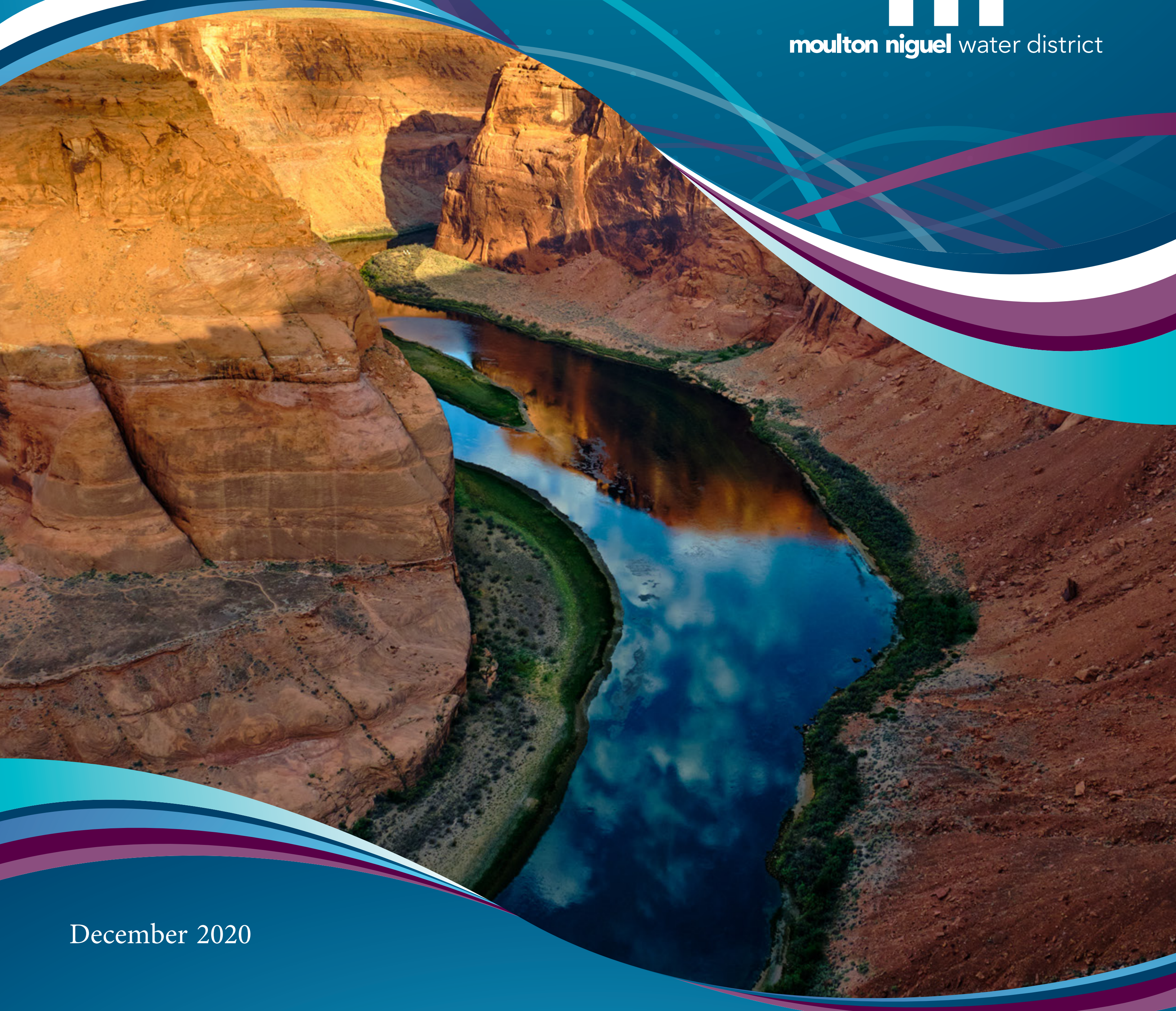
2020 Long-Range Water Reliability Plan Update

moulton niguel water district



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2020 Long-Range Water Reliability Plan Update

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List of Acronyms

3ATP	3A Treatment Plant
AFY	Acre-feet per year
AMP	Allen McCollough Pipeline
BOR	Bureau of Reclamation
CFS	Cubic feet per second
CRA	Colorado River Aqueduct
Diemer WTP	Robert B. Diemer Water Treatment Plant
Delta	Sacramento–San Joaquin River Delta
DPR	Direct Potable Reuse
DWR	California Department of Water Resources
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
EOCF2	East Orange County Feeder No. 2
ET	Evapotranspiration
ETo	Reference evapotranspiration
GPCD	Gallons per capita per day
IPR	Indirect Potable Reuse
IRP	Integrated Water Resources Plan
IRWD	Irvine Ranch Water District
JBLTP	JB Latham Treatment Plant
JRTP	Joint Regional Treatment Plant
LAA	Los Angeles Aqueduct
LRWRP	Long-Range Water Reliable Report
MAF	Million acre-feet
MG	Million gallons
MGD	Million gallons per day
MWD	Metropolitan Water District of Southern California
MNWD	Moulton Niguel Water District
MWDOC	Municipal Water District of Orange County
OCWD	Orange County Water District

RWMP	Recycled Water Master Plan
RWOS	Recycled Water Optimization Study
SWD	Serrano Water District
SMWD	Santa Margarita Water District
SCP	South County Pipeline
SCWD	South Coast Water District
SOC	South Orange County
SOCWA	South Orange County Wastewater Agency
SWP	State Water Project
UWMP	Urban Water Management Plan
USGS	United States Geologic Survey
UCERF3	Uniform California Earthquake Rupture Forecast Version 3
WSAP	Water Supply Allocation Plan
WTP	Water Treatment Plant

Executive Summary

ES.1 Ensuring Reliable Water for MNWD

Water is a limited resource in the arid Southwest and a long-term reliable supply of water is essential to protect the health of the community and local economy. For 60 years, Moulton Niguel Water District (MNWD) has delivered safe and reliable water services to our customers in South Orange County (SOC) in the face of major challenges and severe droughts. The MNWD service area has very little local water resources and relies on imported potable water from the Colorado River and Sacramento–San Joaquin River Delta (Delta). Just recently from 2012 to 2017, the State of California experienced the worst drought in the past 500 years. Due to proactive communication, demand management programs and an extensive recycled water supply and distribution system, MNWD navigated through this challenge stronger than ever with a strong financial foundation and customers making long-term investments to improve their efficiency. After the drought, demands have continued to remain low throughout Southern California with the expectation that less frequent, more intense storms are expected, along with extended dry periods. MNWD continues to exert significant efforts to reduce dependence on imported water supplies. MNWD has been and continues to be a leader in proactive improvements to supply reliable water resources for the service area. MNWD was one of the first utilities in the country to provide recycled water starting in 1968 and today more than 1,360 recycled water meters account for approximately 25 percent of MNWD's total water demand. Additionally, MNWD has a comprehensive portfolio of demand management programs, most notably the Water Budget-Based Rate Structure and extensive rebate programs, to help customers improve their water use efficiency. Our experiences have taught us how to be a resilient agency with a resilient workforce that can adapt to any circumstance. We have been resilient in our planning to prepare for any future condition and adjust as new information becomes available. For example, the COVID-19 pandemic highlights the importance of maintaining water reliability under unforeseen risks. MNWD staff and the services we provide are essential to ensure the safe supply of water to our customers. Handwashing and cleaning depend on providing safe and reliable drinking water and effective treatment of wastewater. Ensuring that drinking water and wastewater services are fully operational is critical to containing COVID-19. Without a reliable water supply, public health is in jeopardy.

Water Reliability planning is an iterative process that is never truly complete. MNWD continues to evaluate various alternative local water supplies to identify additional opportunities to supplement imported water, as well as implement demand management strategies and outreach programs to reduce water waste. New risks arise and updated information necessitates the continued evaluation of balancing supply and demand. MNWD is evaluating potential impacts to its water resources supply to develop strategies to help guide potential future actions. Water resource planning is vital for addressing supply challenges and uncertainties, such as drought, climate variability, imported water supply restrictions, natural disasters, infrastructure limitations and the effects of future regulations. Given the increasing variability of our water supply conditions, there is a heightened need to evaluate reliability impacts and identify opportunities for increased water supply variability where and when appropriate. Continued planning and investment will ensure that MNWD has the necessary supplies and infrastructure in place to ensure water reliability for our customers now and into the future.

ES.1.1 Purpose of Long-Range Water Reliability Plan

In 2015, MNWD published the first comprehensive Long-Range Water Reliability Plan (LRWRP) to evaluate water supply and system reliability under a range of scenarios. Since the 2015 LRWRP, MNWD has implemented several demand management programs and recycled water projects that have reduced potable and recycled water demands within the service area by over 3,600 acre-feet. And since the 2015 LRWRP was issued, the Baker Water Treatment Plant has come online, providing approximately one-third of our treated potable water, and significantly improving local water reliability. This 2020 LRWRP Update is a continuation of the planning cycle that incorporates new data and information and outlines a long-term water resources strategy that best serves the water needs of MNWD through the year 2050.

