shall be reported in the Plan as the reduction in the amount of water used, or in the percentage of water used, from the Delta watershed. For the purposes of reporting, water efficiency is considered a new source of water supply, consistent with Water Code Section 1011(a).

The analysis and documentation provided below include all of the elements described in WR P1(c)(1) that need to be included in a water supplier's UWMP to support a certification of consistency for a future covered action.

A.11.2 Summary of Expected Outcomes for Reduced Reliance on the Delta

As stated in WR P1(c)(1)(C), the policy requires that, commencing in 2015, UWMPs include expected outcomes for measurable reduction in Delta reliance and improved regional self-reliance. WR P1 further states that those outcomes shall be reported in the UWMP as the reduction in the amount of water used, or in the percentage of water used, from the Delta.

The expected outcomes for Metropolitan's Delta reliance and regional self-reliance were developed using the approach and guidance described in Appendix C of DWR's Urban Water Management Plan Guidebook 2020 (Guidebook Appendix C) issued in March 2021.

The data used in this analysis represent the total regional efforts of Metropolitan and its member agencies and their customers (many of them, retail agencies) and were developed in conjunction with Metropolitan's member agencies as part of the UWMP coordination process as described in Section 5 of Metropolitan's UWMP. In accordance with UMWP requirements, Metropolitan's member agencies and their customers (many of them, retail agencies) also report demands and supplies for their service areas in their respective UWMPs. The data reported by those agencies are not additive to the regional totals shown in Metropolitan's UWMP; rather, their reporting represents subtotals of the regional total and should be considered as such for the purposes of determining reduced reliance on the Delta.

While the demands that Metropolitan's member agencies and their customers report in their UWMPs are a good reflection of the demands in their respective service areas, they do not adequately represent each water supplier's contributions to reduced reliance on the Delta. In order to calculate and report their reliance on water supplies from the Delta watershed, water suppliers that receive water from the Delta through other regional or wholesale water suppliers would need to determine the amount of Delta water that they receive from the regional or wholesale supplier. Two specific pieces of information are needed to accomplish this: first is the quantity of demands on the regional or wholesale water supplier that accurately reflect a supplier's contributions to reduced reliance on the Delta, and second is the quantity of a supplier's demands on the regional or wholesale water supplier that are met by supplies from the Delta watershed.

For water suppliers that make investments in regional projects or programs it may be infeasible to quantify their demands on the regional or wholesale water supplier in a way that accurately reflects their individual contributions to reduced reliance on the Delta. Due to the extensive, long-standing and successful implementation of regional demand management and local resource incentive programs in Metropolitan's service area, this infeasibility holds true for Metropolitan's members as well their customers. For Metropolitan's service area, reduced reliance on supplies from the Delta watershed can only be accurately accounted at the regional level, as is demonstrated in this analysis.

The following provides a summary of the near-term (2025) and long-term (2045) expected outcomes for Metropolitan's Delta reliance and regional self-reliance. The results show that as a region, Metropolitan and its members as well as their customers are measurably reducing reliance on the Delta and improving regional self-reliance, both as an amount of water used and as a percentage of water used.

Expected Outcomes for Regional Self-Reliance

- Near-term (2025) – Normal water year regional self-reliance is expected to increase by 813 TAF from the 2010 baseline; this represents an increase of almost 25 percent of 2025 normal water year retail demands (Table A.11-2).
- Long-term (2045) – Normal water year regional self-reliance is expected to increase by more than 1.28 MAF from the 2010 baseline, this represents an increase of more than 25 percent of 2045 normal water year retail demands (Table A.11-2).

Expected Outcomes for Reduced Reliance on Supplies from the Delta Watershed

- Near-term (2025) – Normal water year reliance on supplies from the Delta watershed decreased by 301 TAF from the 2010 baseline, this represents a decrease of 3 percent of 2025 normal water year retail demands (Table A.11-3).
- Long-term (2045) – Normal water year reliance on supplies from the Delta watershed decreased by 314 TAF from the 2010 baseline, this represents a decrease of just over 5 percent of 2045 normal water year retail demands (Table A.11-3).

A11.3 Demonstration of Reduced Reliance on the Delta

The methodology used to determine Metropolitan's reduced Delta reliance and improved regional self-reliance is consistent with the approach detailed in DWR's UWMP Guidebook Appendix C, including the use of narrative justifications for the accounting of supplies and the documentation of specific data sources. Some of the key assumptions underlying Metropolitan's demonstration of reduced reliance include:

- All data were obtained from the current 2020 UWMP or previously adopted UWMPs and represent average or normal water year conditions.
- All analyses were conducted at the service area level, and all data reflect the total contributions of Metropolitan and its members as well as their customers.
- No projects or programs that are described in the UWMPs as "Projects Under Development" were included in the accounting of supplies.

Baseline and Expected Outcomes

In order to calculate the expected outcomes for measurable reduction in Delta reliance and improved regional self-reliance, a baseline is needed to compare against. This analysis uses a normal water year representation of 2010 as the baseline, which is consistent with the approach described in the Guidebook Appendix C. Data for the 2010 baseline were taken from Metropolitan's 2005 UWMP as the UWMPs generally do not provide normal water year data for the year that they are adopted (i.e., 2005 UWMP forecasts begin in 2010, 2010 UWMP forecasts begin in 2015, and so on).

Consistent with the 2010 baseline data approach, the expected outcomes for reduced Delta reliance and improved regional self-reliance for 2015 and 2020 were taken from Metropolitan's 2010 and 2015 UWMPs respectively. Expected outcomes for 2025-2045 are from the current 2020 UWMP. Documentation of the specific data sources and assumptions are included in the discussions below.

Service Area Demands without Water Use Efficiency

In alignment with the Guidebook Appendix C, this analysis uses normal water year demands, rather than normal water year supplies to calculate expected outcomes in terms of the percentage of water used. Using normal water year demands serves as a proxy for the amount of supplies that would be used in a normal water year, which helps alleviate issues associated with how supply capability is presented to fulfill requirements of the Act versus how supplies might be accounted for to demonstrate consistency with WR P1.

Because WR P1 considers water use efficiency savings a source of water supply, water suppliers such as Metropolitan that explicitly calculate and report water use efficiency savings in their UWMP will need to make an adjustment to properly reflect normal water year demands in the calculation of reduced reliance. As explained in the Guidebook Appendix C, water use efficiency savings must be added back to the normal year demands to represent demands without water use efficiency savings accounted for; otherwise the effect of water use efficiency savings on regional self-reliance would be overestimated. Table A.11-1 shows the results of this adjustment for Metropolitan. Supporting narratives and documentation for all of the data shown in Table A.11-1 are provided below.

Table A.11-1
Demands without Water Use Efficiency Accounted For

Total Service Area Water Demands (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Service Area Demands with Water Use Efficiency Accounted For	4,628,000	4,563,000	4,163,000	3,763,000	3,821,000	3,893,000	3,936,000	3,985,000
Reported Water Use Efficiency	865,000	936,000	1,056,000	1,162,000	1,211,000	1,263,000	1,325,000	1,389,000
Service Area Demands without Water Use Efficiency Accounted For	**5,493,000**	**5,499,000**	**5,219,000**	**4,925,000**	**5,032,000**	**5,156,000**	**5,261,000**	**5,374,000**

Service Area Demands without Water Use Efficiency

The service area demands shown in Table A.11-1 represent the total retail water demands for Metropolitan's service area and include municipal and industrial demands, agricultural demands, seawater barrier demands, and storage replenishment demands. These demand types and the modeling methodologies used to calculate them are described in Section 2.2 and Appendix 1 of Metropolitan's UWMP.

Water Use Efficiency

The water use efficiency numbers shown in Table A.11-1 represent the total water use efficiency savings (conservation) for Metropolitan's region, including savings from active, code-based, price-effect and pre-1990 sources. These sources of water use efficiency and the methodologies used to calculate them are described in Section 2.2, Section 3.4, Section 3.7 and Appendix 1 of Metropolitan's UWMP.

The demand and water use efficiency data shown in Table A.11-1 were collected from the following sources:

- Baseline (2010) values – Metropolitan's 2005 UWMP, Table 2-6: Metropolitan Regional Water Demand Average Year
- 2015 values – Metropolitan's 2010 UWMP, Table 2-8: Metropolitan Regional Water Demands Average Year
- 2020 values – Metropolitan's 2015 UWMP, Table 2-3: Metropolitan Regional Water Demands Average Year
- 2025-2045 values – Metropolitan's 2020 UWMP, Table 2-3: Metropolitan Regional Water Demands Normal Water Year

Supplies Contributing to Regional Self-Reliance

For a covered action to demonstrate consistency with the Delta Plan, WR P1 subsection (c)(1)(C) states that water suppliers must report the expected outcomes for measurable improvement in regional self-reliance. Table A.11-2 shows expected outcomes for supplies contributing to regional self-reliance both in amount and as a percentage. The numbers shown in Table A.11-2 represent efforts to improve regional self-reliance for Metropolitan's entire service area and include the total contributions of Metropolitan and its members as well as their customers. Supporting narratives and documentation for the all of the data shown in Table A.11-2 are provided below.

The results shown in Table A.11-2 demonstrate that Metropolitan's service area is measurably improving its regional self-reliance. In the near-term (2025), the expected outcome for normal water year regional self-reliance increases by 747 TAF from the 2010 baseline; this represents an increase of about 23 percent of 2025 normal water year retail demands. In the long-term (2045), normal water year regional self-reliance is expected to increase by more than 1.2 MAF from the 2010 baseline; this represents an increase of 25 percent of 2045 normal water year retail demands.

Table A.11-2
Supplies Contributing to Regional Self-Reliance

Water Supplies Contributing to Regional Self-Reliance (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Water Use Efficiency	865,000	936,000	1,056,000	1,162,000	1,211,000	1,263,000	1,325,000	1,389,000
Water Recycling	316,000	348,000	436,000	550,000	613,000	687,000	698,000	706,000
Stormwater Capture and Use	100,000	103,000	110,000	80,000	82,000	82,000	82,000	82,000
Advanced Water Technologies	111,000	101,000	194,000	194,000	208,000	209,000	209,000	210,000
Conjunctive Use Projects	1,416,000	1,429,000	1,303,000	1,255,000	1,273,000	1,296,000	1,311,000	1,326,000
Local and Regional Water Supply and Storage Projects	252,000	224,000	261,000	257,000	257,000	258,000	258,000	258,000
Other Programs and Projects that Contribute to Regional Self-Reliance	875,000	1,250,000	1,200,000	1,250,000	1,250,000	1,250,000	1,250,000	1,250,000
Water Supplies Contributing to Regional Self-Reliance	**3,935,000**	**4,391,000**	**4,560,000**	**4,748,000**	**4,894,000**	**5,045,000**	**5,133,000**	**5,221,000**

Service Area Demands without Water Use Efficiency (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Service Area Demands without Water Use Efficiency Accounted For	5,493,000	5,499,000	5,219,000	4,925,000	5,032,000	5,156,000	5,261,000	5,374,000

Change in Regional Self Reliance (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Water Supplies Contributing to Regional Self-Reliance	3,935,000	4,391,000	4,560,000	4,748,000	4,894,000	5,045,000	5,133,000	5,221,000
Change in Supplies Contributing to Regional Self-Reliance	**NA**	**456,000**	**625,000**	**813,000**	**959,000**	**1,110,000**	**1,198,000**	**1,286,000**

Percent Change in Regional Self Reliance (As Percent of Demand w/out WUE)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Percent of Supplies Contributing to Regional Self-Reliance	71.6%	79.9%	87.4%	96.4%	97.3%	97.8%	97.6%	97.2%
Change in Percent of Supplies Contributing to Regional Self-Reliance	**NA**	**8.2%**	**15.7%**	**24.8%**	**25.6%**	**26.2%**	**25.9%**	**25.5%**

Water Use Efficiency

The water use efficiency information shown in Table A.11-2 is taken directly from Table A.11-1 above.

Water Recycling

The water recycling values shown in Table A.11-2 reflect the total recycled water production in Metropolitan's service area as described in Section 3.5 and Appendix 2 of Metropolitan's UWMP.

Stormwater Capture and Use

The stormwater capture and use data shown in Table A.11-2 include supplies from local surface water production as described in Section 1.4 and Appendix 2 of Metropolitan's UWMP.

These values do not include production from regional storage reservoirs; storage in these reservoirs is comprised of previously stored water from sources already reflected in Tables A.11-2 and A.11-3. These regional storage resources are generally used to provide additional regional self-reliance in dry years, which is not reflected in this normal water year analysis. The regional storage reservoirs and their yields are described in Section 3.6, Appendix 2 and Appendix 3 of Metropolitan's UWMP.

The stormwater capture and use values shown in Table A.11-2 also do not include stormwater capture that is used to recharge local groundwater basins. Stormwater capture for groundwater recharge supports production of groundwater in the region, and for the purposes of this analysis that production is already captured in Table A.11-2 under conjunctive use projects.

Advanced Water Technologies

The advanced water technologies data shown in Table A.11-2 include total groundwater recovery and seawater desalination production in Metropolitan's service area as described in Section 3.5 and Appendix 2 of Metropolitan's UWMP.

Conjunctive Use Projects

The values for conjunctive use projects shown in Table A.11-2 represent total groundwater production in the region as described in Section 1.4 and Appendix 2 of Metropolitan's UWMP.

The conjunctive use projects numbers shown in Table A.11-2 do not include production from regional groundwater conjunctive use programs. As described in the stormwater capture and use discussion above, these regional storage programs rely on previously stored water from sources already reflected in Tables A.11-2 and A.11-3 and are generally used to provide additional regional self-reliance in dry-years. The regional groundwater conjunctive use programs and their yields are described in Section 3.6 and Appendix 3.

Local and Regional Water Supply and Storage Programs

The data for local and regional water supply and storage programs shown in Table A.11-2 include supplies from the Los Angeles Aqueduct. This supply is described in Section 1.4 and Appendix 2 of Metropolitan's UWMP.

The local and regional supply numbers shown in Table A.11-2, except for "Other Programs and Projects that Contribute to Regional Self-Reliance" which is discussed below, were obtained from the following sources:

- Baseline (2010) values – Metropolitan's 2005 UWMP, Table 2-6: Metropolitan Regional Water Demand Average Year

- 2015 values – Metropolitan's 2010 UWMP, Table 2-8: Metropolitan Regional Water Demands Average Year
- 2020 values – Metropolitan's 2015 UWMP, Table 2-3: Metropolitan Regional Water Demands Average Year
- 2025-2045 values – Metropolitan's 2020 UWMP, Table 2-3: Metropolitan Regional Water Demands Normal Water Year

Other Programs and Projects that Contribute to Regional Self-Reliance

Other programs and projects that contribute to regional self-reliance shown in Table A.11-2 include current programs from the Colorado River Aqueduct. Colorado River supplies include Metropolitan's basic Colorado River apportionment, as well as supplies that result from existing and committed programs, including those from the IID-MWD Conservation Program, the implementation of the Quantification Settlement Agreement (QSA), related agreements, and the exchange agreement with SDCWA. Colorado River Aqueduct supplies and programs are described in Section 3.1 and Appendix 3 of Metropolitan's UWMP.

The values shown in Table A.11-2 for other programs and projects that contribute to regional self-reliance come from the following sources:

- Baseline (2010) values – Metropolitan's 2005 UWMP, Table A.3-7: Maximum Expected Colorado River Aqueduct Deliveries Year 2010 (Average Year)
- 2015 values – Metropolitan's 2010 UWMP, Table A.3-7: Maximum Expected Colorado River Aqueduct Deliveries Year 2015 (Average Year)
- 2020 values – Metropolitan's 2015 UWMP, Table A.3-7: Maximum Expected Colorado River Aqueduct Deliveries Year 2020 (Average Year)
- 2025-2045 values – Metropolitan's 2020 UWMP, Table A.3-7: Maximum Expected Colorado River Aqueduct Deliveries Years 2025, 2030, 2035, 2040, 2045 (Normal Water Year)

Reliance on Water Supplies from the Delta Watershed

In order for a covered action to demonstrate consistency with the Delta Plan, WR P1 subsection (c)(1)(C) requires that water suppliers report the expected outcomes for measurable reductions in supplies from the Delta watershed either as an amount or as a percentage. This analysis provides both calculations. Based on the methodology described in Guidebook Appendix C, and consistent with the approach of this analysis in not including projects under development, this accounting does not include any supplies from potential future covered actions. Table A.11-3 shows the expected outcomes for reliance on supplies from the Delta watershed for Metropolitan's service area. Supporting narratives and documentation for the all of the data shown in Table A.11-3 are provided below.

The results shown in Table A.11-3 demonstrate that Metropolitan's service area is measurably reducing its Delta reliance. In the near-term (2025), the expected outcome for normal water year reliance on supplies from the Delta watershed decreased by 301 TAF from the 2010 baseline; this represents a decrease of 3 percent of 2025 normal water year retail demands. In the long-term (2045), normal water year reliance on supplies from the Delta watershed decreased by 314 TAF from the 2010 baseline; this represents a decrease of just over 5 percent of 2045 normal water year retail demands.

Table A.11-3
Reliance on Water Supplies from the Delta Watershed

Water Supplies from the Delta Watershed (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
CVP/SWP Contract Supplies	1,472,000	1,029,000	984,000	1,133,000	1,130,000	1,128,000	1,126,000	1,126,000
Delta/Delta Tributary Diversions	-	-	-	-	-	-	-	-
Transfers and Exchanges of Supplies from the Delta Watershed	20,000	44,000	91,000	58,000	52,000	52,000	52,000	52,000
Other Water Supplies from the Delta Watershed	-	-	-	-	-	-	-	-
Total Water Supplies from the Delta Watershed	**1,492,000**	**1,073,000**	**1,075,000**	**1,191,000**	**1,182,000**	**1,180,000**	**1,178,000**	**1,178,000**

Service Area Demands without Water Use Efficiency (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Service Area Demands without Water Use Efficiency Accounted For	5,493,000	5,499,000	5,219,000	4,925,000	5,032,000	5,156,000	5,261,000	5,374,000

Change in Supplies from the Delta Watershed (Acre-Feet)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Water Supplies from the Delta Watershed	1,492,000	1,073,000	1,075,000	1,191,000	1,182,000	1,180,000	1,178,000	1,178,000
Change in Supplies from the Delta Watershed	**NA**	**(419,000)**	**(417,000)**	**(301,000)**	**(310,000)**	**(312,000)**	**(314,000)**	**(314,000)**

Percent Change in Supplies from the Delta Watershed (As a Percent of Demand w/out WUE)	Baseline (2010)	2015	2020	2025	2030	2035	2040	2045
Percent of Supplies from the Delta Watershed	27.2%	19.5%	20.6%	24.2%	23.5%	22.9%	22.4%	21.9%
Change in Percent of Supplies from the Delta Watershed	**NA**	**-7.6%**	**-6.6%**	**-3.0%**	**-3.7%**	**-4.3%**	**-4.8%**	**-5.2%**

CVP/SWP Contract Supplies

The CVP/SWP contract supplies shown in Table A.11-3 include Metropolitan's SWP Table A and Article 21 supplies. These supplies are described in Section 3.2 and Appendix 3 of Metropolitan's UWMP.

The values shown in Table A.11-3 do not include Desert Water Agency/Coachella Valley Water District SWP contract supplies. These supplies are exchanged with Desert Water Agency and Coachella Valley Water District for an equal amount of Colorado River water, which is reflected in the Colorado River Aqueduct supplies shown in Table A.11-2. In addition, Desert Water Agency and Coachella Valley Water District should include their SWP contract supplies in their own accountings of reduced reliance. Additional information on these exchange agreements can be found in Section 3.2 and Appendix 3 of Metropolitan's UWMP.

These values also do not include supplies from San Luis Carryover storage or Central Valley storage programs because storage in these programs comprises previously stored water from sources already reflected in Table A.11-3. These storage programs are generally used to provide additional regional self-reliance in dry years, which is not reflected in this normal water year analysis. The Central Valley storage projects and their yields are described in Section 3.3, and Appendix 3. San Luis Carryover storage is described in Section 3.2 and Appendix 3.

Transfers and Exchanges of Supplies from the Delta Watershed

The transfers and exchanges of supplies from the Delta watershed shown in Table A.11-3 include supplies from the San Bernardino Valley MWD Program, Yuba River Accord Purchase Program, the San Gabriel Valley MWD Program, Irvine Ranch Water District Storage and Exchange Program, and other generic SWP and Central Valley transfers and exchanges. These programs are described in Section 3.2 and Appendix 3 of Metropolitan's UWMP.

Supplies from the Delta Watershed shown in Table A.11-3 are from the following sources:

- Baseline (2010) values – Metropolitan's 2005 UWMP, Table A.3-7: California Aqueduct Program Capabilities Year 2010 (Average Year)

- 2015 values – Metropolitan's 2010 UWMP, Table A.3-7: California Aqueduct Program Capabilities Year 2015 (Average Year)
- 2020 values – Metropolitan's 2015 UWMP, Table A.3-7: California Aqueduct Program Capabilities Year 2020 (Average Year)
- 2025-2045 values – Metropolitan's 2020 UWMP, Table A.3-7: California Aqueduct Program Capabilities Years 2025, 2030, 2035, 2040, 2045 (Normal Water Year)

A.11.4 UWMP Implementation

In addition to the analysis and documentation described above, WR P1 subsection (c)(1)(B) requires that all programs and projects included in the UWMP that are locally cost-effective and technically feasible, which reduce reliance on the Delta, are identified, evaluated, and implemented consistent with the implementation schedule. WR P1 (c)(1)(B) states that:

> *(B) Identified, evaluated, and commenced implementation, consistent with the implementation schedule set forth in the Plan, of all programs and projects included in the Plan that are locally cost effective and technically feasible which reduce reliance on the Delta*[.]

In accordance with Water Code Section 10631(f), water suppliers must already include in their UWMP a detailed description of expected future projects and programs that they may implement to increase the amount of water supply available to them in normal and single-dry water years and for a period of drought lasting five consecutive years. The UWMP description must also identify specific projects, include a description of the increase in water supply that is expected to be available from each project, and include an estimate regarding the implementation timeline for each project or program.

Section 3 of Metropolitan's UWMP summarizes the implementation plan and continued progress in developing a diversified water portfolio to meet the region's water needs.

Water Use Efficiency

The water use efficiency numbers used in this analysis include the total water use efficiency savings (conservation) for the service area, including savings from active, code-based, price-effect and pre-1990 savings. The specific water use efficiency programs and their implementation are described in Section 3.4 of Metropolitan's UWMP.

Water Recycling

The water recycling values used in this analysis reflect the total recycled water production in Metropolitan's service area. Water recycling programs and implementation are discussed in Section 3.5 of Metropolitan's UWMP. In addition, individual project-level details are provided in Appendix 5.

Stormwater Capture and Use

The stormwater capture and use data used in this analysis include supplies from local surface water production. Local surface water production and its implementation are discussed in Appendix 2 of Metropolitan's UWMP.

Advanced Water Technologies

The advanced water technologies data used in this analysis include total groundwater recovery and seawater desalination production in Metropolitan's service. Groundwater recovery and seawater desalination programs and implementation are described in Section 3.5 of Metropolitan's UWMP. In addition, individual project-level details are provided in Appendix 5.

Conjunctive Use Projects

The values for conjunctive use projects used in this analysis represent total groundwater production in the region. Groundwater production and its implementation are discussed in Appendix 2 of Metropolitan's UWMP.

Local and Regional Water Supply and Storage Programs

The data for local and regional water supply and storage programs shown this analysis include supplies from the Los Angeles Aqueduct. This program and its implementation are described in Appendix 2 of Metropolitan's UWMP.

Other Programs and Projects that Contribute to Regional Self-Reliance

Other programs and projects that contribute to regional self-reliance used in this analysis include current programs from the Colorado River Aqueduct. Colorado River supplies include Metropolitan's basic Colorado River apportionment, as well as supplies that result from existing and committed programs, including those from the IID-MWD Conservation Program, the implementation of the Quantification Settlement Agreement (QSA), related agreements, and the exchange agreement with SDCWA. Colorado River Aqueduct programs and their implementation are described in Section 3.1 and Appendix 3 of Metropolitan's UWMP.

CVP/SWP Contract Supplies

The CVP/SWP contract supplies shown in this analysis include Metropolitan's SWP Table A and Article 21 supplies. These supplies and their implementation are described in Section 3.2 and Appendix 3 of Metropolitan's UWMP.

Transfers and Exchanges of Supplies from the Delta Watershed

The transfers and exchanges of supplies from the Delta watershed shown in this analysis include supplies from the San Bernardino Valley MWD Program, Yuba River Accord Purchase Program, the San Gabriel Valley MWD Program, Irvine Ranch Water District Storage and Exchange Program, and other generic SWP and Central Valley transfers and exchanges. These programs and their implementation are described in Section 3.2 and Appendix 3 of Metropolitan's UWMP.

A.11.5 2015 UWMP Appendix 11

The information contained in this Appendix 11 is also intended to be a new Appendix 11 attached to Metropolitan's 2015 UWMP consistent with WR P1 subsection (c)(1)(C) (Cal. Code Regs. tit. 23, § 5003). Metropolitan provided notice of the availability of the draft 2020 UWMP (including this Appendix 11 which will also be a new Appendix 11 to its 2015 UWMP) and WSCP and the public hearing to consider adoption of both plans and Appendix 11 to the 2015 UWMP in accordance with CWC Sections 10621(b) and 10642, and Government Code Section 6066, and Chapter 17.5 (starting with Section 7290) of Division 7 of Title 1 of the Government Code. The public review drafts of the 2020 UWMP, Appendix 11 to the 2015 UWMP, and the WSCP were posted prominently on Metropolitan's website, mwdh2o.com, starting February 1, 2021, more than 60 days in advance of the public hearing on April 12, 2021. The notice of availability of the documents was sent to Metropolitan's member agencies, as well as cities and counties in Metropolitan's service area. In addition, a public notice advertising the public hearing in English and Spanish was published in 12 Southern California newspapers. The notification in English language newspapers was published on February 1 and 8, 2021. The notification was published on January 28-30, 2021 and February 1, 4-6, and 8, 2021 in Spanish language newspapers, satisfying the requirement for non-English language notification. Copies of: (1) the notification letter sent to the member agencies, cities and counties in Metropolitan's service area, and (2) the notice published in the newspapers are included in the 2020 UWMP Section 5. Thus, this Appendix 11 to Metropolitan's 2020 UWMP, which was adopted with Metropolitan's 2020 UWMP, will also be recognized and treated as Appendix 11 to Metropolitan's 2015 UWMP.

Metropolitan held the public hearing for the draft 2020 UWMP, draft Appendix 11 to the 2015 UWMP, and draft WSCP on April 12, 2021, at the Board's Water Planning and Stewardship Committee meeting, held online due to COVID-19 concerns. On May 11, 2021, Metropolitan's Board determined that the 2020 UWMP and the WSCP are consistent with the MWD Act and accurately represent the water resources plan for Metropolitan's service area. In addition, Metropolitan's Board determined that Appendix 11 to both the 2015 UWMP and the 2020 UWMP includes all of the elements described in Delta Plan Policy WR P1, Reduce Reliance on the Delta Through Improved Regional Water Self-Reliance (Cal. Code Regs. tit. 23, § 5003), which need to be included in a water supplier's UWMP to support a certification of consistency for a future covered action. As stated in Resolutions 9279, 9280, and 9281, the Board adopted the 2020 UWMP, Appendix 11 to the 2015 UWMP, and the WSCP and authorized their submittal to the State of California. Copies of Resolutions 9279, 9280, and 9281 are included in the 2020 UWMP Section 5, and Resolution 9281 for the WSCP is attached to the WSCP as Attachment C.

This page intentionally left blank.

Appendix 12

DWR 2020 UWMP SUBMITTAL TABLES

Appendix 12
DWR 2020 UWMP SUBMITTAL TABLES

In fulfillment of California Water Code Sections, 10621(d) and 10644(a) and (b), Metropolitan's Final 2020 Urban Water Management Plan, Water Shortage Contingency Plan, and Appendix 11 Addendum to the 2015 Urban Water Management Plan were electronically submitted to the State of California through DWR's WUE Data Portal (https://wuedata.water.ca.gov/) in June 2021. This appendix contains the mandatory DWR 2020 UWMP Submittal Tables that were uploaded to the WUE data website.

Submittal Table 2-2: Plan Identification			
Select Only One	Type of Plan		Name of RUWMP or Regional Alliance *if applicable* (select from drop down list)
☑	**Individual UWMP**		
	☐	Water Supplier is also a member of a RUWMP	
	☐	Water Supplier is also a member of a Regional Alliance	
☐	**Regional Urban Water Management Plan (RUWMP)**		
NOTES:			

Submittal Table 2-3: Supplier Identification	
Type of Supplier (select one or both)	
☑	Supplier is a wholesaler
☐	Supplier is a retailer
Fiscal or Calendar Year (select one)	
☑	UWMP Tables are in calendar years
☐	UWMP Tables are in fiscal years
If using fiscal years provide month and date that the fiscal year begins (mm/dd)	
Units of measure used in UWMP * (select from drop down)	
Unit	AF
** Units of measure (AF, CCF, MG) must remain consistent throughout the UWMP as reported in Table 2-3.*	
NOTES:	

Submittal Table 2-4 Wholesale: Water Supplier Information Exchange (select one)	
☑	Supplier has informed more than 10 other water suppliers of water supplies available in accordance with Water Code Section 10631. Completion of the table below is optional. If not completed, include a list of the water suppliers that were informed.
Section 5 pp. 5-8 to 5-9	**Provide page number for location of the list.**
☐	Supplier has informed 10 or fewer other water suppliers of water supplies available in accordance with Water Code Section 10631. **Complete the table below.**
Water Supplier Name	
Add additional rows as needed	
NOTES: NOTES: See 2020 UWMP Sections 2 and 5 for discussion of Metropolitan's planning coordination, outreach, and notification (list provided in Section 5 Table 5-3 pp. 5-8 and 5-9).	

Submittal Table 3-1 Wholesale: Population - Current and Projected						
Population Served	2020	2025	2030	2035	2040	2045*(opt)*
	19,035,000	**20,089,000**	**20,634,000**	**21,145,000**	**21,610,000**	**22,026,000**
NOTES: See 2020 UWMP Appendix 1 Tabel A.1-2.						

Submittal Table 4-1 Wholesale: Demands for Potable and Non-Potable[1] Water - Actual			
Use Type	2020 Actual		
Drop down list May select each use multiple times These are the only use types that will be recognized by the WUE data online submittal tool	Additional Description (as needed)	Level of Treatment When Delivered Drop down list	Volume[2]
Add additional rows as needed			
Sales to other agencies		Drinking Water	789,218
Sales to other agencies		Raw Water	605,043
Losses			48,520
		TOTAL	1,442,781
[1] *Recycled water demands are NOT reported in this table. Recycled water demands are reported in Table 6-4.*			
[2] *Units of measure (AF, CCF, MG) must remain consistent throughout the UWMP as reported in Table 2-3.*			
NOTES: Sales to other agencies include Metropolitan deliveries to member and non-member agencies and deliveries from conjunctive use programs. Some of these deliveries are not revenue producing nor sales. Losses include evaporation losses from storage reservoirs and distribution system (2019 estimate). Water losses are both drinking and raw water.			

Submittal Table 4-2 Wholesale: Use for Potable and Raw Water [1] - Projected						
Use Type	Additional Description (as needed)	Projected Water Use [2] Report To the Extent that Records are Available				
Drop down list May select each use multiple times These are the only Use Types that will be recognized by the WUEdata online submittal tool.		2025	2030	2035	2040	2045 (opt)
Add additional rows as needed						
Other		1,149,000	1,110,000	1,084,000	1,100,000	1,125,000
Exchanges to other agencies		278,000	278,000	278,000	278,000	278,000
	TOTAL	1,427,000	1,388,000	1,362,000	1,378,000	1,403,000

[1] *Recycled water demands are NOT reported in this table. Recycled water demands are reported in Table 6-4.*
[2] *Units of measure (AF, CCF, MG) must remain consistent throughout the UWMP as reported in Table 2-3.*

NOTES: See 2020 UWMP detailed discussion in Section 2, Metropolitan's Regional Water Demands Table 2-3 for Normal Water Year, and Supply Capability and Projected Demands Table 2-6 for Normal Water Year (average of 1922 to 2017 historic hydrologies).

Submittal Table 4-3 Wholesale: Total Water Use (Potable and Non-Potable)						
	2020	2025	2030	2035	2040	2045 (opt)
Potable and Raw Water From Tables 4-1W and 4-2W	1,442,781	1,427,000	1,388,000	1,362,000	1,378,000	1,403,000
Recycled Water Demand* From Table 6-4W	0	0	0	0	0	0
TOTAL WATER DEMAND	1,442,781	1,427,000	1,388,000	1,362,000	1,378,000	1,403,000

**Recycled water demand fields will be blank until Table 6-4 is complete.*

NOTES:

OPTIONAL Table 4-4 Wholesale: Last Five Years of Water Loss Audit Reporting	
Reporting Period Start Date (mm/yyyy)	Volume of Water Loss [1,2]
01/2015	10,628
01/2016	8,545
01/2017	7,928
01/2018	4,991
01/2019	6,907

[1] *Taken from the field "Water Losses" (a combination of apparent losses and real losses) from the AWWA worksheet.*
[2] ***Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*

NOTES: See 2020 UWMP discussions in Section 2.6 and Appendix 7, and estimate of distribution system water losses in Tables A.7-1, A.7-2, A.7-3, A.7-4, and A.7-5.