The 2020 LRWRP Update provides a framework to provide a reliable and resilient future water supply for our communities.

The 2020 LRWRP Update evaluates how our water demands and our water supply may change over the next 30 years. The 2020 LRWRP Update evaluates water reliability in the face of a variety of risks to our water supply and identifies options to enhance water resiliency for our customers. The 2020 LRWRP Update is a high-level planning document intended to provide information to decision-makers regarding the benefits of future water resource investments in the face of climate variability and other reliability threats. The 2020 LRWRP Update provides a framework for evaluating future water supply projects that results in an adaptive management approach that accounts for future risk and uncertainty. The 2020 LRWRP Update outcome is improved water resource management that provides a roadmap for ensuring reliable and cost-effective long-term water supplies for our customers.

ES.2 Water Reliability Findings

To analyze water reliability for MNWD, projections of water supply and demand are necessary. These projections must be sufficiently broad to capture the plausible ranges of uncertainty in future water supply and water demand to ensure that water reliability is adequately analyzed. The 2020 LRWRP Update compared the water demand forecast against water supplies and system capacity under various hydrologic and emergency outage scenarios. The gap between the demand and the existing supply and system capacity was used to identify and evaluate future water supply approaches that could be implemented by MNWD. The 2020 LRWRP Update then examined the relative risks of various supply options. While imported water supplies have historically been reliable, and are expected to be substantially reliable into the future, the 2020 LRWRP Update analysis of system and supply reliability indicates that without future investments by MNWD, water supply gaps could occur under system outages and certain hydrologic variability conditions. The addition of a new water supply or water storage is recommended to ensure enhanced reliability and resiliency through the 2050 planning period. While it is impossible to know how much risk and uncertainty to guard against, MNWD's reliability will be more secure with a long-term plan that recognizes these risks and provides resource development to offset that risk.

ES.2.1 MNWD Water Demands

Understanding MNWD's water demands is essential to developing a long-term water supply strategy. Water demands are a function of numerous factors including historical water demands, demographics, socioeconomics, water use efficiency and weather. MNWD's service area is primarily a residential area. A demand forecast through 2050 provides a basis on which to evaluate the ability of MNWD's water supply and infrastructure capacity to meet existing and future water demands. The model provides an upper bound and lower bound of demand projections to show how demands can fluctuate over time in response to customer behaviors. The lower bound of the demand forecast is a continuation of existing water uses within MNWD in conjunction with potential state regulations and reflects implementation of a comprehensive portfolio of demand management strategies. Major components of this demand management strategy incorporate MNWD's policy approaches for demand management (e.g., budget-based rates and rebate programs), improvements in technology (and adoption and implementation of new water saving technologies), and long term adjustments in demand as customers respond to pricing signals. The upper bound of the demand forecast is reflective of increased demands primarily as a result of increased irrigation usage due to dry hydrologic conditions. **Figure ES-1** shows the upper and lower bound projected water demands for all water use sectors through 2050. Figure ES-1 also provides the historical water production and how that compares to previous demand projections from the 2010 and 2015 Urban Water Management Plans (UWMP). As shown, actual water use has been lower than previously projected water use, which reflects an overall decreasing demand trend.

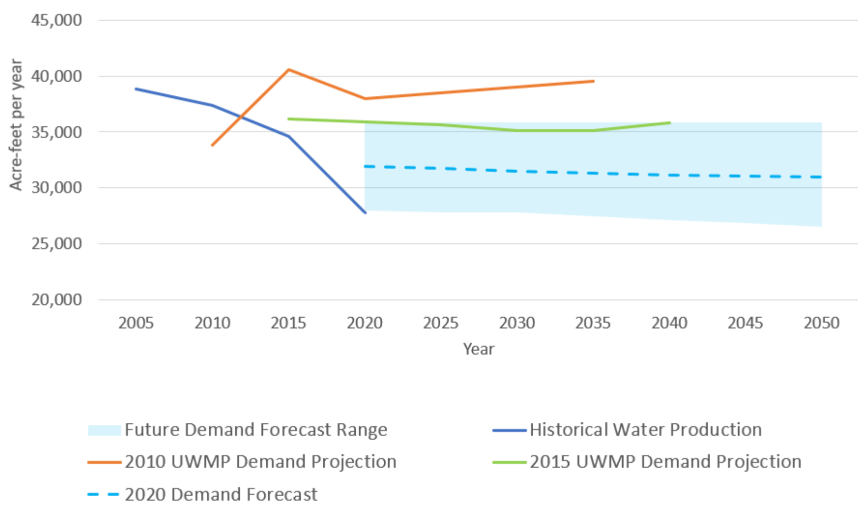


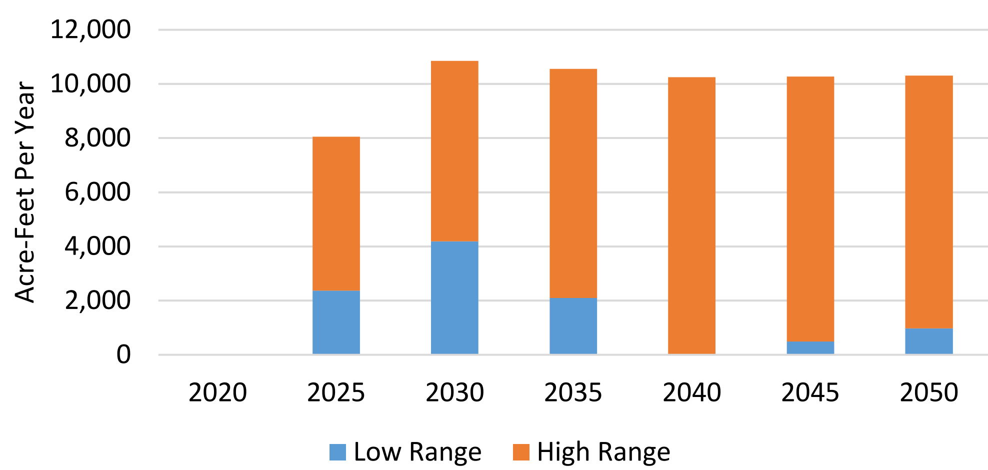
Figure ES-1. Future Water Demand Forecast

ES.2.2 MWD/MWDOC Water Supplies

MNWD's potable water supply consists of imported water purchased from the Metropolitan Water District of Southern California (MWD) through its wholesaler member agency, the Municipal Water District of Orange County (MWDOC). MNWD relies primarily on MWD imported water from the Delta and Colorado River to meet our potable water demands. Local water supplies include recycled water. MWDOC with input from MWD, prepared the 2018 Orange County Water Reliability Study (MWDOC 2018 study) (MWDOC, 2019) to identify the current and future water supply conditions in SOC. The water supply projections accounted for variable climatic conditions and implementation of various local water supply projects. The factor with the greatest degree of variability and with the largest impact on water supply reliability is climate variability and associated effects on hydrology. Climate variability adds a layer of uncertainty in estimating the future availability of imported water. While different climate change models show differing effects, potential changes could include more precipitation falling in the form of rain rather than snow and earlier snowmelt. Snow provides a natural storage reservoir for the water. More rain as opposed to snow could mean less storage for use later in the season, which in turns impacts supply availability during late spring and summer.

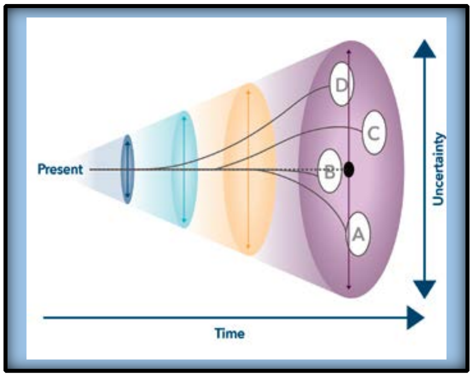
This 2020 LRWRP Update incorporates MWDOC's 2018 study results related to water supply projections for SOC and identifies expected supplies available to MNWD based on our demand projections through 2050. To estimate the reliability of imported water delivered to MNWD, the frequency and magnitude of regional water supply gaps from MWDOC's 2018 study were applied directly to MNWD—meaning if there is a 20 percent regional water supply gap for a given hydrologic year, then for that same hydrologic year there would be a 20 percent supply gap for MNWD. While water supply is not necessarily allocated to water agencies in this manner, this simplified assumption was considered to be fairly representative given MWD's overall drought management allocation goal of "retail-level" reliability and the fact that all of MNWD's potable water is provided by MWD. **Figure ES-2** summarizes the maximum potential supply gaps (in acre-feet) identified for MNWD under the MWDOC planning scenarios with updated 2020 information based on actual conditions. However, these supply gaps could be much smaller depending on how hydrologic conditions evolve over the coming years, water use efficiency gains locally and regionally, management of storage reserves, and the implementation of State, regional and local projects.

Figure ES-2. Range of Maximum Water Supply Gaps for MNWD[1]



It is important to note that while Figure ES-2 1 identifies potential supply gaps into 2050, MWD has always been able to provide the imported water needed to MNWD. In that sense, MWD has been a reliable source of imported water to serve MNWD's customers. It is expected that MWD would be able to continue to provide a reliable source of imported water to MNWD. As such, the supply gaps identified in Figure ES-2 do not necessarily represent lack of supply but rather the amount of supply that would be substantially more costly to purchase consistent with MWD's Water Supply Allocation Plan (WSAP) penalty fees. Given the drought conditions experienced in 2015-2016 that are anticipated to be more commonplace in the future, these potential supply gaps represent a risk to MNWD's future water supply costs that may be better balanced with more cost-effective local supplies or storage that would also increase water reliability.

ES.2.3 Supply Reliability



Supply reliability is the ability to meet demand based on hydrologic variability and long-term changes in available imported water supply. The 2020 LRWRP Update evaluated several water supply and demand planning scenarios. The scenario planning process provides a broad range of projections of future water supply and demand. The scenarios represent different views of future imported water supply and demand conditions. The use of planning scenarios assumes that the future is unknown and provides flexibility in responding to various future conditions. Each planning scenario is then evaluated against different water supply portfolios to determine the reliability in meeting projected demands in MNWD's service area.

Four water supply portfolios were developed from various combinations of water supply options, including existing sources of water. New water supplies can be added into the system at a relatively constant supply rate through the year (base-loaded) compared to projects that provide supplies only during specific peak periods or dry years when needed (on-demand). The 2020 LRWRP Update portfolios evaluated existing supplies and three new supply types, base-loaded, on-demand and a mix of both base-loaded and on-demand (referred to as hybrid).

Eight different supply and demand scenarios were evaluated in this 2020 LRWRP Update. Evaluation of the existing supply portfolio (or no new water supply projects) reveals MNWD would experience potential supply gaps beginning as early as 2025. However, the results also indicate decreasing regional MWD demands and implementation of regional supply projects have the potential to substantially increase water reliability for MNWD beyond 2025. Depending on how each of these variables shape up over the next five years, will help determine the size of investments MNWD could consider to enhance water reliability into 2050. For example, while the scenarios identify some potentially large supply gaps through 2050, the scenarios also reveal there is a potential for these gaps to be much smaller as demands on MWD supplies have been trending down. MWD's 2019 water transactions were the lowest in nearly 40 years. Population growth and water demands (in large part due to tremendous strides in efficiency) are far less than once predicted by MWD. If fewer demands continue to be placed on MWD than currently projected, this could result in reduced (e.g., smaller, and less frequent) supply gaps than what has been identified for MNWD through 2050. In addition, if future local water supply projects in the region are fully implemented as currently planned, demand for imported water in an average year could be less than 60 percent of what MWD projected in the 2015 IRP (MWD, 2019b), thereby further increasing regional water reliability.

The base-loaded portfolio and on-demand portfolio increases reliability compared to the existing supply portfolio but could still result in supply gaps beginning in 2025. The hybrid portfolio includes adding a mix of supply types (base-loaded and on-demand), for a total of approximately 12 CFS (cubic feet per second [8,693 acre-feet per year (AFY)]). While the hybrid portfolio does not eliminate all risk for MWND, it provides water reliability in the near-term and allows for a scaled approach to water supply implementation if it is later determined to be needed. For example, adding the on-demand portion in the near-term would increase supply reliability through 2025. This provides time to evaluate how changing regional demands and implementation of other local agency projects will influence water reliability for MNWD over the next 5 years. With decreasing demand trends continuing and increasing implementation of local supply projects, supply reliability could be increased through 2050 and future base-loaded projects may not be needed or could be scaled down accordingly. Because future supply reliability is dependent on these outside factors, the addition of an on-demand supply that is only operated when needed would best serve MNWD in the near-future. The 2025 LRWRP Update would inform plans on other water supply planning projects needed in the future to support supply reliability goals into 2050. This approach avoids over building expensive new sources of water supply that are not needed now and may not be needed in the future.

ES.2.4 System Reliability

Critical to the 2020 LRWRP Update is understanding how reliability threats could impact MNWD and its ability to meet the water reliability needs of its customers. Imported water supplies are susceptible to both system and supply reliability disruptions. System reliability is the ability to meet customer demands during an unplanned emergency outage of key facilities (e.g., due to seismic events, infrastructure failures, and other catastrophic events). Deliveries of imported supplies are dependent on an extensive network of facilities used to pump, store, and convey imported supplies to MNWD. Water systems are vulnerable to seismic events (as well as other unplanned failures and catastrophes) that can result in varying degrees of water supply disruptions for periods of days, weeks, or months. Given the presence of several major earthquake fault lines in proximity to MWD facilities, earthquakes have a high potential for resulting in an infrastructure outage that could disrupt service to MNWD. System reliability disruptions for MNWD can be caused by outages of key water facilities, such as MWD's Diemer WTP which delivers water to MNWD, as well as conveyance and distribution pipelines. MWD and MWDOC worked together several years ago to determine the likely time to restore regional import or treatment facilities to partial operations based on the location of earthquake faults in Orange County and the potential maximum considered earthquakes. Based on these conditions, MWDOC suggests that its member agencies should plan for a 100 percent interruption of MWD supplies for up to 60 days with a concurrent power grid outage for a minimum of 7 days (MWDOC, 2019). These criteria indicate MNWD may need to provide supply locally for up to 2 months following a major earthquake that damages MWD facilities (MWDOC, 2019). The potential outage duration of imported water facilities is summarized in **Table ES-1**.

On November 13, 2008, MNWD adopted Resolution No. 08-38 which outlines the current goal for system reliability. The policy identified the intention to develop adequate capacity and supplies through local facilities and regional projects, including both storage and water supply development, to provide at least 31-days average annual potable water supply to meet demands in the event the MWD supply source to southern Orange County is interrupted on a short term basis. MNWD currently meets the 31-day average annual potable supply goal. However, as identified in Table ES-1, MNWD may be without imported supply for up to 60 days during an emergency event. As such, the current policy's goal of 31-days may result in insufficient supplies to meet demands during a 60-day outage of imported water. In addition, system reliability varies throughout the year based on the changes in seasonal demands.

Table ES-1. Length of Facility Outages Following Maximum Considered Earthquake

MWD Facility	Estimated Outage Durations
MWD – Colorado River Aqueduct	2-6 months
DWR – State Water Project East and West Branches	6-24+ months
MWD – Conveyance and Distribution Pipelines	1 week - 3 months
MWD Treatment Plants	1-2 months (partial flow) Up to 6 months (full capacity)

Source: MWDOC, 2019

Given these potential shortage conditions during emergency situations, demand curtailment may be a necessary water reliability management strategy to stretch supplies. During major system outages it is expected that nonessential water uses (e.g., outdoor landscape irrigation) would be minimized or eliminated for the duration of the outage to ensure enough water is available for public health and safety. It is assumed that during a catastrophic outage of imported water, MNWD would impose emergency water restrictions asking customers to curtail all outdoor water use and conservatively assuming that the customer response would result in a 20 percent reduction of water use. Emergency restrictions of 20 percent would provide up to 44 days of average annual supply or 94 days of supply in the winter months and 30 days of supply in the summer months, however this is dependent on the amount of flow available from emergency interconnections. This magnitude of water shortage would significantly impact MNWD's customers, as it was assumed that they would already be conserving 20 percent of their normal water demand. To ensure water reliability for up to 60 days during an emergency outage, MNWD would need to add new emergency water supplies to the system on top of the implementation of a 20 percent demand curtailment. **Table ES-2** summarizes the additional supplies needed to meet 60-days average annual water supply, assuming 20 percent mandatory restrictions are in place—meaning the shortages in this table are on top of the 20 percent reduction in demands that are assumed to be achieved during these outage scenarios.

Table ES-2. Summary of Emergency Water Shortages for MNWD[1]

Shortage Type	30-Day Outage	60-Day Outage
System Shortage	0 CFS[2]	0-15 CFS[3] (0-10,867 AFY)

[1] Shortages are net (or on top) of assumed mandatory demand restrictions of 20 percent utilizing annual average demands of 2019.
[2] Shortages are only anticipated in the event the IRWD SOC Interconnection is unavailable, which represents up to 11 CFS (7,969 AFY). If the SOC Interconnection is available, no shortages would occur.
[3] Shortages are anticipated up to 10 CFS (7,245 AFY) to meet a 60-day outage. An additional 11 CFS (7,969 AFY) shortage would occur if supplies were unavailable from the SOC Interconnection (for a total of up to 21 CFS [15,213 AFY). An additional 5 CFS is recommended to provide flexibility in the event the SOC Interconnection is unavailable or for when the agreement expires.