Submittal Table 6-1 Wholesale: Groundwater Volume Pumped						
☑	Supplier does not pump groundwater. The supplier will not complete the table below.					
☐	All or part of the groundwater described below is desalinated.					
Groundwater Type	Location or Basin Name	2016*	2017*	2018*	2019*	2020*
Add additional rows as needed						
	TOTAL	**0**	**0**	**0**	**0**	**0**
**** Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*						
NOTES:						

Submittal Table 6-3 Wholesale: Wastewater Treatment and Discharge Within Service Area in 2020											
☑	Wholesale Supplier neither distributes nor provides supplemental treatment to recycled water. The Supplier will not complete the table below.										
							2020 volumes [1]				
Wastewater Treatment Plant Name	Discharge Location Name or Identifier	Discharge Location Description	Wastewater Discharge ID Number *(optional)* [2]	Method of Disposal ***Drop down list***	Does This Plant Treat Wastewater Generated Outside the Service Area? ***Drop down list***	Treatment Level ***Drop down list***	Wastewater Treated	Discharged Treated Wastewater	Recycled Within Service Area	Recycled Outside of Service Area	Instream Flow Permit Requirement
Add additional rows as needed											
						Total	0	0	0	0	0
[1] **Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3. [2] If the **Wastewater Discharge ID Number** is not available to the UWMP preparer, access the SWRCB CIWQS regulated facility website at https://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=RegulatedFacility											
NOTES:											

Submittal Table 6-4 Wholesale: Current and Projected Retailers Provided Recycled Water Within Service Area							
☑	Recycled water is not directly treated or distributed by the Supplier. The Supplier will not complete the table below.						
Name of Receiving Supplier or Direct Use by Wholesaler	Level of Treatment *Drop down list*	2020*	2025*	2030*	2035*	2040*	2045* *(opt)*
Add additional rows as needed							
	Total	0	0	0	0	0	0
*** Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.							
NOTES:							

Submittal Table 6-5 Wholesale: 2015 UWMP Recycled Water Use Projection Compared to 2020 Actual		
☑	Recycled water was not used or distributed by the supplier in 2015, nor projected for use or distribution in 2020. The wholesale supplier will not complete the table below.	
Name of Receiving Supplier or Direct Use by Wholesaler	2015 Projection for 2020*	2020 Actual Use*
Add additional rows as needed		
Total	0	0
***Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*		
NOTES: The 2015 UWMP Table 2-3 included projection for recycled water use in 2020 of 436 TAF under average hydrology. In 2020, the actual recycled water use (regional total within Metropolitan service area) is estimated at 441 TAF (excluding Santa Ana River baseflow), as discussed in this 2020 UWMP Section 3.5 on Table 3-14 p. 3-78 and Appendix 2 p. A.2-8. Regional total represents the projected production of projects by Metropolitan member agencies. Metropolitan's Regional Recycled Water Program is still a pilot project, with recent Board approval to proceed with environmental planning.		

Submittal Table 6-7 Wholesale: Expected Future Water Supply Projects or Programs						
☐	No expected future water supply projects or programs that provide a quantifiable increase to the agency's water supply. Supplier will not complete the table below.					
☑	Some or all of the supplier's future water supply projects or programs are not compatible with this table and are described in a narrative format.					
2020 UWMP Section 3 and Appendix 3	Provide page location of narrative in the UWMP					
Name of Future Projects or Programs	Joint Project with other suppliers?		Description *(if needed)*	Planned Implementation Year	Planned for Use in Year Type *Drop Down list*	Expected Increase in Water Supply to Supplier*
	Drop Down Menu	*If Yes, Supplier Name*				
Add additional rows as needed						
***Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*						
NOTES: See 2020 UWMP Section 3 description of resources and program development for CRA, SWP, Central Valley/SWP storage and transfers programs, conservation, LRP (groundwater recovery, recycling, desalination), and groundwater. Also, see Appendix 3 detailed discussion of all supply programs and justification for supply projections.						

Submittal Table 6-8 Wholesale: Water Supplies — Actual				
Water Supply	Additional Detail on Water Supply	2020		
Drop down list May use each category multiple times.These are the only water supply categories that will be recognized by the WUEdata online submittal tool		Actual Volume*	Water Quality Drop Down List	Total Right or Safe Yield* (optional)
Add additional rows as needed				
Purchased or Imported Water		1,069,648	Other Non-Potable Water	
Supply from Storage		367,069	Other Non-Potable Water	
Transfers		6,064	Other Non-Potable Water	
	Total	1,442,781		0
*Units of measure (AF, CCF, MG) must remain consistent throughout the UWMP as reported in Table 2-3.				
NOTES: Actual volume of water reported in this table are raw water. The "Other Non-Potable Water" from the Water Quality column drop down list is the closest description to raw water.				

Submittal Table 6-9 Wholesale: Water Supplies — Projected											
Water Supply	Additional Detail on Water Supply	Projected Water Supply* Report To the Extent Practicable									
		2025		2030		2035		2040		2045 (opt)	
Drop down list May use each category multiple times. These are the only water supply categories that will be recognized by the WUEdata online submittal tool		Reasonably Available Volume	Total Right or Safe Yield (optional)	Reasonably Available Volume	Total Right or Safe Yield (optional)	Reasonably Available Volume	Total Right or Safe Yield (optional)	Reasonably Available Volume	Total Right or Safe Yield (optional)	Reasonably Available Volume	Total Right or Safe Yield (optional)
Add additional rows as needed											
Other		3,912,000		3,906,000		3,903,000		3,901,000		3,898,000	
	Total	3,912,000	0	3,906,000	0	3,903,000	0	3,901,000	0	3,898,000	0
*Units of measure (AF, CCF, MG) must remain consistent throughout the UWMP as reported in Table 2-3.											
NOTES: See 2020 UWMP detailed discussion in Section 2 and Supply Capability and Projected Demands Table 2-6 for Normal Water Year (average of 1922-2017 hydrologies). Projected water supply includes capability of current and proposed programs.											

Submittal Table 7-1 Wholesale: Basis of Water Year Data (Reliability Assessment)			
Year Type	Base Year If not using a calendar year, type in the last year of the fiscal, water year, or range of years, for example, water year 1999-2000, use 2000	Available Supplies if Year Type Repeats	
		☑ Quantification of available supplies is not compatible with this table and is provided elsewhere in the UWMP. Location: 2020 UWMP Section 2 Tables 2-4, 2-5, 2-6, and Appendix 3.	
		☐ Quantification of available supplies is provided in this table as either volume only, percent only, or both.	
		Volume Available *	% of Average Supply
Average Year	1922-2017		100%
Single-Dry Year	1977		
Consecutive Dry Years 1st Year	1988		
Consecutive Dry Years 2nd Year	1989		
Consecutive Dry Years 3rd Year	1990		
Consecutive Dry Years 4th Year	1991		
Consecutive Dry Years 5th Year	1992		

Supplier may use multiple versions of Table 7-1 if different water sources have different base years and the supplier chooses to report the base years for each water source separately. If a supplier uses multiple versions of Table 7-1, in the "Note" section of each table, state that multiple versions of Table 7-1 are being used and identify the particular water source that is being reported in each table. Suppliers may create an additional worksheet for the additional tables.

***Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*

NOTES: See 2020 UWMP Section 2.3 discussion of sources of supply and water reliability assessment under normal water year, single dry year, and five consecutive drought years (summarized in Tables 2-4, 2-5, and 2-6). See Section 3 and Appendix 3 for a detailed discussion of all supply programs and justifications for supply projections. See Section 2 p. 2-7 for description, assumption, and basis of the three year types.

Submittal Table 7-2 Wholesale: Normal Year Supply and Demand Comparison					
	2025	2030	2035	2040	2045 *(Opt)*
Supply totals *(autofill from Table 6-9)*	3,912,000	3,906,000	3,903,000	3,901,000	3,898,000
Demand totals *(autofill fm Table 4-3)*	1,427,000	1,388,000	1,362,000	1,378,000	1,403,000
Difference	2,485,000	2,518,000	2,541,000	2,523,000	2,495,000

NOTES: See 2020 UWMP detailed discussion in Section 2, and Supply Capabilities and reliability assessment in Table 2-6 for Normal Water Year condition (average of 1922-2017 historic hydrology).

Submittal Table 7-3 Wholesale: Single Dry Year Supply and Demand Comparison					
	2025	2030	2035	2040	2045 (Opt)
Supply totals*	2,772,000	2,761,000	2,760,000	2,760,000	2,757,000
Demand totals*	1,544,000	1,500,000	1,473,000	1,496,000	1,525,000
Difference	1,228,000	1,261,000	1,287,000	1,264,000	1,232,000

***Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*

NOTES: See 2020 UWMP detailed discussion in Section 2, and Supply Capabilities and reliability assessment in Table 2-4 for Single Dry Year condition (repeat of 1977 hydrology).

Submittal Table 7-4 Wholesale: Multiple Dry Years Supply and Demand Comparison						
		2025*	2030*	2035*	2040*	2045* (Opt)
First year	Supply totals	2,178,800	2,219,000	2,241,000	2,263,000	2,239,000
	Demand totals	1,592,000	1,570,000	1,537,000	1,539,000	1,564,000
	Difference	586,800	649,000	704,000	724,000	675,000
Second year	Supply totals	2,178,800	2,219,000	2,241,000	2,263,000	2,239,000
	Demand totals	1,592,000	1,570,000	1,537,000	1,539,000	1,564,000
	Difference	586,800	649,000	704,000	724,000	675,000
Third year	Supply totals	2,178,800	2,219,000	2,241,000	2,263,000	2,239,000
	Demand totals	1,592,000	1,570,000	1,537,000	1,539,000	1,564,000
	Difference	586,800	649,000	704,000	724,000	675,000
Fourth year	Supply totals	2,178,800	2,219,000	2,241,000	2,263,000	2,239,000
	Demand totals	1,592,000	1,570,000	1,537,000	1,539,000	1,564,000
	Difference	586,800	649,000	704,000	724,000	675,000
Fifth year	Supply totals	2,178,800	2,219,000	2,241,000	2,263,000	2,239,000
	Demand totals	1,592,000	1,570,000	1,537,000	1,539,000	1,564,000
	Difference	586,800	649,000	704,000	724,000	675,000
Sixth year *(optional)*	Supply totals					
	Demand totals					
	Difference	0	0	0	0	0

***Units of measure (AF, CCF, MG)** must remain consistent throughout the UWMP as reported in Table 2-3.*

NOTES: See 2020 UWMP detailed discussion in Section 2, and Supply Capabilities and reliability assessment in Table 2-5 for Five Consecutive Drought Year condition (repeat of 1988-1992 hydrology). Similar to the multiple dry-year reporting in past UWMPs, Metropolitan's reliability assessment for the five consecutive year drought is developed by simulating the five-year driest sequence leading to each of the fifth year reporting. This allows impacts of multiple consecutive years of droughts to be captured within the sequential accounting of Metropolitan's various supply program storage balance. The five consecutive years of supply and demand are then averaged and presented every five years rather than a year by-year display. Over the years, Metropolitan has developed numerous programs to increase its water supply capabilities, dry year supplies, and regional storage. These programs may be exercised in conjunction with effective demand management measures during drought years. Under this reliability planning, if a five consecutive year drought sequence was to repeat, Metropolitan could exercise similar supply augmentation and demand management options for each of the five drought years at the appropriate level to meet demands. This methodology best captures Metropolitan's complex demand and supply planning with appropriate flexibility.

Submittal Table 7-5: Five-Year Drought Risk Assessment Tables to address Water Code Section 10635(b)

2021	Total
Total Water Use	1,596,000
Total Supplies	1,164,000
Surplus/Shortfall w/o WSCP Action	(432,000)
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	432,000
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%

2022	Total
Total Water Use	1,669,000
Total Supplies	1,903,000
Surplus/Shortfall w/o WSCP Action	234,000
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	0
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	234,000
Resulting % Use Reduction from WSCP action	0%

2023	Total
Total Water Use	1,688,000
Total Supplies	1,300,000
Surplus/Shortfall w/o WSCP Action	(388,000)
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	388,000
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%

2024	Total
Total Water Use	1,491,000
Total Supplies	1,468,000
Surplus/Shortfall w/o WSCP Action	(23,000)
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	23,000
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%

2025	Total
Total Water Use	1,592,000
Total Supplies	1,369,000
Surplus/Shortfall w/o WSCP Action	(223,000)
Planned WSCP Actions (use reduction and supply augmentation)	
WSCP - supply augmentation benefit	223,000
WSCP - use reduction savings benefit	0
Revised Surplus/(shortfall)	0
Resulting % Use Reduction from WSCP action	0%

Note: See 2020 UWMP discussion in Section 2.4 Drought Risk Assessment and the supply augmentation actions that may be exercised to meet demands through 2025.

Submittal Table 8-1
Water Shortage Contingency Plan Levels

Shortage Level	Percent Shortage Range	Shortage Response Actions (*Narrative description*)
1	Up to 10%	Shortage response actions will be customized to meet the circumstances for the particular shortage. Response actions may include a combination of supply augmentation from flexible supplies and dry year storage, demand response actions, and operational measures.
2	Up to 20%	Shortage response actions will be customized to meet the circumstances for the particular shortage. Response actions may include a combination of supply augmentation from flexible supplies and dry year storage, demand response actions, and operational measures.
3	Up to 30%	Shortage response actions will be customized to meet the circumstances for the particular shortage. Response actions may include a combination of supply augmentation from flexible supplies and dry year storage, demand response actions, and operational measures.
4	Up to 40%	Shortage response actions will be customized to meet the circumstances for the particular shortage. Response actions may include a combination of supply augmentation from flexible supplies and dry year storage, demand response actions, and operational measures.
5	Up to 50%	Shortage response actions will be customized to meet the circumstances for the particular shortage. Response actions may include a combination of supply augmentation from flexible supplies and dry year storage, demand response actions, and operational measures.
6	>50%	Shortage response actions will be customized to meet the circumstances for the particular shortage. Response actions may include a combination of supply augmentation from flexible supplies and dry year storage, demand response actions, operational measures, and emergency storage if needed.

NOTES: Actions taken will be based on resource and operational conditions throughout the year. To determine specific actions that would be taken at each level, Metropolitan will evaluate circumstances including cost, timing, distribution needs and capabilities, and other variables that include SWP allocation, Colorado River conditions, take capacities, and storage balances. See Table A.4-5 Shortage Stages and Response Actions from Appendix 4: Water Shortage Contingency Plan.

Submittal Table 8-2: Demand Reduction Actions

Shortage Level	Demand Reduction Actions ***Drop down list*** *These are the only categories that will be accepted by the WUEdata online submittal tool. Select those that apply.*	How much is this going to reduce the shortage gap? *Include units used (volume type or percentage)*	Additional Explanation or Reference *(optional)*	Penalty, Charge, or Other Enforcement? ***For Retail Suppliers Only*** *Drop Down List*
Add additional rows as needed				
1 to 6	Expand Public Information Campaign	Range between 160,000 to 320,000 acre-feet	Assumed range of between 5% and 10% effectiveness in demand reduction realized at the wholesale level, using a hypothetical single dry year assessment of wholesale demand within the 2020 Urban Water Management Plan (2025 single-dry year). Based on assumptions of service area retail M&I demand of 4.379 MAF and up to 20 percent of retail demands could be reduced if a successful media campaign reached and influenced the entire service area population (source: American Water Works Association. 2019. Manual of Water Supply Practices – M60, Second Edition: Drought Preparedness and Response. p. 35)	
1 to 6	Other	Up to 900,000 acre-feet	Water Supply Allocation Plan (WSAP) allocates Metropolitan's wholesale water supplies among its member agencies. The WSAP is designed to reduce demands by up to approximately 50 percent of the WSAP's calculated base demand. Up to 900,000 AF of savings is based on a hypothetical WSAP base demand of 1.8 MAF. Actual reductions and base demands are based on a formula that includes various factors such as actual local supply production, population growth, and conservation.	

NOTES: Total estimated savings potential from differerent Demand Reducation Actions are nonadditive. Savings potential from voluntary actions overlaps with savings from supply allocations.

Submittal Table 8-3: Supply Augmentation and Other Actions			
Shortage Level	Supply Augmentation Methods and Other Actions by Water Supplier **Drop down list** *These are the only categories that will be accepted by the WUEdata online submittal tool*	How much is this going to reduce the shortage gap? *Include units used (volume type or percentage)*	Additional Explanation or Reference *(optional)*
Add additional rows as needed			
1 to 6	Transfers	Up to 64,000 acre-feet	Based on a hypothetical 2025 single dry year assessment within the 2020 Urban Water Management Plan. See Table 2-1 in the 2020 UWMP.
1 to 6	Other Actions (describe)	Up to 1,714,000 acre-feet	Dry year storage. Based on a hypothetical 2025 single dry year assessment within the 2020 Urban Water Management Plan.
6	Stored Emergency Supply	Up to 750,000 acre-feet	Based on Metropolitan's Emergency Storage Objective, set at 750,000 AF. Emergency storage represents water Metropolitan reservees for the region for use in the event of supply interruptions from earthquakes or similar emergencies.
NOTES:			

Submittal Table 10-1 Wholesale: Notification to Cities and Counties (select one)		
☑	Supplier has notified more than 10 cities or counties in accordance with Water Code Sections 10621 (b) and 10642. **Completion of the table below is not required. Provide a separate list of the cities and counties that were notified.**	
2020 UWMP Section 5 Table 5-3	Provide the page or location of this list in the UWMP.	
☐	Supplier has notified 10 or fewer cities or counties. **Complete the table below.**	
City Name	60 Day Notice	Notice of Public Hearing
Add additional rows as needed		
County Name *Drop Down List*	60 Day Notice	Notice of Public Hearing
Add additional rows as needed		
NOTES: See 2020 UWMP Section 5 discussion on Metropolitan's notification to cities and counties (list provided in Table 5-3). Metropolitan sent a total of 195 notification letters to cities, counties, and member agencies within its service area.		