ES.2.5 Recommendations

The 2020 LRWRP Update recommends water supply and system actions based on the best information at the time. The analysis conducted in support of this 2020 LRWRP Update has determined the MNWD's current supply portfolio may not be sufficient to meet system and supply reliability goals. MNWD formulated a set of recommendations from the water portfolio strategies that can be implemented in phases and create a trigger for initiating further Board discussion of future water supply options about 5-years ahead of when those supplies are needed. By monitoring and updating water supplies and demands regularly, MNWD can implement recommendations in the short-term while keeping other, larger scale recommendations available for implementation if future conditions suggest they may be necessary. To continue strengthening MNWD's water system and supply resiliency, the following near-term and mid-to-long-term actions are recommended. **Figure ES-3** outlines the timeline for implementation of the 2020 LRWRP Update recommendations.

Near-Term:

- Update the Water Reliability Policy to include a statement to:
    - Continue to engage with MWD, MWDOC and other local water agencies to identify opportunities to enhance water reliability;
    - provide at least 31-days and up to 60-days of annual average supply for emergency response;
    - identify requesting customer demand curtailment during emergency events; and
    - addition of dry-year storage supplies to increase supply reliability.
- Continue to implement and expand upon water use efficiency programs based on customer interest and regular evaluation of cost effectiveness.
- Continue to build-out the recycled water system per the Recycled Water Optimization Study.
- Move forward with evaluating implementation of up to 15 CFS (10,867 AFY) of new emergency water reliability project.
- Identify opportunities for on-demand dry-year storage and consider phasing-in 2,000 to 4,000 acre-feet of storage.
- Annually assess progress made on implementation of new supply projects and re-assess supply and demand to determine changes to timing of water reliability needs.

Mid-to-Long-Term:

- Continue to monitor the development of DPR regulations for the potential to implement a potable reuse project into the MNWD water system based on future regulations.
- Expand dry-year storage up to 10,000 acre-feet as necessary based on water supply and demand conditions.
- Update the LRWRP in 2025 (and every 5 years thereafter) to identify changes in demand trends, reliability of imported water, and additional resource options.

ES.2.6 Adaptive Management Plan

The 2020 LRWRP Update will be implemented through an adaptive management approach that will provide MNWD with the information needed to make informed decisions regarding implementation of specific water supply projects. Using the information obtained through the adaptive management approach will help to inform the MNWD Board on what level of investment, and at what time, is desired to achieve enhanced water reliability and resiliency needed to serve our customers into the future. The adaptive management approach provides a mechanism for adapting to changing supply and demand conditions, climate variability, regulatory and policy changes, other risks, and uncertainty. The adaptive management strategy is based on risk triggers. The risk triggers are points of uncertainty that result in projected possible outcomes to determine future alternative paths of implementation based on changing conditions. MNWD will monitor risk triggers such as changes in regional and local water demands, imported water supplies, climate variability, success or failure of the Delta Conveyance Project in Northern California, implementation of other regional/local water supply projects, evolving regulations, and other factors that could impact water reliability for MNWD. Monitoring will identify where adjustments might be needed to respond to changed conditions. Planned actions and strategies would then be reevaluated and updated based on the status of risk triggers or decision points that help to reveal whether past uncertainties now have more clarity. Such adjustments could include accelerating or delaying projects due to changes in the demand trend, changing projects due to implementation challenges, adding projects due to lower than expected supply trends, etc. The adaptive management approach is an important tool for MNWD to continuously assess its current water supplies, demands, and progress of implementation of the 2020 LRWRP Update water supply recommendations and to evaluate the next steps if milestones are not met or potentially no longer needed.

ES2.7 Conclusion

The one certainty in planning for and providing a reliable supply of water is that supply challenges and uncertainties will continue to exist. Adaptive management is key to balancing insufficient supplies with stranding significant investments if there is too much water. Adaptive management also requires periodic re-assessment over time. Through continuous long-term planning, MNWD will reexamine our water reliability strategies and supply goals, accounting for uncertainties. Major additions of new water sources or improvements to water system facilities may significantly reduce vulnerability. A key part of the 2020 LRWRP Update and adaptive management approach will involve re-assessing the status of customer demands and water use efficiency successes, which drives demands on the system, and periodic monitoring and review will allow MNWD to capture newly identified risks as well as supply options without ending up in a position whereby too much time has passed between updates to make meaningful and proactive course corrections.

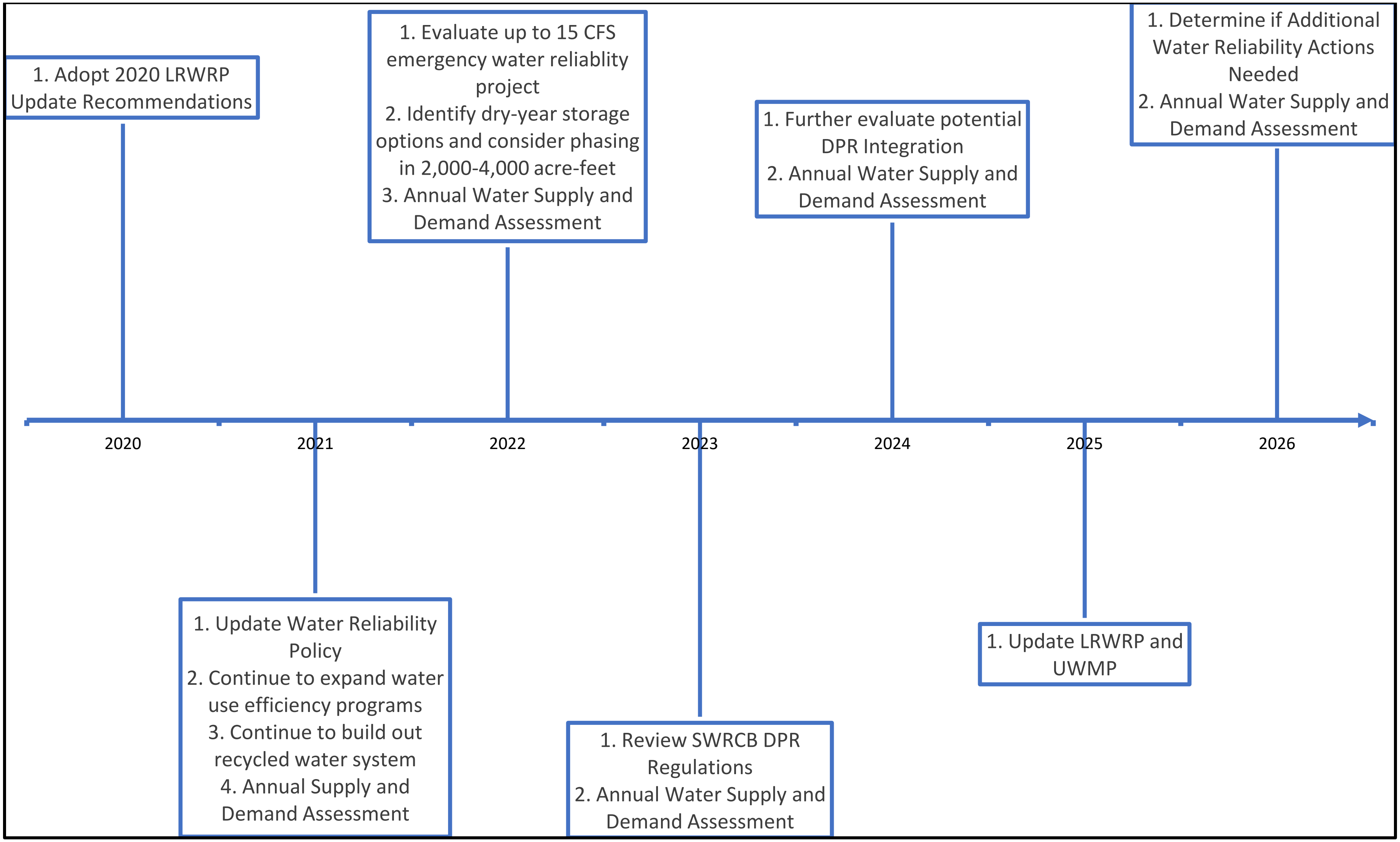


Figure ES-3. 2020 LRWRP Update Recommendations Timeline

Section 1 Introduction

1.1 Purpose of the Long-Range Water Reliability Plan

The purpose of the 2020 Long-Range Water Reliability Plan Update (2020 LRWRP Update) is to evaluate future water supply scenarios and develop a long-term strategy that best serves the water needs of Moulton Niguel Water District (MNWD). MNWD provides potable water, recycled water, and wastewater services to over 170,000 customers within its service area. The service area encompasses approximately 37 square miles of almost the entire area of the Cities of Laguna Niguel and Aliso Viejo and portions of the Cities of Laguna Hills, Dana Point, Mission Viejo, and San Juan Capistrano. **Figure 1-1** depicts MNWD's service area.