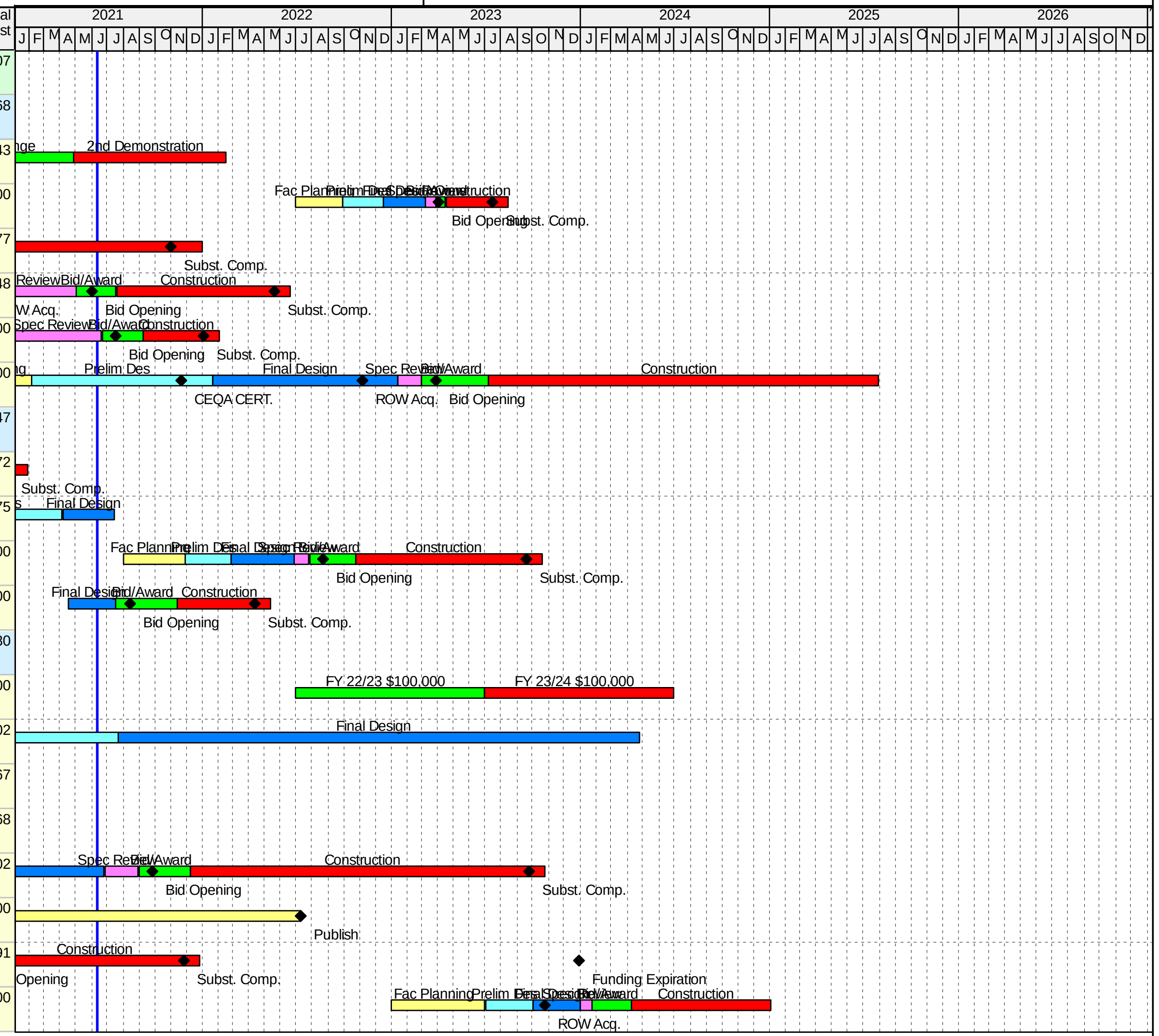
WATER TOMORROW

Planning for the Future

THE METROPOLITAN WATER DISTRICT
OF SOUTHERN CALIFORNIA

2021 5YR Capital Improvement Program

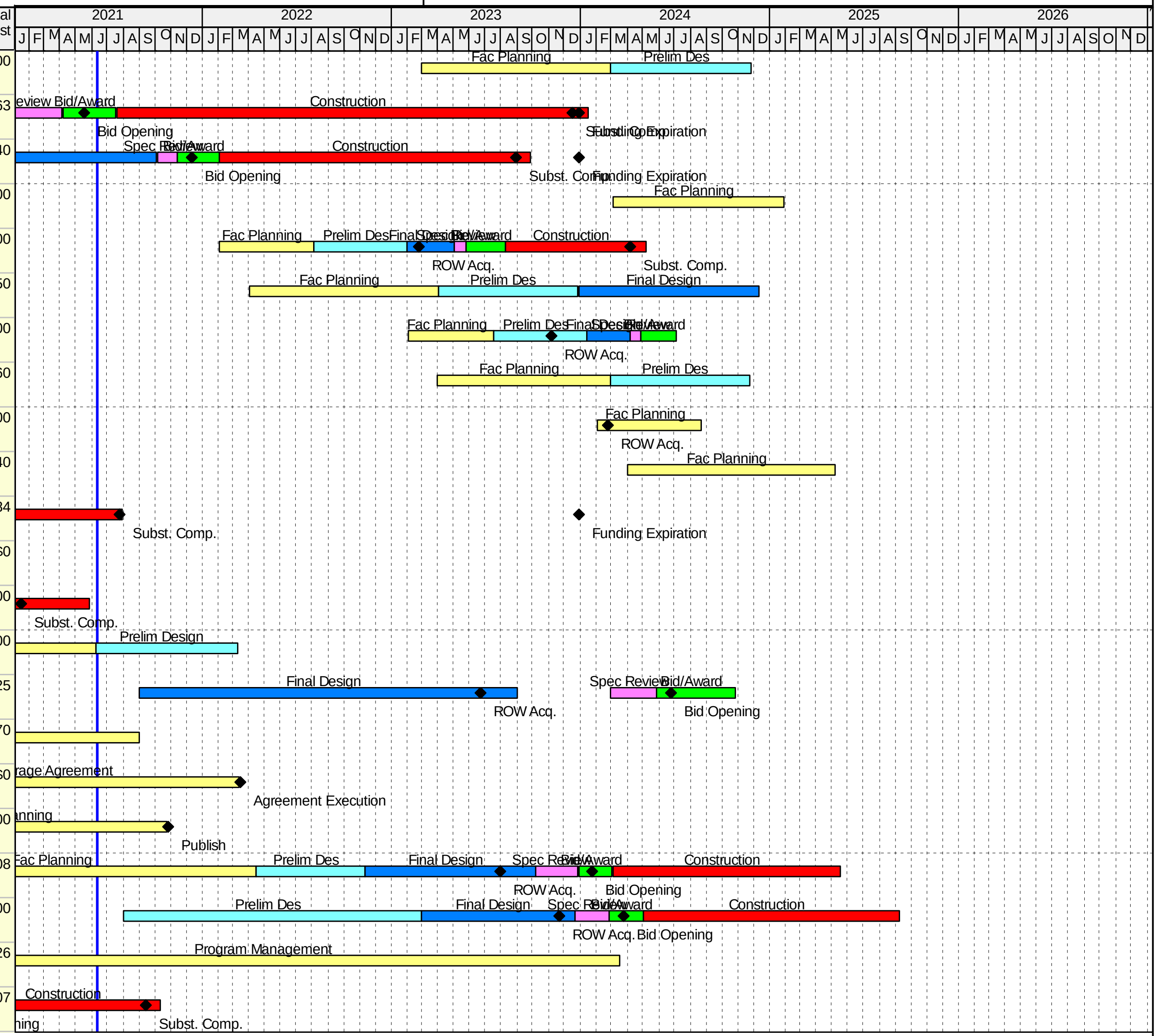
Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
WATER	21-Feb-07 A	27-Jan-26	7075	$458,176,507
WATER DESALINATION	09-Mar-15 A	31-Jul-25	3798	$90,396,468
DESALITECH CONCENTRATOR DEMONSTRATION	01-Aug-17 A	17-May-22	1683	$919,743
MENIFEE DESALTER BLEND LINE REPLACEMENT	01-Jul-22	12-Nov-23	500	$130,000
PERRIS II DESALTER	09-Mar-15 A	17-Jul-22	2688	$71,519,477
SHERMAN ROAD BRACKISH TRANSMISSION PIPELINE	16-Dec-19 A	17-Sep-22	1007	$2,870,948
MENIFEE DESALTER DECARBONATOR REPLACEMENT	31-Mar-20 A	12-May-22	693	$700,300
VALLEY BLVD BRACKISH WATER CONVEYANCE PIPELINE PHASE I	01-Sep-20 A	31-Jul-25	1795	$14,256,000
WATER FILTRATION	08-Nov-17 A	18-Dec-23	2232	$2,642,247
PWFP RRF SETTLING CHANNEL	08-Nov-17 A	30-Jul-21	1277	$934,372
HWFP HYPOCHLORITE TANKS REPLACEMENT	17-Jun-19 A	14-Jul-21	765	$86,375
PWFP RAW WATER PUMP CANS REPLACEMENT	01-Aug-21	18-Dec-23	870	$1,334,000
PWFP AIR COMPRESSOR REPLACEMENT	18-Apr-21 A	10-Aug-22	480	$287,500
WATER GROUNDWATER DEV	31-Jul-12 A	10-Sep-25	5700	$179,239,680
ANNUAL ALLOCATION - EXPL G/W TEST HOLES	01-Jul-22	30-Jun-24	731	$200,000
PURIFIED WATER REPLENISHMENT TREATMENT PLANT	31-Jul-12 A	24-Apr-24	5197	$8,844,802
WELLS 94, 95 AND 96 DRILL AND EQUIP	20-Mar-15 A	09-Jul-21	2150	$18,606,167
WELL 37 DRILLING AND TESTING	01-Jun-15 A	12-May-22	2454	$2,194,968
WELL 37 EQUIPPING AND DISCHARGE PIPELINE	15-Sep-15 A	18-Feb-24	3079	$3,885,402
SAN JACINTO VALLEY WELL PROPERTY IDENTIFICATION AND EVALUATION	25-Jul-15 A	11-Jul-22	2544	$2,500,000
WELLS 201, 202, AND 203 PHASE 1B PIPELINES	01-Jan-17 A	31-Dec-23	2555	$3,472,391
WELL PS D1 DRILLING	02-Jan-23	04-Jan-25	734	$1,287,000



PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

2021 5YR Capital Improvement Program

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
WELL PS D1 EQUIPPING	01-Mar-23	25-Nov-24	636	$245,000
WELLS 201, 202, 203, AND 205 EQUIPPING	01-Jan-17 A	24-Apr-24	2671	$23,313,363
HEWITT AND EVANS GROUNDWATER TREATMENT FACILITY PHASE I	01-Jan-17 A	05-Jan-24	2561	$7,619,440
WELL PS D2 EQUIPPING	04-Mar-24	29-Jan-25	332	$70,000
WELL ERRP SJ4 DRILLING	04-Feb-22	04-Aug-24	913	$1,300,000
WELL ERRP SJ4 EQUIPPING	02-Apr-22	12-Dec-24	986	$1,634,550
WELL ERRP SJ5 DRILLING	02-Feb-23	05-Jul-24	520	$247,000
WELL ERRP SJ5 EQUIPPING	01-Apr-23	25-Nov-24	604	$274,960
WELL ERRP SJ6 DRILLING	04-Feb-24	21-Aug-24	200	$26,000
WELL ERRP SJ6 EQUIPPING	02-Apr-24	08-May-25	402	$69,440
MOUNTAIN AVE WEST REPLENISHMENT BASIN	01-Jun-17 A	31-Dec-23	2404	$18,446,684
ERRP ADMIN PH I	01-Aug-17 A	20-Jul-18 A	349	$0
WELL 59 WELLHEAD TREATMENT	01-Feb-18 A	12-Sep-21	1341	$3,766,000
BRACKISH WELL SITING STUDY	13-Nov-19 A	09-Mar-22	983	$95,000
PURIFIED WATER REPLENISHMENT CONVEYANCE PIPELINES	01-Sep-21	27-Oct-24	1152	$1,229,625
PWR BRINE CONCENTRATION PILOT	11-Feb-19 A	01-Sep-21	780	$1,191,670
ERRP ADMIN PH II	31-Jan-20 A	14-Mar-22	774	$0
LAKEVIEW CONJUNCTIVE USE FEASIBILITY STUDY PH II	22-Mar-20 A	26-Oct-21	584	$593,500
WELL 56 WELLHEAD TREATMENT	01-Mar-20 A	17-May-25	1904	$3,964,208
WELL 93D WELLHEAD TREATMENT	01-Aug-21	10-Sep-25	1501	$3,316,500
PERRIS NORTH BASIN GROUNDWATER PROGRAM	01-Jul-20 A	18-Mar-24	1356	$2,367,026
PERRIS NORTH WELLS 65, 66, AND 209 DRILLING AND TESTING	23-Dec-19 A	19-Jan-22	845	$4,355,407



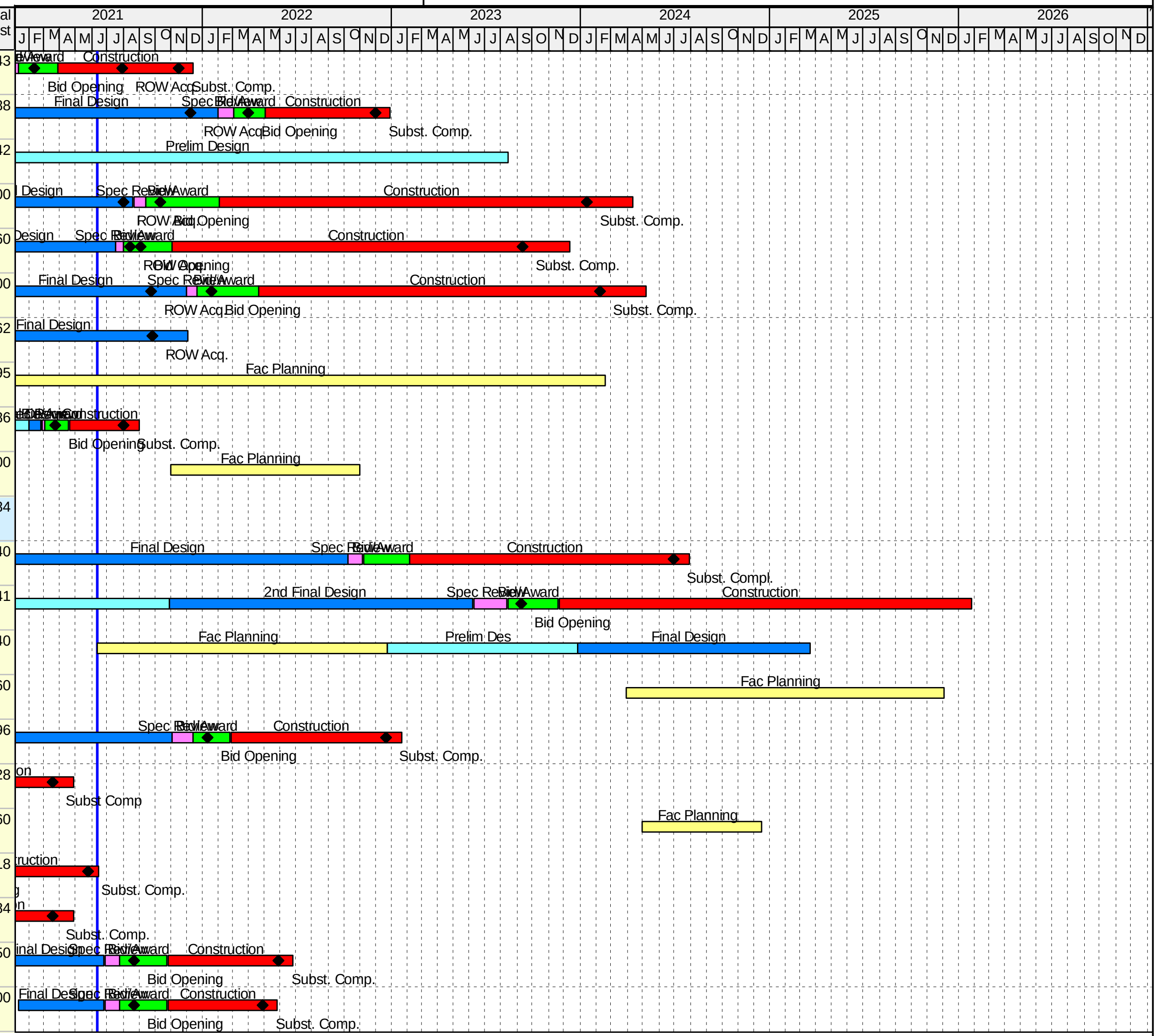
PHASE LEGEND
- FAC PLANNING
- PRELIM DESIGN
- FINAL DESIGN
- SPEC REVIEW
- BID/AWARD
- CONSTRUCTION
- ADMIN CLOSEOUT