MNWD understands that water is a limited resource and that a long-term reliable supply of water is essential to protect the health of the community and local economy. MNWD's potable water supply is imported from MWD from the State Water Project (SWP) and the Colorado River Aqueduct (CRA). Given our reliance on imported potable water, MNWD is evaluating potential risk elements associated with impacts to that supply to develop strategies to mitigate those risks. Since 2000, the Colorado River Basin has been experiencing an extended drought that has impacted regional water supply (DOI, 2020). Water supply from the SWP has also been significantly reduced due to state restrictions on conveyance to protect fisheries in the Delta. MNWD has been able to meet demands during periods of extreme drought through a portfolio approach of demand management and water-use efficiency programs. As a result of future climate variability, less frequent, more intense storms are expected, along with extended dry periods. Preparing for climate variability is a challenge for long-term water supply planning, with two core impacts of an earlier snowmelt and more variable precipitation. Given the increasing variability, there is a heightened need to evaluate reliability impacts and develop responses to increase water supply resiliency.

MNWD recognizes the importance of understanding these potential changes in supply variability and preparing for the resulting reliability challenges. MNWD's 2020 LRWRP Update evaluates water reliability in the face of a variety of risks to water resources in its service area and identifies options to enhance resiliency for its customers. The 2020 LRWRP Update is a high-level planning document intended to provide information to decision-makers regarding the benefits of future water resource investments, with a long-range viewpoint through 2050. The 2020 LRWRP Update provides valuable information that will help MNWD make informed water supply planning decisions. The outcome of the 2020 LRWRP Update is a flexible and adaptive management approach that accounts for future risk and uncertainty. The 2020 LRWRP Update will not, however, make recommendations on specific projects because project implementation recommendations will require more in-depth planning and engineering studies. The 2020 LRWRP Update has the following primary objectives:

- Identify the reliability risks and analyze their impact on MNWD's ability to meet future demands.
- Develop a framework to evaluate options that would help MNWD improve its resiliency in the face of potential risks.
- Recommend a portfolio or strategy that provides increased resiliency and meets MNWD priorities.

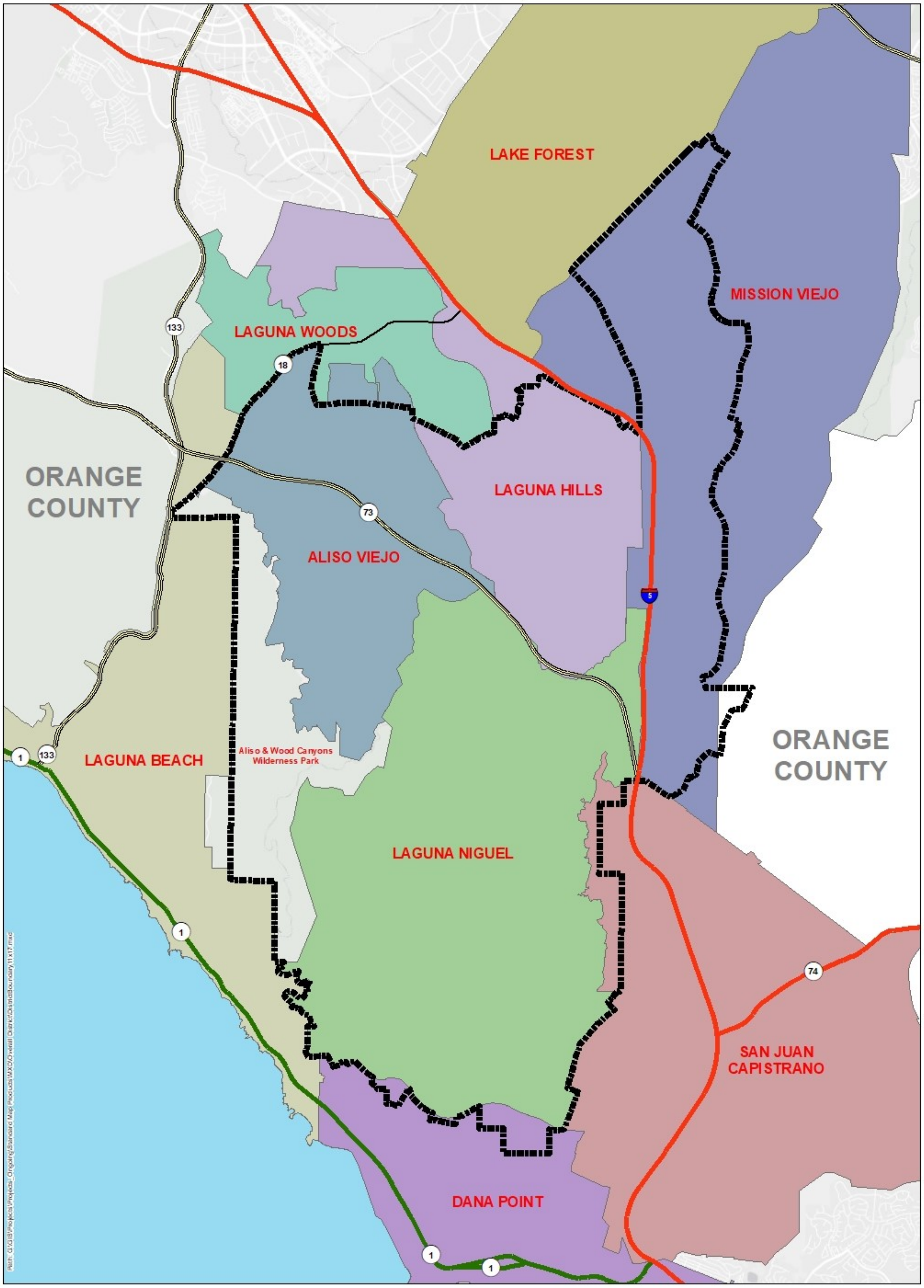


Figure 1-1. MNWD Service Area

- Provides a tool to evaluate future water resource projects to support increased resiliency.
- Provides analysis to support the preparation of the Urban Water Management Plan (UWMP), long-range financial plan, future masterplans and informs areas to develop additional focused planning studies to evaluate potential water supply projects.
- And supports applications for future grants to support water resource projects.

1.2 Background

In 2015 Moulton Niguel Water District (MNWD) published a comprehensive Long-Range Water Reliability Plan (2015 LRWRP) (MNWD, 2015) to evaluate water supply and system reliability under a range of scenarios, and then examined the relative risks of various supply options. The 2015 LRWRP compared the water demand forecast against water supplies and system capacity under various hydrologic and emergency outage scenarios. The gap between the demand and the existing supply and system capacity was used to identify and evaluate future water supply approaches that could be implemented by MNWD, or in partnership with other Orange County agencies. Based on the 2015 LRWRP modeling results, the 2015 LRWRP developed an adaptive management strategy that was based on key triggers. Since the 2015 LRWRP, MNWD has implemented several demand management programs and recycled water projects that have reduced potable water demands within the service area. Additionally, since the 2015 LRWRP was issued, the Baker Water Treatment Plant has come online and provides water treatment redundancies to reduce risks to local water supplies.

This 2020 LRWRP Update is an update to the 2015 LRWRP that further incorporates data from 2015 through 2019 and extends the planning period from 2035 to 2050. The goal of this 2020 LRWRP Update is to provide an assessment of current and future water supply conditions for MNWD and provide a framework for evaluating future supplies with targets for meeting system and supply reliability goals. The 2020 LRWRP Update is MNWD's strategy for ensuring long-term water resilience for our customers over the next 30 years. This 2020 LRWRP Update characterizes updated projected population growth, development, and water demand forecasts and assesses updated water supplies and supply source vulnerability. The 2020 LRWRP Update objective is to identify current and future water supply and system vulnerabilities and develop a framework for evaluating various types of supplies to reduce these risks. The 2020 LRWRP Update aims to improve water resource management for MNWD that results in both reliable and cost-effective long-term water supplies for our service area. The main planning goals that guide this 2020 LRWRP Update include:

- **Water Reliability** –Having enough water supplies to meet water demands under different hydrologic conditions, measured in terms of frequency (probability of occurrence), duration (length of occurrence), and magnitude (size) of water shortages.
- **Cost-Effectiveness** – Continue providing water services in a cost-effective manner.
- **Water Resilience** – The capacity to recover from water shortages caused by droughts, climate variability, system capacity limitations, and/or catastrophic system outages.
- **Water Efficiency** – Continue to incentivize customers to install water efficient devices and replace water-intensive turf with native landscaping to support wasting less water and reduce demands.
- **Implementation Ease** – Streamline future water resource project implementation, factoring in permitting and regulatory approval, and public acceptance.

- **Environmental Sustainability** – Support positive environmental effects of reducing reliance on imported water during times that cause ecosystem harm; improving energy efficiency; and enhancing watershed health and water quality.