emwd EASTERN MUNICIPAL WATER DISTRICT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
PERRIS NORTH CACTUS AVE CORRIDOR WELL DRILLING	01-Jul-20 A	15-Mar-22	623	$6,157,643
PERRIS NORTH MONITORING WELLS PH1	18-Oct-20 A	30-Mar-23	894	$2,247,388
PERRIS NORTH PLANNING MODELING AND PDR	01-Jul-20 A	14-Aug-23	760	$3,402,042
PERRIS NORTH MORENO VALLEY WELLS EQUIPPING AND TREATMENT	20-Jul-20 A	20-Jul-24	1462	$16,499,600
PERRIS NORTH CACTUS CORRIDOR TRANSMISSION PIPELINE PHASE II	20-Jul-20 A	13-Mar-24	1333	$15,657,960
PERRIS NORTH CACTUS CORRIDOR WELL EQUIPPING AND TREATMENT	18-Oct-20 A	05-Aug-24	1388	$17,746,900
PERRIS NORTH SOUTH AREA WELLS EQUIPPING AND TREATMENT	20-Jul-20 A	03-Dec-21	433	$911,862
PERRIS NORTH BASIN MONITORING AND REPORTING PLAN	18-Oct-20 A	19-Feb-24	1219	$317,295
PERRIS NORTH CACTUS CORRIDOR TRANSMISSION PIPELINE PHASE I	04-Jan-20 A	29-Dec-21	936	$1,132,886
WELL 75 AND 85 BLOW OFF TO SALT CREEK	01-Nov-21	31-Oct-22	365	$50,000
WATER STORAGE	01-Oct-13 A	27-Jan-26	4502	$38,132,584
JUDSON STREET 2.2 MG TANK	02-Jun-15 A	30-Jul-24	3346	$4,984,240
GOETZ RD 8 MG TANK & PIPELINE	01-Oct-13 A	27-Jan-26	4502	$12,259,241
NUEVO 4.6 MG TANK AND PIPELINE (PVEPW-107)	13-Jun-21	19-Mar-25	1376	$1,322,940
MOUNTAIN VIEW II 7MG TANK	31-Mar-24	05-Dec-25	615	$281,460
JUDSON TANK SITE GRADING AND CIVIL WORK	24-May-17 A	29-Apr-23	2167	$1,819,296
HIDDEN SPRINGS TANK INTERIOR RECOATING	01-Oct-19 A	30-Jul-21	641	$1,113,628
WINCHESTER HILLS I 4.5 MG TANK	01-May-24	17-Dec-24	231	$169,660
HUNTER TANK INTERIOR RECOATING	04-Oct-18 A	27-Aug-21	1065	$1,393,218
MARKHAM TANK INTERIOR RECOATING	01-Oct-19 A	30-Jul-21	660	$803,884
LOWER LAS BRISAS TANK INTERIOR RECOATING	30-Nov-20 A	23-Sep-22	663	$467,050
KALMIA TANK INTERIOR RECOATING	10-Jan-21 A	24-Aug-22	592	$661,700

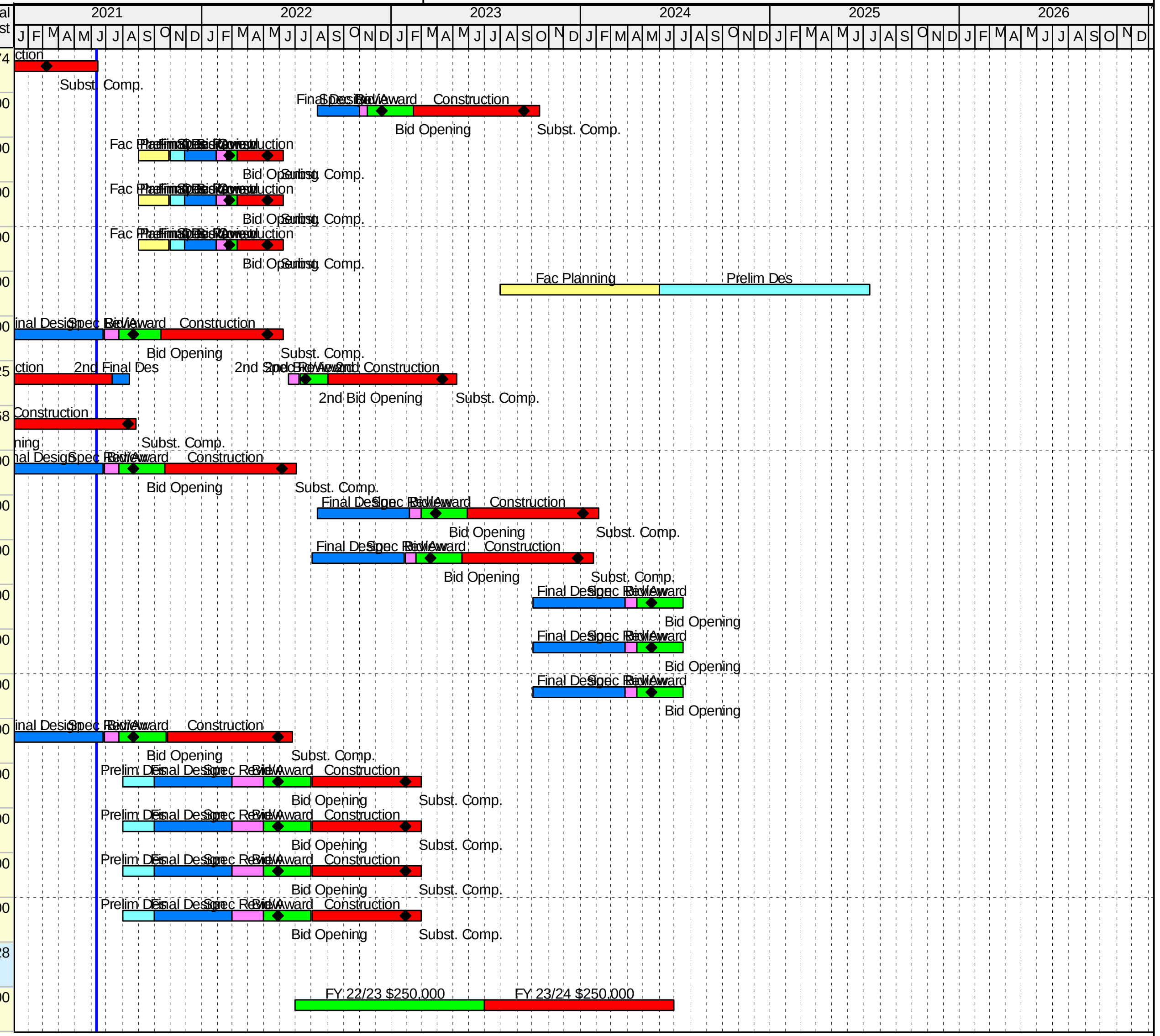


Data Date 13-Jun-21 / Run Date 29-Jun-21
ENGSCHED - 5 Yr CIP by type by prog PLN
TASK filters: No Z Projects, Not Cancelled, Project Start within 5 yr CIP.

EASTERN MUNICIPAL WATER DISTRICT

PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
VISTA TANK INTERIOR RECOATING	01-Oct-19 A	10-Sep-21	759	$1,137,874
DUTCH VILLAGE INTERIOR RECOATING	11-Aug-22	13-Dec-23	490	$875,000
MICROWAVE BACKBONE TOWER MISSION II TANK	01-Sep-21	05-Sep-22	370	$290,000
MICROWAVE BACKBONE TOWER RANCHO GLEN OAKS	01-Sep-21	05-Sep-22	370	$290,000
MICROWAVE BACKBONE TOWER SUN CITY TANK	01-Sep-21	07-Jul-22	310	$290,000
GOLDEN MEADOWS 4MG TANK	01-Aug-23	13-Jul-25	713	$490,000
CITRUS I TANK INTERIOR RECOATING	30-Nov-20 A	04-Sep-22	644	$868,300
CITRUS II TANK INTERIOR RECOATING	01-Oct-19 A	13-Jul-23	1382	$1,898,725
MICROWAVE BACKBONE TOWER SKY MESA, HUNTER AND BRODERSON TANKS	16-Sep-19 A	27-Sep-21	723	$765,168
CONTOUR TANK INTERIOR RECOATING	04-Nov-20 A	01-Oct-22	697	$366,100
PARK HILL TANK INTERIOR RECOATING	11-Aug-22	05-May-24	634	$1,000,000
MAPES TANK INTERIOR RECOATING	01-Aug-22	25-Apr-24	634	$300,000
UPPER LAS BRISAS 1 TANK INTERIOR RECOATING	01-Oct-23	16-Jul-24	290	$102,000
SUN CITY TANK INTERIOR RECOATING	01-Oct-23	16-Jul-24	290	$72,000
WOLFSKILL TANK INTERIOR RECOATING	01-Oct-23	16-Jul-24	290	$45,000
MANZANITA I TANK INTERIOR RECOATING	30-Nov-20 A	23-Sep-22	663	$366,100
MORENO BEACH TANK INTERIOR RECOATING	01-Aug-21	29-May-23	667	$775,000
MOUNTAIN VIEW TANK INTERIOR RECOATING	01-Aug-21	29-May-23	667	$1,075,000
MENIFEE VILLAGE TANK INTERIOR RECOATING	01-Aug-21	29-May-23	667	$975,000
OLEANDER TANK I INTERIOR RECOATING	01-Aug-21	29-May-23	667	$875,000
WATER TRANSMISSION	21-Feb-07 A	10-Sep-25	6936	$147,765,528
ANNUAL ALLOCATION - MISC. SYSTEM IMPRV. - WATER	01-Jul-22	30-Jun-24	731	$500,000

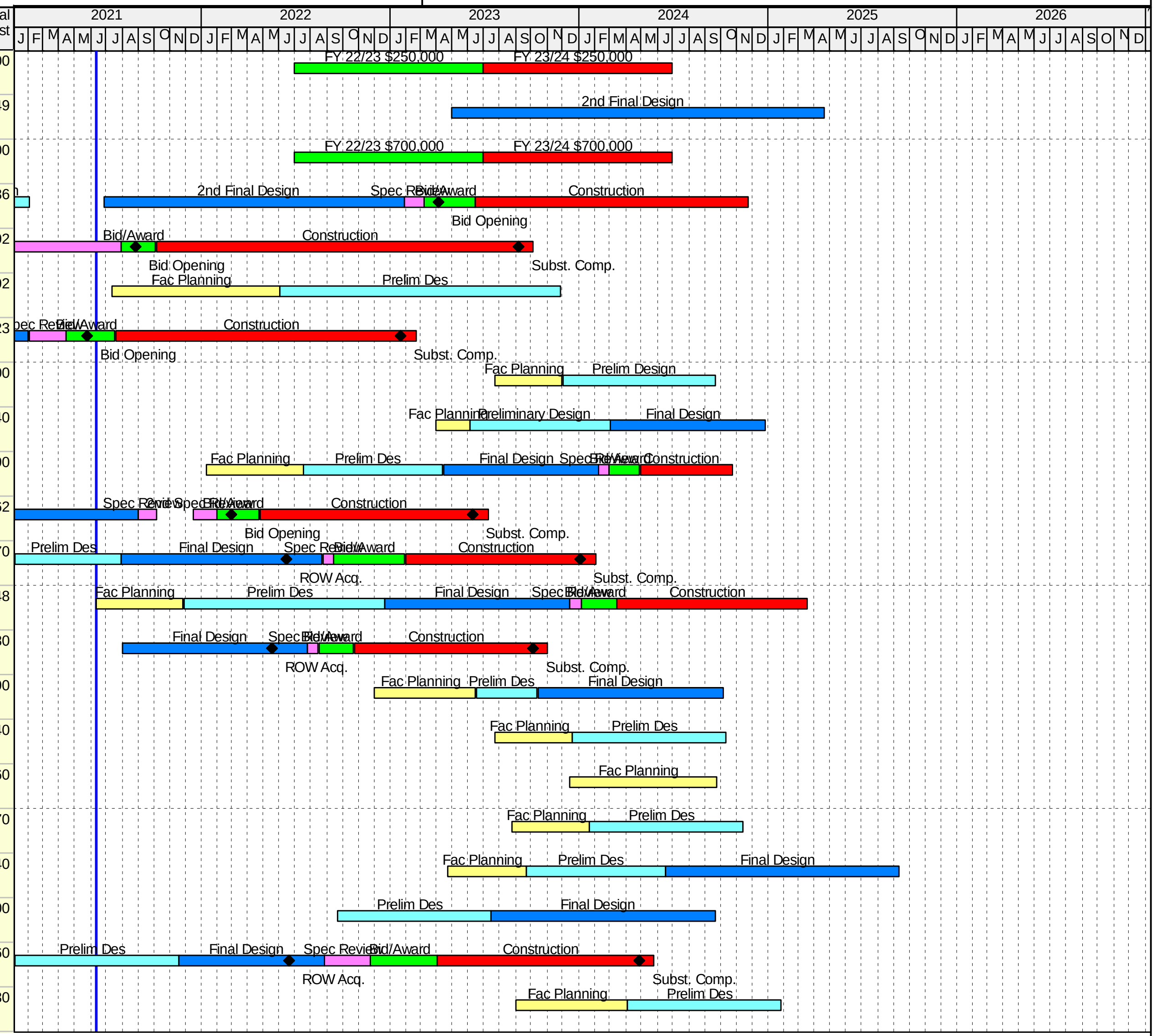


PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
ANNUAL ALLOCATION - PIPELINE & VALVE REPL	01-Jul-22	30-Jun-24	731	$500,000
WESTERN WAY BOOSTER STATION AND PIPELINE	21-Feb-07 A	19-Apr-25	6792	$4,133,049
ANNUAL ALLOCATION - ELECTRICAL CONVERSION OF GAS DRIVEN PUMP STATIONS	01-Jul-22	30-Jun-24	731	$1,400,000
MURRIETA ROAD BOOSTER STATION	09-Feb-15 A	23-Nov-24	3576	$7,217,536
PETTIT REGULATED PRESSURE ZONE	27-Jul-16 A	22-Jan-24	2736	$2,795,392
EM-11 BPS AND PIPELINE - PHASE I	12-Jul-21	28-Nov-23	870	$2,907,692
SAN JACINTO RAW WATER PIPELINE PHASE I	04-Apr-16 A	30-May-23	2613	$22,555,823
CRAIG BOOSTER EXPANSION- PH I (PVSPW-103A)	22-Jul-23	22-Sep-24	429	$21,700
BAUTISTA 1 BOOSTER UPGRADE (SJPW-106)	01-Apr-23	26-Dec-24	636	$369,240
1650 PRESSURE ZONE REALIGNMENT (SJPW-101)	11-Jan-22	25-Oct-24	1019	$792,990
INDIAN ST PIPELINE REPLACEMENT	09-Nov-17 A	17-Oct-23	2169	$591,562
JUDSON TRANSMISSION PIPELINES	07-Jan-21 A	03-May-24	1213	$5,054,770
BRIGGS ROAD WATER PIPELINE	13-Jun-21	18-Mar-25	1375	$979,548
ELLIS BPS & MENIFEE RD WATER PIPELINE (PVEPW-102)	01-Aug-21	31-Jan-24	914	$3,688,380
NUEVO ROAD POTABLE WATER PIPELINE	01-Dec-22	06-Oct-24	676	$781,490
LEON ROAD PRESSURE REDUCING VALVE	22-Jul-23	12-Oct-24	449	$11,340
WALNUT ST BS AND WATER PIPELINE	15-Dec-23	23-Sep-24	284	$242,760
CITY OF PERRIS SUPPLY IMPROVEMENT	24-Aug-23	14-Nov-24	449	$140,770
LEON RD TRANSMISSION PIPELINES	23-Apr-23	10-Sep-25	872	$727,940
SCOTT RD GAP TRANSMISSION PIPELINE	22-Sep-22	22-Sep-24	732	$89,400
MEAD VALLEY I BOOSTER PUMP STATION REPLACEMENT (PVWPW-102a)	06-Jan-21 A	24-Aug-24	1327	$6,363,560
ELLIS TANK TRANSMISSION PIPELINE	01-Sep-23	27-Jan-25	515	$29,330



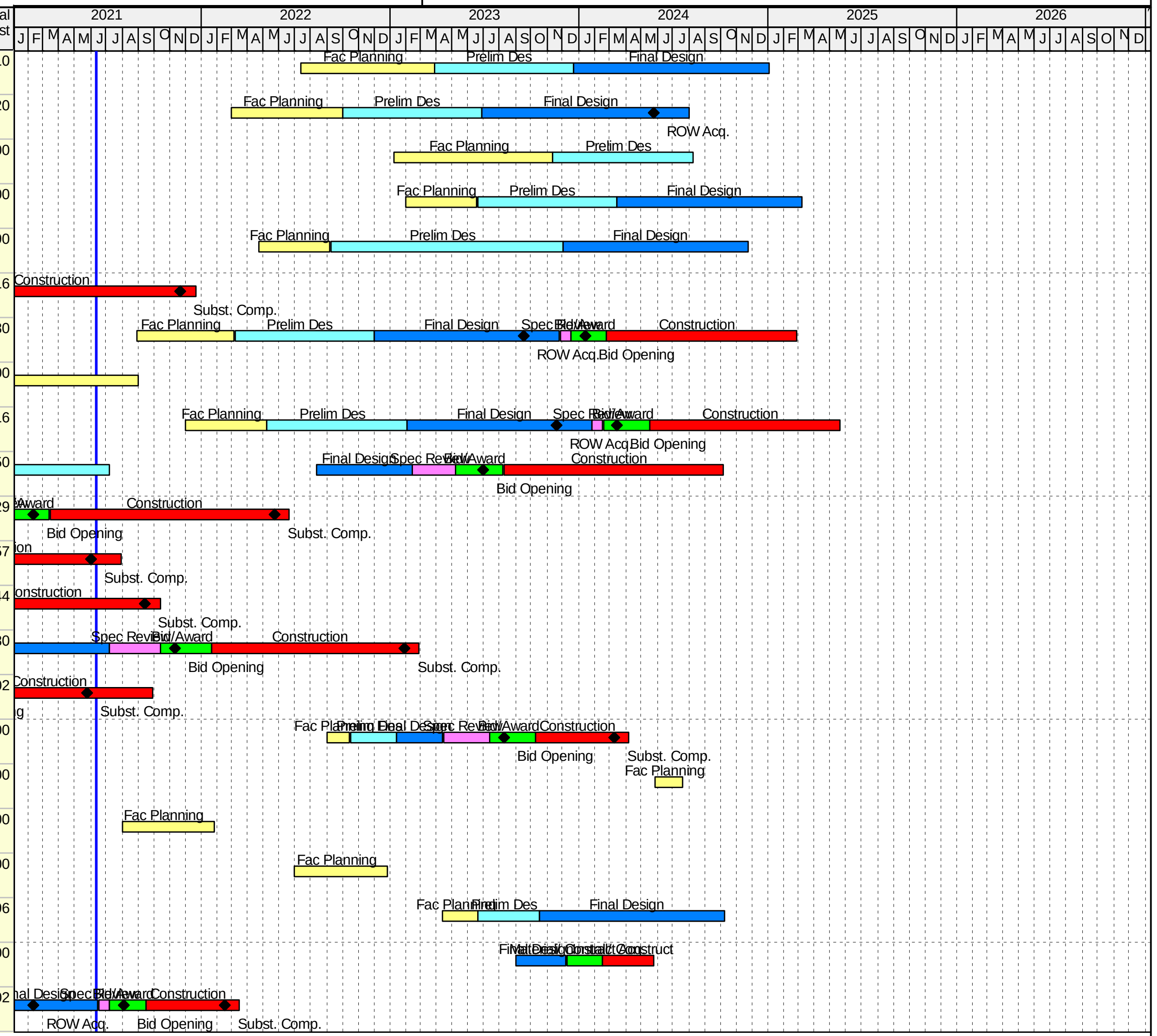
PHASE LEGEND
- FAC PLANNING
- PRELIM DESIGN
- FINAL DESIGN
- SPEC REVIEW
- BID/AWARD
- CONSTRUCTION
- ADMIN CLOSEOUT

emwd EASTERN MUNICIPAL WATER DISTRICT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
MISSION CANYON II PUMP STATION REPLACEMENT	13-Jul-22	03-Jan-25	906	$474,810
1719 RE-ZONE TO 1840	01-Mar-22	02-Aug-24	885	$109,820
DOMENIGONI PARKWAY PIPELINE PHASE I	09-Jan-23	09-Aug-24	578	$751,100
RIDGEWOOD DRIVE REZONING	01-Feb-23	08-Mar-25	767	$10,200
RANCH HOUSE STREET REZONING	23-Apr-22	24-Nov-24	947	$169,490
PAT RD BOOSTER STATION PUMPING OPTIMIZATION	27-Jul-17 A	30-Mar-22	1708	$6,879,716
DALE 2194 PZ FIRE FLOW IMPROVEMENT (MVPW-107Rb)	30-Aug-21	26-Feb-25	1277	$863,280
WATER SYSTEM RELIABILITY ANALYSIS	28-Jan-19 A	31-Aug-21	794	$335,000
STATE STREET PIPELINE REPLACEMENT	01-Dec-21	20-May-25	1267	$1,028,016
DALE 2199C PZ LOOPING PIPELINE (MVPW-107Ra)	01-Jul-18 A	06-Oct-24	2290	$612,150
MURRIETA ROAD TRANSMISSION PIPELINE IMPROVEMENT PHASE I	21-May-19 A	27-Sep-22	1226	$18,568,429
CORWIN BOOSTER ELECTRICAL REPLACEMENT	20-Aug-18 A	15-Oct-21	1215	$1,180,357
GRANT ST BOOSTER ELECTRICAL REPLACEMENT	20-Aug-18 A	20-Jan-22	1153	$1,102,144
REDLANDS AND COTTONWOOD BOOSTER ELECTRICAL REPLACEMENT	20-Aug-18 A	05-Jun-23	2026	$1,451,880
MCCALL BOULEVARD PIPELINE REPLACEMENT	24-Oct-18 A	06-Jan-22	1171	$3,290,702
PAT ROAD BOOSTER LIGHTING UPGRADE	01-Sep-22	06-Jul-24	675	$90,000
REDLANDS AND LOCUST BPS CAPACITY IMPROVEMENT	27-May-24	19-Jul-24	54	$3,000
2021 POTABLE WATER HYDRAULIC MODEL UPDATE	01-Aug-21	26-Jan-22	179	$90,000
2022 POTABLE WATER HYDRAULIC MODEL UPDATE	01-Jul-22	26-Dec-22	179	$90,000
SUN CITY LEAKY PIPE REPLACEMENT PHASE 3	12-Apr-23	09-Oct-24	547	$188,496
GOETZ RD HYDRO ABANDONMENT	01-Sep-23	25-May-24	267	$95,500
MOUNTAIN AVE GAP PIPELINE	15-Apr-20 A	23-Jun-22	800	$676,002

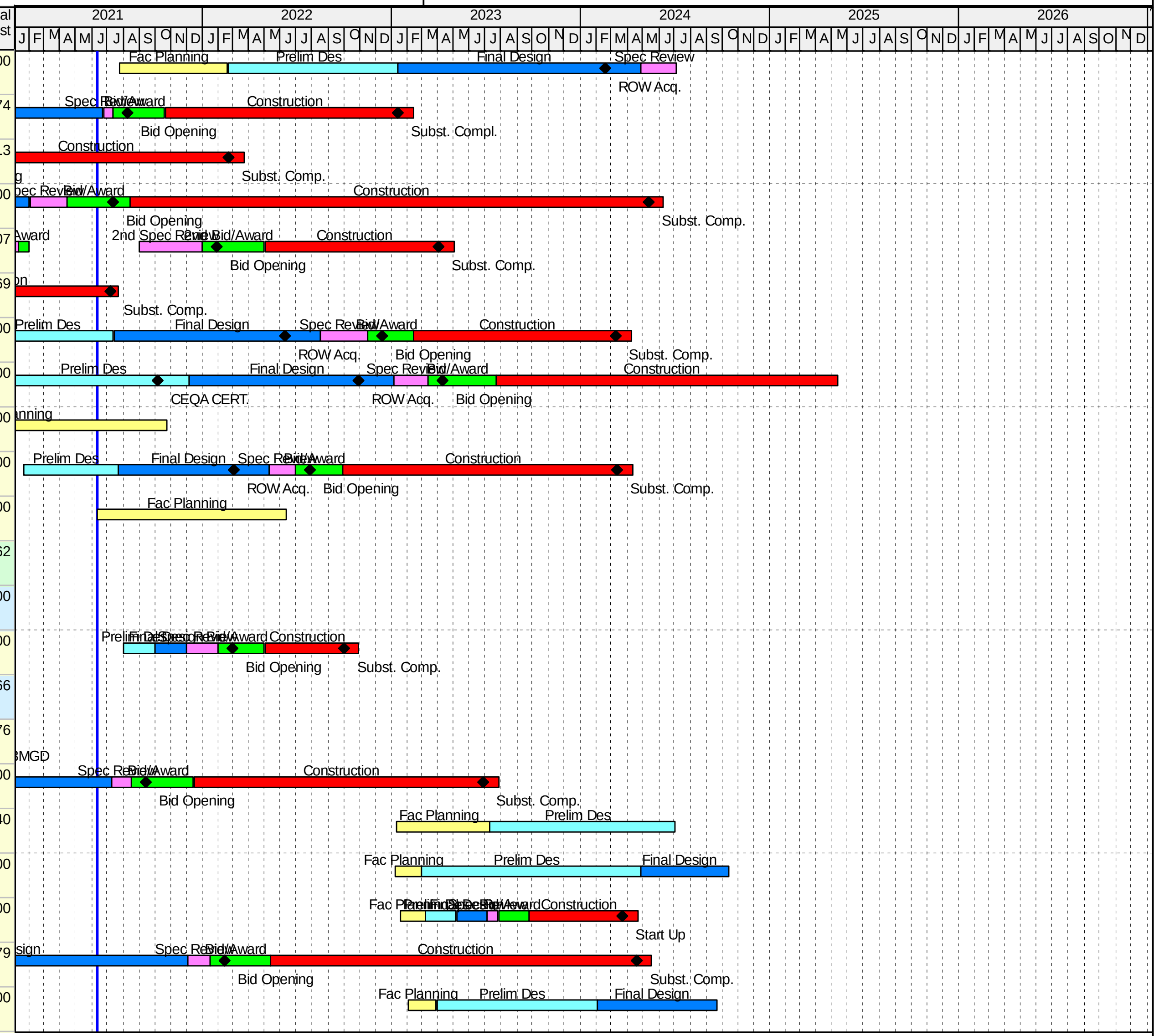


PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
VALLEY BLVD PIPELINE - PHASE 1	26-Jul-21	05-Jul-24	1076	$1,478,400
CACTUS II FEEDER PHASE 1	09-Mar-15 A	01-Jun-23	2149	$14,459,174
EUCALYPTUS BOOSTER STATION	08-Jun-07 A	29-Jun-22	5464	$6,028,113
39 INCH RAW WATER FEEDER CP IMPROVEMENTS	22-Sep-19 A	24-Oct-24	1859	$690,000
BRINE PIPELINE MAINTENANCE ACCESS IMPROVEMENTS	01-Dec-19 A	01-Aug-23	1340	$3,116,407
I 215 AND PLACENTIA AVE INTERCHANGE WATER AND SEWER RELOCATION	19-Nov-19 A	28-Oct-21	702	$2,491,669
RIDGEMOOR ROAD 12 AND 24 INCH PIPELINE	19-Nov-20 A	07-Jul-24	1327	$6,300,000
MATTHEWS BOOSTER STATION AND PIPELINES	01-Jul-20 A	13-May-25	1769	$9,666,000
WINCHESTER MAC POTABLE WATER SYSTEM EVALUATION	26-Mar-20 A	24-Oct-21	595	$95,000
STEEPLECHASE AND KALMIA BOOSTER REPLACEMENT	21-Jan-21 A	12-Jul-24	1266	$3,386,400
MISSION CANYON WATER SYSTEM PLANNING STUDY	13-Jun-21	13-Jun-22	366	$100,000
SEWER	10-Apr-04 A	14-Mar-26	7926	$324,801,962
WATER FILTRATION	01-Aug-21	04-Dec-23	856	$422,000
PWFP CO2 PH ADJUSTMENT PILOT	01-Aug-21	04-Dec-23	856	$422,000
SEWER REGIONAL WATER RECLAMATION FAC	09-Apr-07 A	14-Mar-26	6901	$217,314,666
TVRWRF 23 MGD EXPANSION	09-Apr-07 A	30-Aug-21	5035	$99,732,576
SJVRWRF PLANT I REHAB	11-Jan-19 A	04-Nov-23	1759	$14,600,000
MVRWRF 17 MGD EXPANSION	11-Jan-23	03-Jul-24	540	$3,299,940
SJVRWRF VACTOR TRUCK DUMP STATION	10-Jan-23	13-Oct-24	643	$510,000
MVRWRF VACTOR TRUCK DUMP STATION	18-Jan-23	20-Jul-24	550	$1,500,000
MVRWRF PLANT 2B AND FLOW DIVERSION	15-May-17 A	25-Aug-24	2468	$26,016,279
PVRWRF CNG REFUELING INFRASTRUCTURE	04-Feb-23	20-Sep-24	595	$229,500



Data Date 13-Jun-21 / Run Date 29-Jun-21
ENGSCHED - 5 Yr CIP by type by prog PLN
TASK filters: No Z Projects, Not Cancelled, Project Start within 5 yr CIP.

EASTERN MUNICIPAL WATER DISTRICT

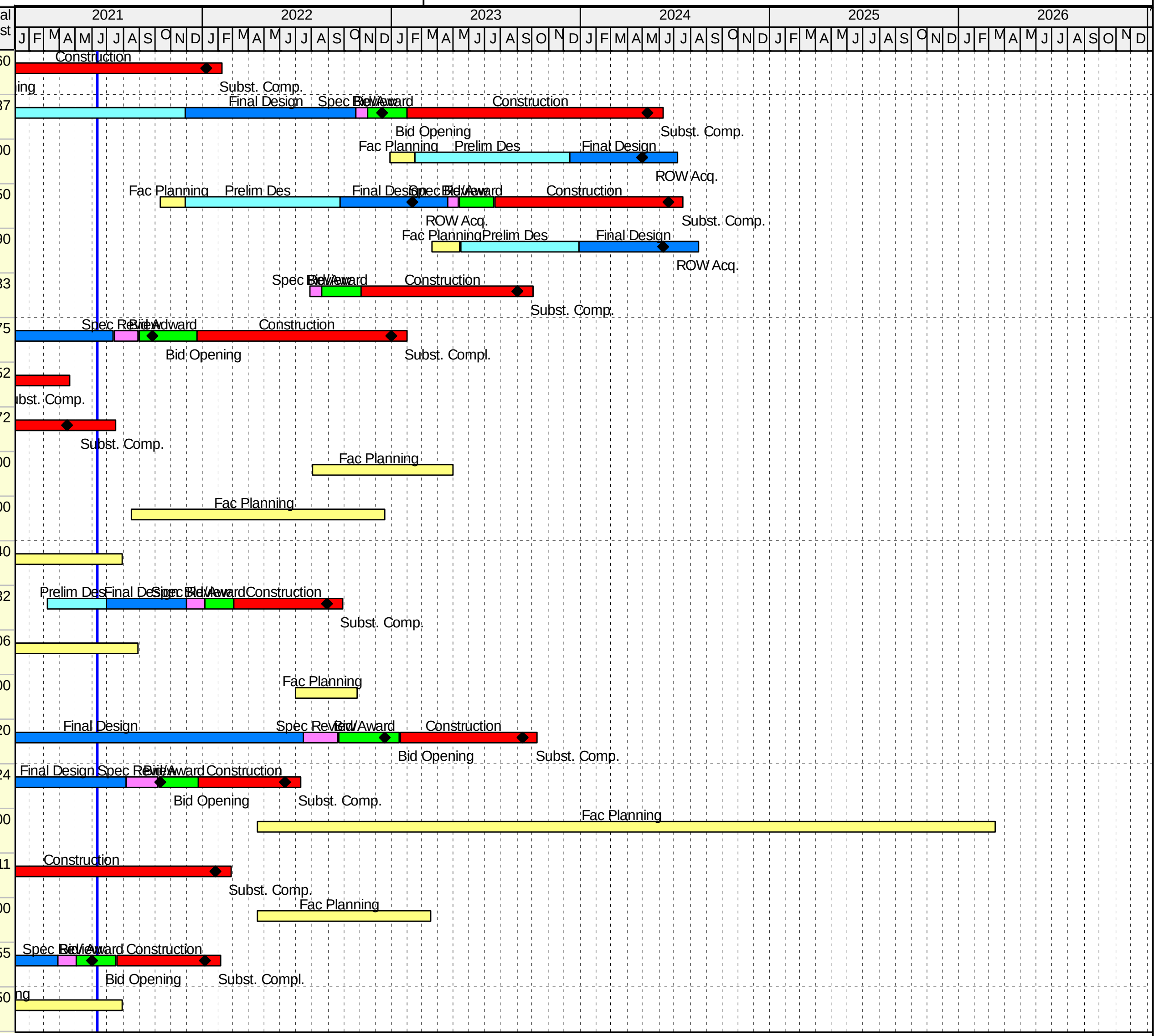
PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

emwd EASTERN MUNICIPAL WATER DISTRICT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
MVRWRF SOLIDS HANDLING MCC REPLACEMENT	25-Feb-19 A	17-May-22	1178	$1,907,560
TVRWRF DIGESTER GAS BENEFICIAL USE	25-Feb-19 A	16-Sep-24	2031	$3,835,037
TVRWRF NUTRIENT SIDE STREAM TREATMENT	30-Dec-22	08-Jul-24	557	$850,000
PVRWRF SIDE STREAM TREATMENT (PVST-100A)	11-Oct-21	18-Jul-24	1012	$7,746,750
PVRWRF FUEL CELL REPLACEMENT (PVST-101)	22-Mar-23	16-Aug-24	514	$2,223,090
TVRWRF AND SJVRWRF LIGHTING UPGRADE	28-Jul-22	08-Jan-24	530	$1,274,633
SJVRWRF CENTRATE EQ	12-Apr-17 A	17-Aug-23	2319	$2,875,375
MVRWRF TEPS MCC REPLACEMENT	19-Mar-18 A	08-Aug-21	1225	$3,233,152
RWRF BLOWER ELECTRIFICATION	06-Jul-17 A	25-Nov-21	1604	$16,467,472
IRIS AERATION VALVE PILOT STUDY	01-Aug-22	30-Apr-23	273	$350,000
NEUROS TURBO BLOWER PILOT	16-Aug-21	19-Dec-22	490	$60,000
RWRF SIDE STREAM TREATMENT PLANNING	20-Feb-19 A	30-Jul-21	725	$232,840
PVRWRF VACTOR TRUCK DUMP STATION	07-Mar-21 A	28-Dec-22	662	$491,032
RWRF NUTRIENT LOADING AND TREATMENT EVALUATION	15-Oct-18 A	30-Aug-21	990	$481,806
PVRWRF CONTROL BUILDING ADDITION	01-Jul-22	28-Oct-22	120	$100,000
PVRWRF MAIN ENTRANCE MODIFICATION	26-Sep-19 A	17-Jan-24	1575	$269,120
TVRWRF BREAK ROOM BUILDING RETROFIT	31-Jan-20 A	13-Sep-22	957	$1,183,524
RWRF CONDITION REHAB	18-Apr-22	14-Mar-26	1426	$1,000,000
MVRWRF TERTIARY EFFLUENT EQUALIZATION	13-Jan-17 A	04-Jun-22	1979	$5,405,411
RWRF SCADA STANDARDS DEVELOPMENT	18-Apr-22	19-Mar-23	336	$125,000
TVRWRF STORMWATER ASSESSMENT AND IMPROVEMENTS	02-Jul-19 A	14-May-22	1048	$3,064,855
SJVRWRF MACHINE LEARNING PROCESS CONTROL PILOT	23-Mar-20 A	30-Jul-21	334	$99,950