1.3 Risks to Water System and Supply Reliability

Critical to the 2020 LRWRP Update is understanding how reliability threats could impact MNWD and its ability to meet the needs of its customers. Imported water supplies are susceptible to system and supply reliability disruptions. System Reliability is the ability to meet customer demands during unplanned emergency outages (e.g., seismic events, facility failures, and other catastrophic events) of key facilities. Supply Reliability is the ability to meet demand based on hydrologic variability (e.g., drought and high temperatures) and long-term changes in available imported water supply. Both system and supply reliability disruptions impact MNWD's ability to serve its water customers. MNWD Resolution No. 08-38, adopted on November 13, 2008, outlines the goal for system reliability as the following:

> *Moulton Niguel Water District intends to develop adequate capacity and supplies through local facilities and regional projects, including both storage and water supply development, to provide at least a 31-day average annual potable water supply to meet demands throughout the District in the event the MWD supply source to southern Orange County is interrupted on a short term basis as a result of emergency or planned water outages.*

Deliveries of imported supplies are dependent on an extensive network of facilities used to pump, store, and convey imported supplies to MNWD. Water systems are vulnerable to seismic events (as well as other unplanned failures and catastrophes) that can result in varying degrees of water supply disruptions for periods of days, weeks, and months. Given the presence of several major earthquake fault lines in proximity to MWD facilities, earthquakes have a high potential for resulting in an infrastructure outage that could disrupt service to MNWD. System reliability disruptions for MNWD can be caused by outages of key water facilities, such as MWD's Robert B. Diemer Water Treatment Plant (Diemer WTP) located north of Yorba Linda which delivers water to MNWD, as well as conveyance and distribution pipelines, such as the East Orange County Feeder No. 2 (EOCF2), or Allen McCollough Pipeline (AMP). MWD has stated that a full failure of the Diemer WTP, while not likely, could take up to six months to repair (MWDOC, 2019). MNWD can deliver almost its entire treated imported water through one of two available pipelines, EOCF2 or AMP. The risk of both pipelines failing, due to seismic or other catastrophic failure, at the same time is extremely low (MNWD, 2015). Also, it is expected that repair of conveyance and distribution pipelines can occur within one week to three months (MWDOC, 2019). However, the outage duration for the CRA could range from two to six months while the outage duration for the SWP East and West branches could last six to twenty-four months (MWDOC, 2019). This 2020 LRWRP Update includes an assessment of the ability to meet demands during an extended outage of a key imported water facility.

Supply reliability disruptions can be caused by droughts, environmental regulations resulting in restrictions in water exports from the Sacramento-San Joaquin River Delta (Delta), seismic risks to levees in the Delta that protect it from seawater intrusion, and long-term climate variability. In addition, as outlined in the MWDOC 2018 study, emergency system failure could result in variations in water demand, due to severe leaks of the water system and damage caused by fire or earthquakes. Of the many factors affecting supply reliability, the factor with the greatest degree of variability and with the largest impact on supplies, is climate variability and associated effects on hydrology. Climate variability adds a layer of uncertainty in estimating the future availability of imported water. While different climate change models show differing effects, potential changes could include more precipitation falling in the form of rain rather than snow and earlier snowmelt. Earlier snowmelt would result in more runoff occurring in the winter rather than spread out over winter and spring, which in turns impacts supply availability during late spring and summer. This 2020 LRWRP Update includes an assessment of the ability to meet demands during various supply reliability disruptions.

1.4 Other Related Planing Efforts

MNWD's potable water supply is entirely imported water purchased from MWD via the Municipal Water District of Orange County (MWDOC). MWD's main two sources of imported water come from the CRA and SWP. Because MNWD relies on MWDOC and in turn MWD for water supplies, the water supply planning efforts of these water agencies is incorporated into this 2020 LRWRP Update. The 2020 LRWRP Update incorporates applicable information contained in the MWDOC 2018 Orange County Water Reliability Study (MWDOC 2018 study) (MWDOC, 2019) and the MWD 2015 IRP (MWD, 2015). In addition, the 2020 Draft Water Resilience Portfolio (California Natural Resources Agency, et. al, 2020) is also referenced and summarized below as it includes actions to ensure the State's long-term water resilience and provides recommendations to help water agencies cope with a multitude of water resources challenges, such as droughts, varying temperatures, and aging infrastructure. Lastly, because MNWD receives CRA water supplies, the Colorado River Basin Drought Contingency Plan is also included since it implements actions in the Colorado River Basin in order to respond to droughts that could affect available water supplies for California and in turn MNWD. A summary of each document and the conclusions are provided below and incorporated throughout the 2020 LRWRP Update as applicable.

1.4.1 MNWD 2015 Long-Range Water Reliability Plan

The 2015 LRWRP addressed water supply and system challenges through 2035. The 2015 LRWRP quantified the water supply and system reliability needs, identified potential projects to meet those needs, and developed an adaptive strategy for implementation. The water demand forecast was compared against existing water supplies and system capacity under various hydrologic and outage scenarios. The 2015 LRWRP evaluated four alternatives (Low Cost, High Reliability, High Diversity, and Status Quo), for comparison under four supply scenarios for imported water availability. The Low-Cost alternative included supply concepts with expected unit costs equal or lower to MWD water. The High Reliability alternative included supply concepts with the highest reliability in terms of providing water supply under extreme droughts and system outages. The High Diversity alternative included a mix of supply concepts with the notion that a portfolio of options may represent the best balance between cost and risk. The Status Quo alternative included no new supply or system investments and has the greatest reliance on imported water from MWD. The four water supply scenarios evaluated how implementation of the Department of Water Resources' (DWR) Delta Conveyance Project in the Sacramento-San Joaquin River Delta (Delta) with no climate change and more severe climate change would impact water supply availability. In addition, no implementation of the Delta Conveyance Project with no climate change and more severe climate change was also evaluated for the impact to water supply availability. The four alternatives were evaluated to identify how each alternative performed under the different water supply scenarios. The system capacity was then used as the basis to identify and evaluate future water supply projects that could be implemented by MNWD, or in partnership with other Orange County agencies.

The 2015 LRWRP concluded that both the Low Cost and High Diversity Alternatives had the most merit for achieving MNWD's goals. The Low-Cost Alternative included no/low regret projects that provided reliability benefits at a cost equal to or less than treated imported water. The High Diversity Alternative included a mix of water supply concepts with the notion that a portfolio of options may represent the best balance between cost and risk. Given the unknowns of the future, an adaptive management approach was implemented to achieve the objectives stated in the 2015 LRWRP. Adaptive management is utilized to re-assess water supply reliability based on implementation of reliability projects, outcomes of regulatory actions, changes in demographic growth and water efficiency, and evolving understanding of the impacts of climate variability. The adaptive management approach implemented "no/low regret" projects that provided benefits under a wide range of scenarios. The next step in the adaptive management program was to identify key triggers that determine possible paths forward based on changing conditions. The 2015 LRWRP assessed two triggers: (1) implementation of the Delta Conveyance Project (previously known as Bay Delta Conservation Plan in the 2015 LRWRP); and (2) effects of climate change. Depending on the outcome of these events, additional actions by MNWD would be taken to assure both supply and system reliability. Implementing actions and projects using the adaptive management approach represented the best balance between cost-effectiveness and preparedness for the unknown.

Due to the passage of time since the 2015 LRWRP was prepared and implemented, MNWD is updating the water reliability study to identify necessary changes to water demands, supply reliability and the adaptive management approach. Differences between the 2015 LRWRP and this 2020 LRWRP Update include differing demand and supply assumptions used in the analyses, analysis of different supply scenarios, and use of a different analytic tool and methodology to conduct the analysis. This 2020 LRWRP Update is meant to identify updated demand forecasts into 2050, anticipated water supplies, and reliability of those supplies and potential supply risks. Further, the 2020 LRWRP Update identifies how base-loaded supplies and/or emergency storage supplies could help reduce potential risks to MNWD's supplies into 2050. However, the 2020 LRWRP Update does not compare individual water supply projects in terms of reliability benefits and costs. The findings from this 2020 LRWRP Update will guide MNWD in identifying the adaptive management approach to evaluate projects as they develop and how those projects could support overall system and supply reliability objectives.

1.4.2 Metropolitan Water District of Southern California Integrated Water Resources Plan 2015 Update

Southern California's water reliability falls under MWD's Integrated Resources Plan (IRP) (MWD, 2015). To address imported water supply issues, MWD initiated the first regional IRP in 1993 and subsequently adopted the plan in 1996. Updates were completed in 2004, 2010, and 2015. MWD's next IRP Update is scheduled to be completed in 2020-2021. The IRP defines MWD's vision of water supply and conservation actions needed for achieving water supply reliability. For the 2015 IRP Update, reliability was defined as determining the right level of investment in water conservation, local water supplies and imported water to meet demands and maintain enough levels of water in storage reserves. The 2015 MWD IRP forecasts future regional water demands and local water supplies to determine future needs for the region through the year 2040.

The 2015 IRP Update emphasized water conservation and local supply development as a key to future water supply reliability. The 2015 IRP Update reliability targets identify developments in imported and local water supply and in water conservation that would provide a future without water shortages and mandatory restrictions under planned conditions. The 2015 IRP Update identified MWD intentions for investments in additional partnerships and initiatives to maximize CRA deliveries in dry years and on the SWP, to make ecologically-sound infrastructure investments so that the water system can capture sufficient supplies to help meet average year demands and to refill MWD's storage network in above-average and wet years.