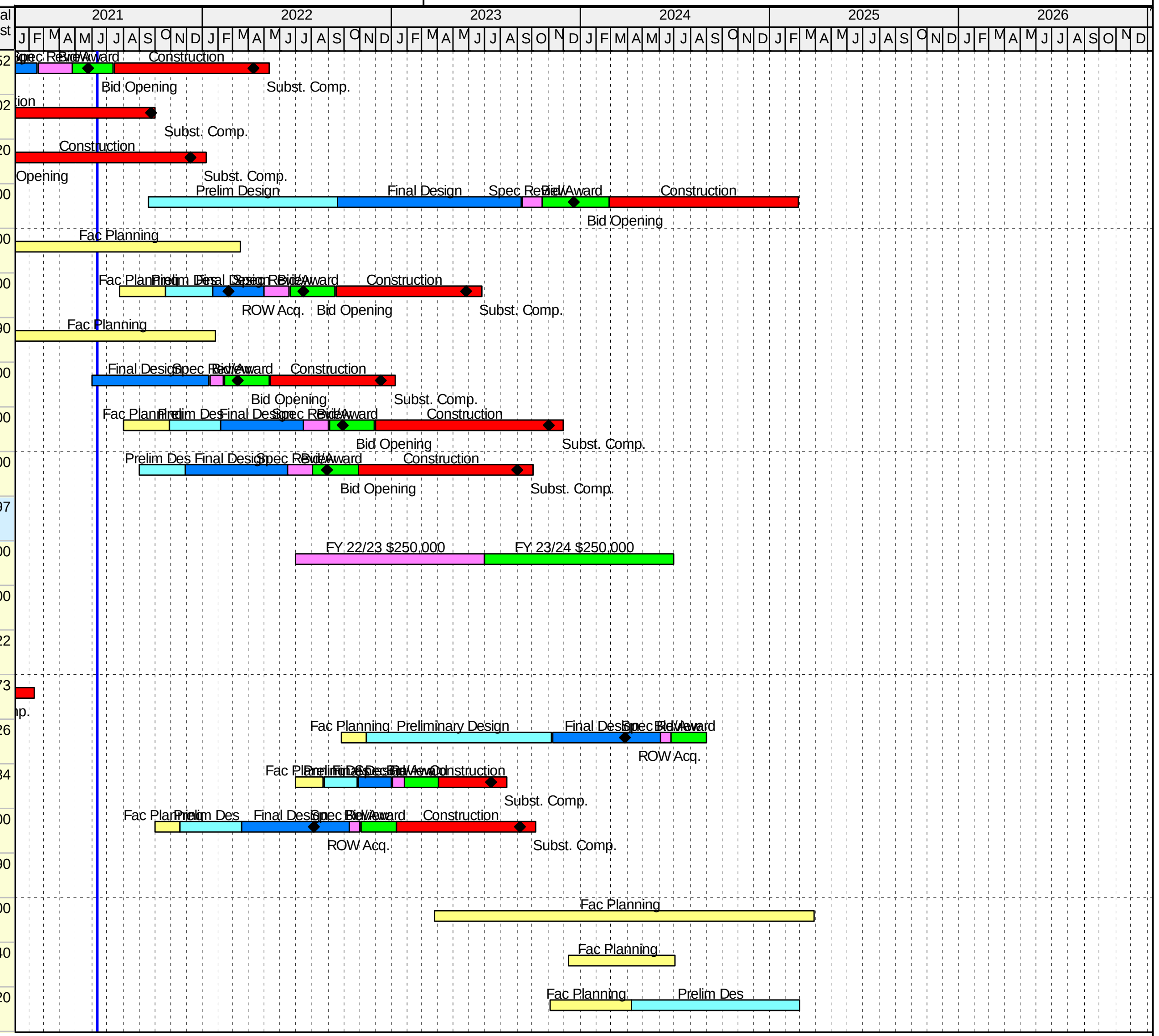
Data Date 13-Jun-21 / Run Date 29-Jun-21
ENGSCHED - 5 Yr CIP by type by prog PLN
TASK filters: No Z Projects, Not Cancelled, Project Start within 5 yr CIP.

EASTERN MUNICIPAL WATER DISTRICT

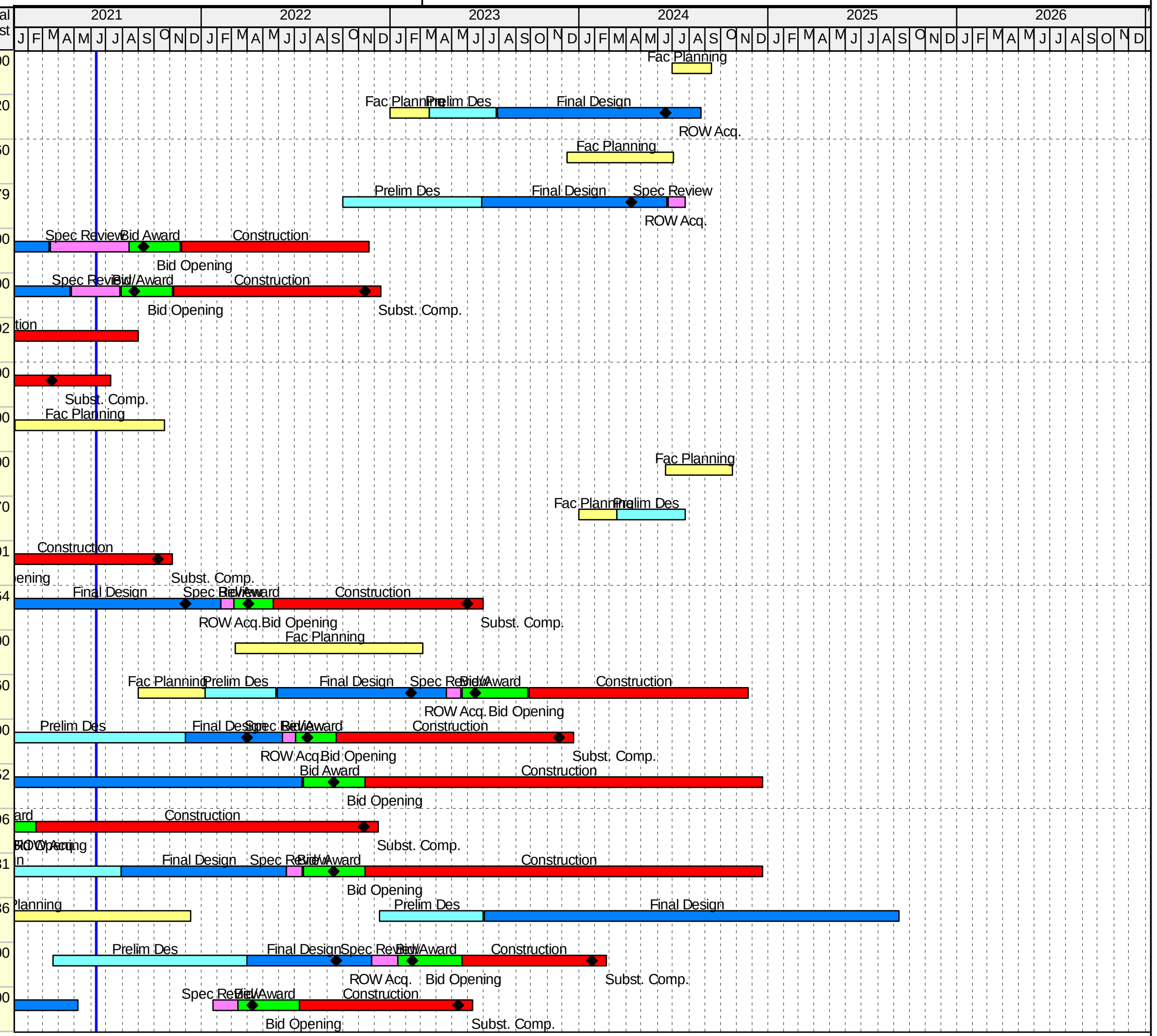
PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

emwd EASTERN MUNICIPAL WATER DISTRICT

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
MVRWRF AIR LINE REHABILITATION	01-Jul-20 A	16-Aug-22	777	$1,229,052
TVRWRF HOT WATER BOILERS INSTALLATION	20-Sep-19 A	30-Dec-21	833	$2,230,102
SKINNER I LIFT STATION REPLACEMENT	28-Mar-17 A	08-Apr-22	1838	$1,322,320
MVRWRF PLANT 2A REHABILITATION	19-Sep-21	25-Feb-25	1256	$4,752,000
RWRF AERATION DIFFUSER REPLACEMENT PLANNING STUDY	20-Dec-20 A	14-Mar-22	285	$400,000
TVRWRF PLANT 3 ELECTRICAL MODS	26-Jul-21	22-Sep-23	789	$1,700,000
RWRF DIGESTER GAS UTILIZATION SOLICITATION	21-Dec-20 A	27-Jan-22	327	$76,890
TVRWRF DEWATERING BUILDING CORROSION MITIGATION	01-Jun-21 A	09-Apr-23	678	$1,749,400
PVRWRF DEWATERING BUILDING HOPPER REHAB	01-Aug-21	28-Feb-24	942	$1,500,000
PVRWRF BIOSOLIDS LOADOUT FACILITY REHABILITATION	01-Sep-21	30-Dec-23	851	$3,190,000
SEWER TRANSMISSION	10-Apr-04 A	11-Sep-25	7743	$107,065,297
ANNUAL ALLOCATION - MISC. SYSTEM IMPRV. - SEWER	01-Jul-22	30-Jun-24	731	$500,000
QUAIL VALLEY SEWER IMPRVS, SUB AREA 9	01-Dec-05 A	27-Sep-15 A	3860	$630,000
QUAIL VALLEY SEWER IMPRVS SUB-AREA 9 - PHASE I	28-Jan-14 A	30-Jul-21	2587	$10,835,222
WINCHESTER LIFT STATION ODOR CONTROL	14-Nov-16 A	30-Jul-21	1583	$2,326,273
ELLIS AVE SEWER	26-Sep-22	01-Sep-24	707	$360,126
KITCHING STREET SEWER - PHASE I (MVSC-101)	01-Jul-22	18-Nov-23	506	$239,884
CAWSTON LS PUMP REPLACEMENT & FORCEMAIN RE-ROUTING	01-Oct-21	04-Jan-24	826	$1,141,000
AUDIE MURPHY ROAD SEWAGE LIFT STATION	01-Jan-16 A	02-Feb-22	2113	$3,833,590
PARADISE PALM AVE 15 INCH REPLACEMENT	25-Mar-23	29-Mar-25	735	$27,300
TURISMO LN AND MURRIETA RD 10-12 INCH EXPANSION	10-Dec-23	01-Jul-24	205	$116,640
NUEVO 5 LS EXPANSION	05-Nov-23	28-Feb-25	482	$995,120



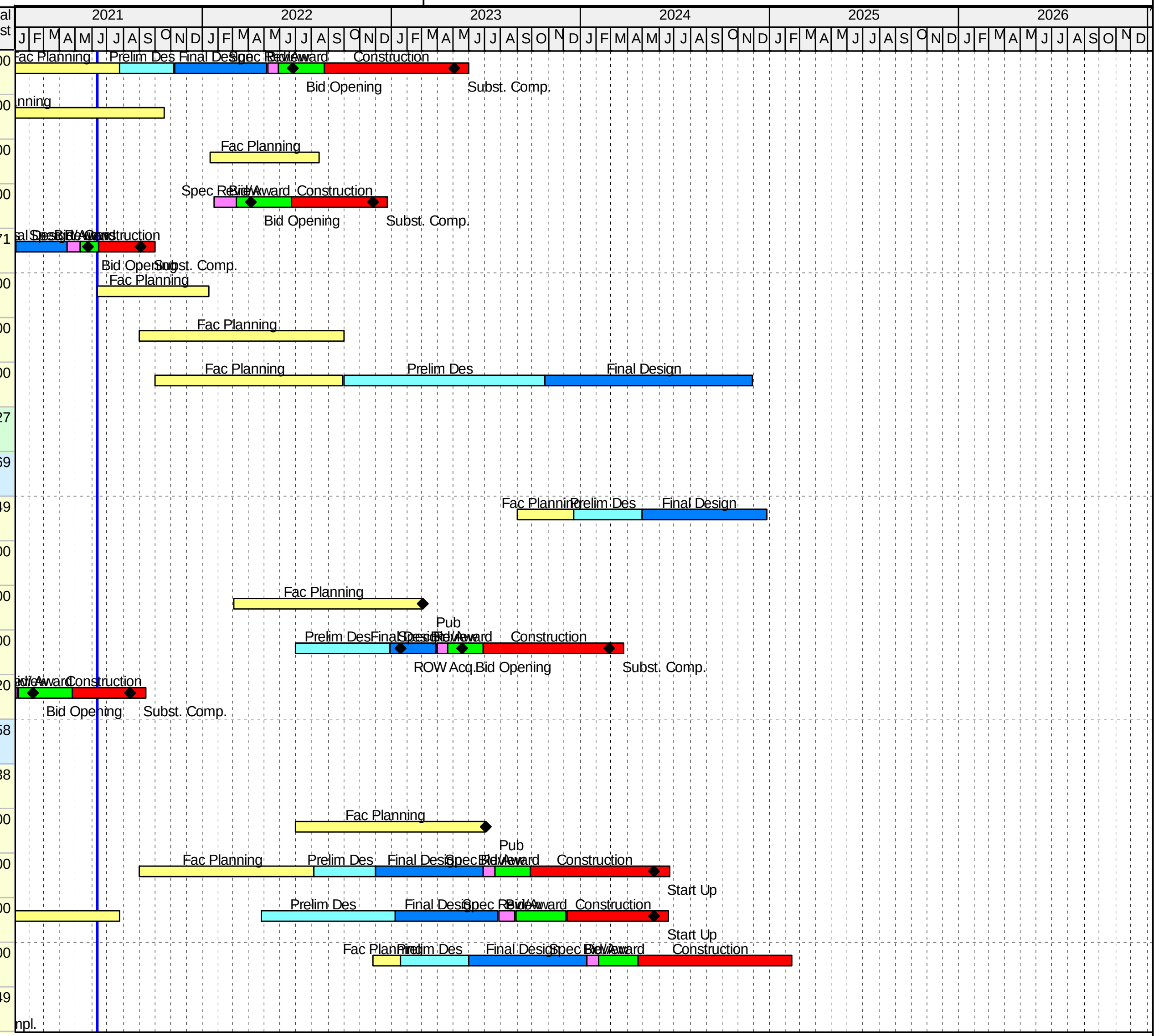
Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
ETHANAC LS 10 INCH EXPANSION	30-Jun-24	13-Sep-24	76	$59,700
ZEIDERS RD 12-15 INCH EXPANSION	01-Jan-23	25-Aug-24	602	$307,020
RECORD RD 21-30 INCH EXPANSION	10-Dec-23	01-Jul-24	205	$123,560
KITCHING AND HEACOCK STREET SEWER	21-Dec-17 A	25-Jul-24	2409	$722,179
NEWPORT LIFT STATION PIPING REPLACEMENT	10-Jul-17 A	27-Jan-23	2028	$841,000
DAY ST LIFT STATION WETWELL PIPING REPLACEMENT	17-Aug-17 A	23-Mar-23	2045	$1,913,100
LAKE PERRIS SEWER SIPHON DIVERSION	02-Oct-17 A	29-Nov-21	1520	$209,302
PALA LIFT STATION ELECTRICAL UPGRADE	11-Oct-17 A	16-Oct-21	1467	$3,677,400
GREEN ACRES HOMELAND AREAS COLLECTION SYSTEM ASSESSMENT	06-Jan-21 A	22-Oct-21	290	$494,900
STONEY MOUNTAIN RANCH LS REPLACEMENT AND EXPANSION	18-Jun-24	24-Oct-24	129	$105,300
KIRBY ST 21 INCH REPLACEMENT	01-Jan-24	25-Jul-24	207	$291,270
EL CENTRO LIFT STATION WET WELL PIPING REPLACEMENT	28-Oct-19 A	12-Jan-22	808	$540,701
WICKERD RD SEWER	01-Jun-20 A	06-Oct-23	1223	$2,003,064
SAN JACINTO RIVER CROSSING FEASIBILITY STUDY	07-Mar-22	06-Mar-23	365	$100,000
RIDER ST 21 INCH REPLACEMENT	01-Sep-21	23-Nov-24	1180	$3,914,460
CALLE MEDUSA SEWER PIPELINE PROTECTION	20-Jan-20 A	22-Mar-24	1524	$1,168,700
DIAZ SEWAGE LIFT STATION REPLACEMENT	10-Apr-04 A	22-Dec-24	7480	$20,918,552
SKY CANYON 36 INCH EXPANSION	21-Sep-17 A	19-Mar-23	2006	$14,395,496
WARM SPRINGS LIFT STATION REPLACEMENT	14-Jul-19 A	22-Dec-24	1989	$20,662,431
QUAIL VALLEY AREA 4 SEWER PHASE I	18-Mar-20 A	11-Sep-25	2051	$1,649,436
DIAZ SEWER MODIFICATION(TVSV-214)	21-Mar-21 A	24-May-24	1161	$2,242,500
GOLDEN TRIANGLE SEWER INFRASTRUCTURE	12-Aug-19 A	08-Sep-23	1711	$2,500,000