MWD's 2015 IRP Update called for considering Future Supply Actions, which prepare the region to adapt to water supply condition changes that are different than what is anticipated. These steps ranged from exploring the feasibility of new local supply options, investing in water-saving technologies, and acquiring land and proposing ways to reduce regulatory impediments to supply development. The 2015 IRP refined the adaptive management strategy developed under the 2010 IRP to ensure water supply reliability. 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 2015 IRP concluded that while it is impossible to know how much risk and uncertainty to guard against, the region's reliability will be more secure with a long-term plan that recognizes risk and provides resource development to offset that risk. The 2015 IRP further concluded that without the investments in conservation, local supplies and the Delta Conveyance, shortages and implementation of MWD's Water Supply Allocation Plan (WSAP) would likely occur in an unacceptable level of frequency in the years ahead.

MNWD's 2020 LRWRP Update incorporates MWD's modeling reliability results, future supply actions and adaptive management strategy to identify how MNWD can support MWD's goal of increasing conservation and local supplies.

1.4.3 Metropolitan Water District of Southern California Water Surplus And Drought Management Plan

MWD's Water Surplus and Drought Management (WSDM) Plan is used to direct MWD's resource operations to help attain the region's 100 percent reliability goal (MWD, 1999). The WSDM Plan recognizes the interdependence of surplus and shortage actions and is a coordinated plan that utilizes all available resources to maximize supply reliability. The overall objective of the WSDM Plan is to ensure that shortage allocation of MWD's imported water supplies is not required. The WSDM Plan distinguishes between shortages, severe shortages, and extreme shortages, as noted below.

- Surplus: Supplies are enough to allow MWD to meet Full-Service demands, make deliveries to all interruptible programs (replenishment, long-term seasonal storage, and agricultural deliveries), and deliver water to regional and local facilities for storage.
- Shortage: MWD can meet full-service demands using stored water or water transfers, as necessary.
- Severe Shortage: MWD can meet full-service demands only by using stored water, transfers, and possibly calling for extraordinary conservation.
- Extreme Shortage: MWD must allocate available supply to full-service customers.

There are six shortage management stages to guide resource management activities. These stages are defined by shortfalls in imported supply and water balances in MWD's storage programs. When MWD must make net withdrawals from storage to meet demands, it is in a shortage condition. The goal of the WSDM Plan is to avoid Stage 6, an extreme shortage. MWD's Board of Directors adopted a Water Supply Condition Framework in June 2008 to communicate the urgency of the region's water supply situation and the need for further water conservation practices. The framework has four conditions, each calling increasing levels of conservation. Descriptions for each of the four conditions are listed below:

- Baseline Water Use Efficiency: Ongoing conservation, outreach, and recycling programs to achieve permanent reductions in water use and build storage reserves.
- Condition 1 Water Supply Watch: Local agency voluntary dry-year conservation measures and use of regional storage reserves.
- Condition 2 Water Supply Alert: Regional call for cities, counties, member agencies, and retail water agencies to implement extraordinary conservation through drought ordinances and other measures to mitigate use of storage reserves.
- Condition 3 Water Supply Allocation: Implement MWD's WSAP (MWD, 1999).

MNWD's 2020 LRWRP Update considers how the WSDM Plan is implemented and could affect supply reliability for MNWD.

1.4.4 Metropolitan Water District of Southern California Water Shortage Allocation Plan (WSAP)

MWD's Board of Directors adopted the Water Shortage Allocation Plan (WSAP) in February 2008 to fairly distribute a limited amount of water supply through a detailed methodology to reflect a range of local conditions and needs of the region's retail water consumers. The current WSAP was last updated in 2014 and was utilized during the 2015-16 fiscal year. The WSAP includes specific formulas for calculating member agency supply allocations if a shortage is declared. The formula is calculated in three steps:

- Base period calculations
- Allocation year calculations
- Supply allocation calculations

The first two steps involve standard computations, while the third step contains specific methodology for actual application of the WSAP for the supply reduction in the year being implemented. The frequency and severity of allocations from MWD is one measurement of water supply reliability. During periods of extreme water supply shortage MWD utilizes its WSAP to allocate a specific reduced level of MWD supplies as determined by the MWD Board. If MWD member agencies need and purchase water above their allocation amount, substantial allocation surcharges are imposed. MWD water allocations have been imposed three times since 2000 with allocation reductions of 10 percent to 15 percent of the baseline imported sales. It is expected that the likelihood of MWD allocations being implemented again will be highest between now and when the Delta Conveyance project is completed.

MWD's allocation surcharge is charged for water use above the MWD member agency's annual allocation amount and is charged in addition to MWD's standard rates for water service. Allocation surcharges are only assessed to the extent that an agency's total annual usage exceeds its total annual allocation. 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. Water use between 100 percent and 115 percent of WSAP supply allocations is charged with the Allocation Surcharge of $1,480 per acre-foot. Water use greater than 115 percent of WSAP supply allocations is charged at two times the Allocation Surcharge or $2,960 per acre-foot. MNWD's 2020 LRWRP Update considers how the MWD WSAP is implemented and could affect supply allocations if a shortage is declared, as well as affect the costs of water supplies.

1.4.5 Municipal Water District of Orange County (MWDOC) 2018 Orange County Water Reliability Study

The MWDOC 2018 study prepared by MWDOC (MWDOC, 2019) provided information on the current and future water supply conditions in Orange County. The objectives of the MWDOC 2018 study were to examine MWDOC's projected water demands through 2050 under four planning scenarios (including variable climatic conditions and levels of MWD investments (both high and low)), identify water shortages caused by unplanned major outages (system reliability) and hydrologic droughts (supply reliability), and to evaluate potential local water supply projects that provide both system and supply reliability benefits and rank these projects based on cost-effectiveness. All four scenarios were considered "plausible" and no formal probabilities were assigned a likelihood of one scenario occurring over another. The MWDOC 2018 study noted that all SOC is short of emergency supplies today, which can be met through a combination of local projects and emergency projects. The MWDOC 2018 study noted that emergency needs are the major driver of the need for new local projects in SOC.

The MWDOC 2018 study evaluated potential water supply projects that are currently in the planning phases; including water storage programs and base loaded supply projects. Each of the potential projects was evaluated on a comparable basis under the four planning scenarios using two reliability metrics – system reliability (benefits of the potential project under unplanned outages) and supply reliability (ability of the potential project to meet projected water demand). The potential water supply projects were evaluated according to their ability to provide system and supply reliability benefits compared to an alternative water supply option – directly purchasing treated water from MWD. Both evaluations considered present value project costs (including all capital, O&M, and other costs) in comparison to avoided MWD water purchases through 2050.

The MWDOC 2018 study concluded the system reliability benefits from the potential projects exceeded the cost of buying water from MWD, even under the most severe climate change scenario. Several of the evaluated projects including all the water storage programs provided supply reliability benefits with positive cost-benefits under the most severe climate scenario (i.e., the total costs of the proposed water storage program in dollars per AF were lower than acquiring water from MWD). The MWDOC 2018 study recommended additional studies to determine the appropriate timing and sizing of phases of projects, to better understand system integration issues with water quality and stranding of assets, operational issues during winter months and operational issues to enable water to be moved through various pipelines in SOC to deal with emergency situations.

MNWD's 2020 LRWRP Update incorporates MWDOC's 2018 study results related to water supply projections for SOC as well as the study's evaluation of MWD's regional water demands and supplies. The 2020 LRWRP Update builds off the MWDOC supply projections to identify expected supplies available based on MNWD's demand projections. The 2020 LRWRP Update also identifies MWDOC's understanding of what other MWD member agencies are planning in terms of future water projects that may also benefit water reliability for MNWD. In addition, the 2020 LRWRP Update includes an adaptive management approach that considers water reliability actions being implemented and contemplated by MWD, MWDOC, and other local agencies.

1.4.6 Municipal Water District of Orange County (MWDOC) Water Supply Allocation Plan

To prepare for the potential allocation of imported water supplies from MWD, MWDOC worked collaboratively with its retail agencies to develop its own WSAP that was adopted in January 2009 and amended in 2015. The MWDOC WSAP outlines how MWDOC will determine and implement each of its retail agency's allocation during a time of shortage. The MWDOC WSAP uses a similar method and approach, when reasonable, as that of the MWD's WSAP. However, MWDOC's plan remains flexible to use an alternative approach when MWD's method produces a significant unintended result for the member agencies. (MWDOC, 2019). MNWD's 2020 LRWRP Update considers how the MWDOC WSAP is implemented and could affect supply allocations if a shortage is declared, as well as affect the costs of water supplies.

1.4.7 2020 Water Resilience Portfolio

In April 2019, Governor Newsom directed state agencies through Executive Order N-10-19 to develop a water resilience portfolio, described as a set of actions to meet California's water needs through the 21st century. The order identified seven principles on which to base the portfolio:

- Prioritize multi-benefit approaches that meet several needs at once
- Utilize natural infrastructure such as forests and floodplains
- Embrace innovation and new technologies
- Encourage regional approaches among water users sharing watersheds
- Incorporate successful approaches from other parts of the world
- Integrate investments, policies, and programs across state government
- Strengthen partnerships with local, federal, and tribal governments, water agencies and irrigation districts, and other stakeholders.