2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
INDIAN ST SEWER CROSSING	15-Nov-20 A	29-Aug-23	1018	$1,000,000
WINCHESTER MAC SEWER COLLECTION SYSTEM EVALUATION	26-Mar-20 A	19-Oct-21	609	$82,700
JEFFERSON AVE SEWER REPLACEMENT	17-Jan-22	14-Aug-22	210	$350,000
GOLDEN TRIANGLE SEWER INFRASTRUCTURE MHS CROSSING	24-Jan-22	16-Mar-23	417	$523,300
WARM SPRINGS CREEK SEWER CROSSING EROSION MITIGATION	01-Sep-20 A	06-Nov-22	859	$1,714,071
WASTEWATER COLLECTION SYSTEM CONDITION ASSESSMENT	13-Jun-21	12-Jan-22	214	$500,000
TEMECULA COLLECTION SYSTEM FLOW MONITORING AND MODEL CALIBRATION	01-Sep-21	01-Oct-22	395	$500,000
CAWSTON LS REPLACEMENT	01-Oct-21	28-Nov-24	1155	$2,550,000
RECYCLED	07-Apr-14 A	13-Feb-25	3965	$38,908,427
RECYCLED STORAGE	10-Aug-15 A	27-Dec-24	3428	$3,647,069
ALESSANDRO POND OPTIMIZATION PHASE II	03-Sep-23	27-Dec-24	482	$172,549
WINCHESTER POND SITE RECOVERY WELLS PH I	10-Aug-15 A	30-Jul-21	2028	$1,597,200
WINCHESTER POND A AND B SLOPE STABILIZATION	02-Mar-22	03-Mar-23	366	$500,000
WINCHESTER POND SITE OPTIMIZATION PHASE III	01-Jul-22	24-Jun-24	725	$1,100,000
ALESSANDRO PONDS EROSION MITIGATION	19-Dec-19 A	21-Dec-21	590	$277,320
RECYCLED TRANSMISSION	07-Apr-14 A	13-Feb-25	3965	$35,261,358
REACH 4 BOOSTER STATION PUMP UPGRADE	23-Dec-15 A	15-Jul-21	1918	$3,843,538
REC WTR SYSTEM OPTIMIZATION STUDY	01-Jul-22	02-Jul-23	366	$300,000
SKILAND POND NORTH RECYCLED WATER PUMP STATION	01-Sep-21	20-Sep-24	1115	$1,000,000
MSJC SJ CAMPUS RECYCLED WATER RETROFIT	01-Feb-20 A	27-Sep-24	1701	$429,000
CHAMBERS TANK 36" INLET/OUTLET PIPE	27-Nov-22	13-Feb-25	809	$2,275,000
TEMECULA VALLEY RECYCLED WATER PIPELINE PHASE I	07-Apr-14 A	31-Jul-21	2501	$12,623,649



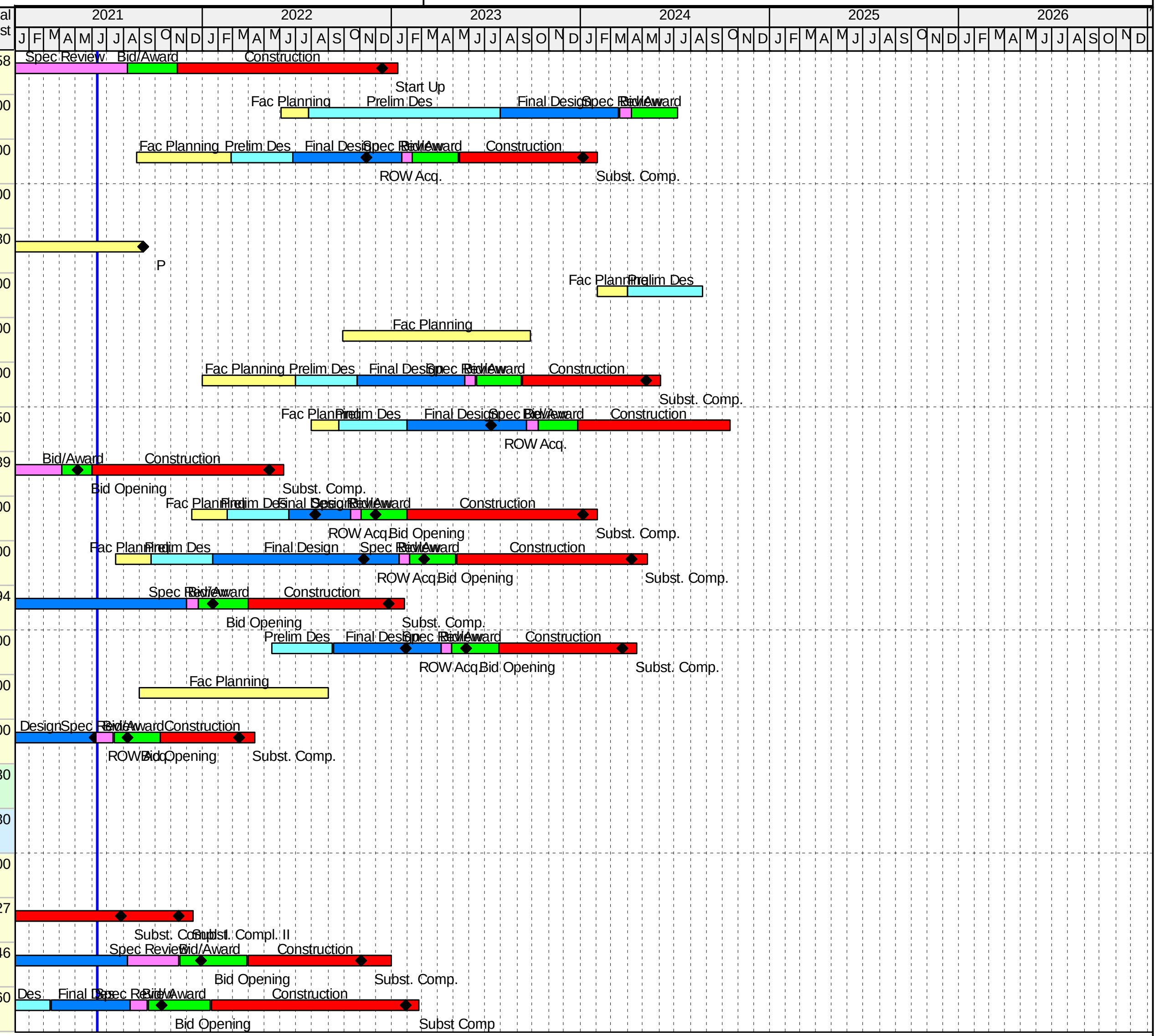
PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

emwd EASTERN MUNICIPAL WATER DISTRICT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
FRENCH VALLEY REC WTR DIST P/L EXPANSION PH II	18-Nov-19 A	22-Apr-23	1392	$1,886,158
COTTONWOOD AVENUE RW PIPELINE (EAST)	01-Jun-22	06-Jul-24	767	$383,800
INDIAN AVENUE RW DISTRIBUTION PIPELINE	28-Aug-21	04-May-24	981	$1,500,000
WINCHESTER RW PIPE CORROSION PROTECTION (PVRW-024)	29-Jan-18 A	14-Jul-21	1176	$1,042,600
RW DISTRIBUTION STUDY (PVRW-024)	06-Jun-18 A	09-Sep-21	1192	$188,780
BRADLEY ROAD SOUTH RW PIPELINE (PVRW-027)	03-Feb-24	24-Aug-24	204	$140,000
BRADLEY ROAD NORTH RW PIPELINE (PVRW-002)	29-Sep-22	28-Sep-23	365	$56,000
TVRWRF TEPS DUAL ZONE SPLIT (TV-RW-003)	01-Jan-22	03-Sep-24	977	$2,000,000
ANTELOPE RD SOUTH RW PIPE (PVRW-001)	31-Jul-22	17-Oct-24	810	$546,250
TEMECULA VALLEY RECYCLED WATER PIPELINE PHASE II	19-Dec-17 A	15-Sep-22	1719	$2,728,989
REDLANDS BLVD CROSSING	11-Dec-21	04-May-24	876	$500,000
MURRIETA HOT SPRINGS RD CREEK CROSSING	18-Jul-21	07-Aug-24	1117	$500,000
DUNLAP DRIVE PIPELINE REPLACEMENT	14-Jul-19 A	26-Apr-23	1383	$1,217,594
FRENCH VALLEY REC WTR DIST P/L EXPANSION PH III	15-May-22	19-Jul-24	797	$1,600,000
WINCHESTER RD 24" PIPELINE CORROSION PROTECTION STUDY	01-Sep-21	01-Sep-22	366	$150,000
HIGHWAY 74 RECYCLED WATER PIPELINE CROSSING	23-Sep-20 A	10-Jul-22	449	$350,000
GENERAL	01-Mar-16 A	26-Jan-24	2888	$15,186,930
GENERAL MULTIPLE	01-Mar-16 A	26-Jan-24	2888	$15,186,930
OMC LABORATORY MODIFICATION	01-Mar-16 A	23-Jul-21	1802	$4,058,000
SOLAR RENEWABLE ENERGY INITIATIVE PHASE III DESIGN BUILD	30-Sep-16 A	18-Apr-22	2026	$2,884,427
OMC GATE 5 IMPROVEMENTS	10-Jan-18 A	11-Apr-23	1918	$1,120,546
HEADQUARTERS FIRE ALARM SYSTEM REPLACEMENT	01-Oct-19 A	03-Jun-23	1342	$793,160



Data Date 13-Jun-21 / Run Date 29-Jun-21
ENGSCHED - 5 Yr CIP by type by prog PLN
TASK filters: No Z Projects, Not Cancelled, Project Start within 5 yr CIP.

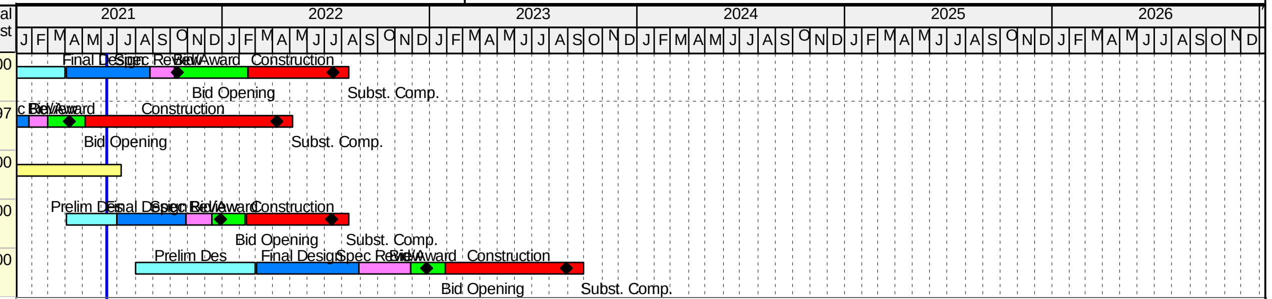
EASTERN MUNICIPAL WATER DISTRICT

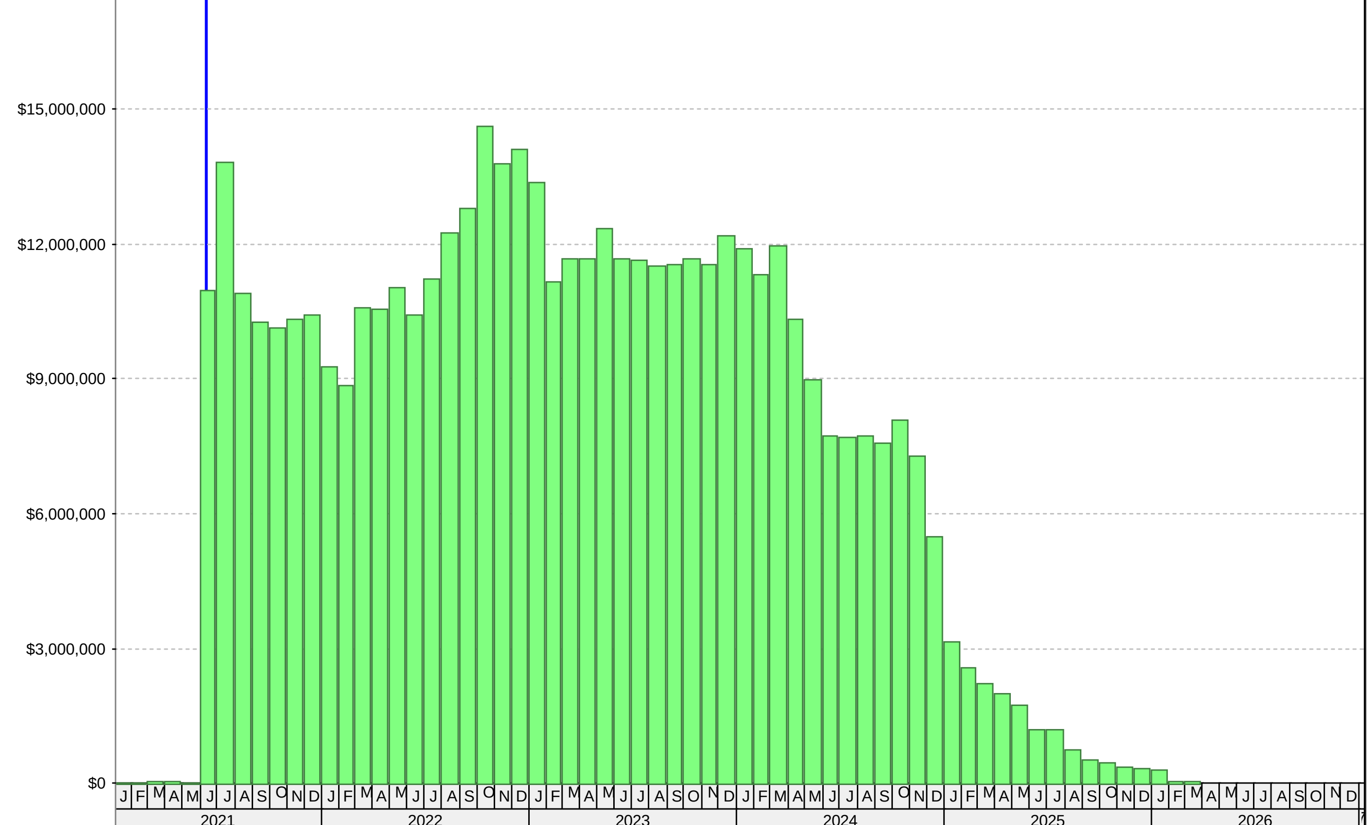
PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT

2021 5YR Capital Improvement Program

29-Jun-21 09:20

Activity Name	PROJ START	Finish	Original Duration	Budgeted Total Cost
SUN CITY WATER OPERATIONS BUILDING RENOVATION	04-May-20 A	11-Nov-22	922	$552,000
FLEET SERVICES CNG RETROFIT	02-Dec-19 A	13-Aug-22	986	$1,405,597
PIPELINE CORROSION PROTECTION PROGRAM	06-May-19 A	08-Jul-21	618	$315,000
EMERGENCY FUEL STORAGE FACILITIES	01-Apr-21 A	09-Nov-22	588	$1,858,200
OMC FUEL STATION UPGRADE	01-Aug-21	26-Jan-24	909	$2,200,000





Data Date 13-Jun-21 / Run Date 29-Jun-21
ENGSCHED - 5 Yr CIP by type by prog PLN
TASK filters: No Z Projects, Not Cancelled, Project Start within 5 yr CIP.

EASTERN MUNICIPAL WATER DISTRICT

PHASE LEGEND
FAC PLANNING
PRELIM DESIGN
FINAL DESIGN
SPEC REVIEW
BID/AWARD
CONSTRUCTION
ADMIN CLOSEOUT