The California Natural Resources Agency, California Environmental Protection Agency and Department of Food and Agriculture developed the Draft Water Resilience Portfolio (California Natural Resources Agency, et. al, 2020) to fulfill Governor Gavin Newsom's Executive Order N-10-19 calling for a portfolio of actions to ensure the state's long-term water resilience and ecosystem health. The Plan builds on state and local initiatives and the draft portfolio helps empower local and regional entities to meet their unique challenges, while delivering on the state's responsibility to provide tools and leadership, advance projects of statewide scale and importance, and help address challenges that are beyond the scope of any region. The draft portfolio outlines more than 100 integrated actionable recommendations in four broad areas to help regions build water resilience as resources become available, while at the same time providing state leadership to improve infrastructure and protect natural ecosystems (Cal EPA, 2020). Those areas include:

- **Maintain and diversify water supplies**: State government will continue to help regions reduce reliance on any one water source and diversify supplies to enable flexibility amidst changing conditions. Diversification will look different in each region based on available water resources, but the combined effect will strengthen resilience and reduce pressure on river systems.
- **Protect and enhance natural ecosystems**: State leadership is essential to restore the environmental health of key river systems to sustain fish and wildlife. This requires effective standard-setting, continued investments, and more adaptive, holistic environmental management.
- **Build connections**: State actions and investment will improve physical infrastructure to store, move, and share water more flexibly and integrate water management through shared use of science, data, and technology.

- **Be prepared**: Each region must prepare for new threats, including more extreme droughts and floods and hotter temperatures. State investments and guidance will enable preparation, protective actions, and adaptive management to weather these stresses.

MNWD's 2020 LRWRP Update aims to be consistent with many of the principles and goals of the Draft Water Resilience Portfolio to ensure MNWD's long-term water resilience. Evaluation of future water resource projects will consider how those projects align with the applicable strategies in the Draft Water Resilience Portfolio. It is anticipated that future water supply projects that align with the State goals would increase project competitiveness for grant support, streamline regulatory project approvals and result in greater regulatory and stakeholder support.

1.4.8 Bureau of Reclamation Colorado River Basin Drought Contingency Plan 2019

On March 19, 2019, the Department of the Interior, Bureau of Reclamation and representatives from all seven Colorado River Basin states (Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming) signed two Drought Contingency Plans for the Upper and Lower Colorado River basins. On April 16, 2019, the Colorado River Drought Contingency Plan Authorization Act was signed into law. The Drought Contingency Plan enables all seven states to conserve water and protect the entire Colorado River system and were designed to reduce risks from ongoing drought. The Drought Contingency Plan allows voluntary, proactive conservation measures to be developed to bolster water levels in Lake Powell and Lake Mead and are intended to further the goals of the 2007 Interim Guidelines. The Lower Basin States, the U.S. Bureau of Reclamation, and Mexico will voluntarily leave water in the reservoir each year the elevation of Lake Mead is between 1,090 feet and 1,075 feet to help prevent the Colorado River system from going into shortage. When a shortage is declared, the Lower Basin states have agreed to cut water use depending on how low Lake Mead levels fall. The more Lake Mead drops and hits key trigger elevations, the more cuts the Lower Basin states will need to make to their water use. Once Lake Mead reaches 1,075 feet, Arizona and Nevada will be the first states to curtail water use. California will reduce its use of water when Lake Mead's elevation reaches 1,045 feet. The Drought Contingency Plan also creates opportunities for the Upper Basin states to conserve water through development of a demand management program. The Drought Contingency Plan provides a strong foundation for continued collaboration across the Basin as climate changes creates greater water scarcity.

The Bureau of Reclamation (BOR) has indicated that the likelihood of a declared water shortage for the Lower Colorado River Basin states (Arizona, Nevada and California) is 57 percent by 2020, 68 percent by 2021, and 70 percent by 2022 (MWDOC, 2019). Because MNWD receives approximately 34 percent of supplies from the CRA, it is important to understand how this Drought Contingency Plan could impact this source of water supply during the various levels of triggers. While it is unknown when these triggers would occur, the 2020 LRWRP Update takes into consideration the potential reductions that may occur into the future and how this could affect the risk to MNWD supplies.

1.5 Service Area

Moulton Niguel Water District (MNWD) began servicing parts of SOC in 1960 as a small water district serving eight ranchers desiring a reliable water supply for their cattle. Over the past 60 years the area transformed from ranches to a residential community. As water demands converted from ranching to residential needs, MNWD focused on developing the necessary infrastructure to serve its changing and growing customer base. With the service area largely urbanized now, MNWD has turned its focus to ensuring continued water reliability through the development of additional water supplies and system capacity.

MNWD provides potable water, recycled water, and wastewater service to more than 170,000 customers within its service area. The service area encompasses approximately 37 square miles of almost the entire area of the Cities of Laguna Niguel and Aliso Viejo and portions of the Cities of Laguna Hills, Dana Point, Mission Viejo, and San Juan Capistrano.

1.6 Communities Served

1.6.1 Population

Population growth between 2000 and 2020 averaged 670 residents per year or an average annual growth rate of approximately 0.41 percent. However, during the period 2004 to 2006 the annual average growth declined by approximately -668 residents per year or -0.41 percent over those three years. As there are fewer and fewer areas to develop within the MNWD's service area, population growth will primarily come from redevelopment and infill activities and is anticipated to be on average 2 percent over the next 10 years. Beginning in 2030, population is expected to decrease in the service area by approximately 1 percent through 2050. Historic and forecast population for MNWD from 2000 to 2045 was provided by the Center for Demographic Research at California State University Fullerton (CDR). MNWD then used a similar projection rate to forecast out to 2050. **Figure 1-2** presents historic and projected population for the service area from 2000 through 2050.

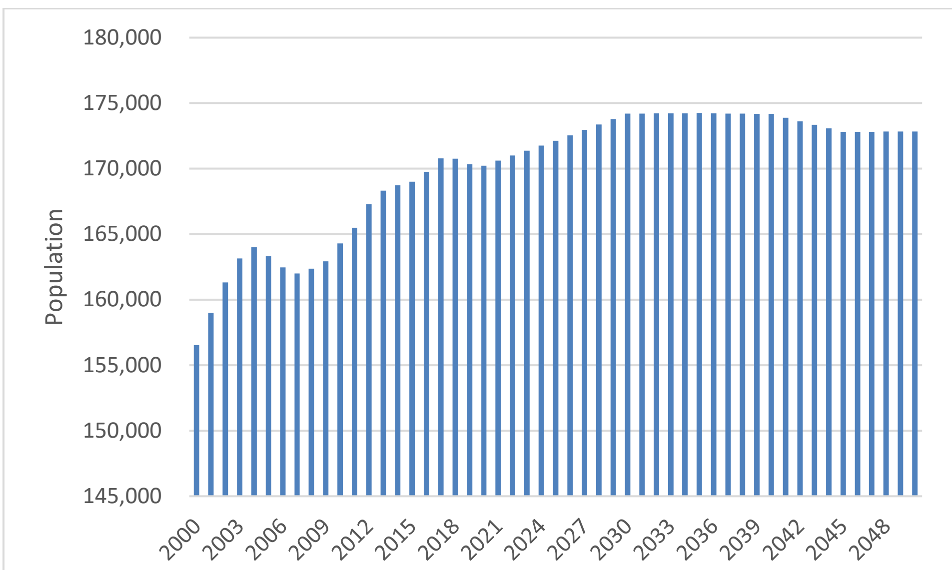


Figure 1-2. Historic and Projected Population for MNWD's Service Area

1.6.2 Land Use

MNWD's service area is comprised of approximately 29 square miles or 18,576 acres. **Table 1-1** summarizes land uses within the service area. Residential land uses are the greatest single land use occupying approximately 51 percent of the service area, or 9,490 acres; 85 percent of the residential land use is single-family homes while the balance is composed of multi-family homes. Open space and park lands comprise the second largest land occupying approximately 31 percent of the service area, or

5, 708 acres, with most of the acreage concentrated in the Cities of Laguna Niguel and Aliso Viejo. Commercial/industrial/institutional (CII) land uses occupy approximately 16 percent of the service area, or 2,917 acres. CII land uses are present in all cities throughout the service area; however, the greatest concentration occurs in Mission Viejo. Miscellaneous land uses, including those using no water, vacant areas, and freeway, occupy approximately 2 percent of the service area, or 461 acres. As previously described, the service area is built-out and expectations of future growth are minimal and would be primarily limited to infill and redevelopment.

Table 1-1. Land Use Summary for MNWD's Service Area

Land Use Category	Total Acres	Percent
Community Facility	1,205	6.49
Freeway	153	0.82
High Density Residential	1,413	7.61
Low Density Residential	4,475	24.1
Medium Density Residential	3,602	19.4
Mixed Use	295	1.59
Neighborhood Commercial	241	1.3
Office Professional	909	4.9
Open Space	4,388	23.6
Parks	1,320	7.10
Public Commercial	454	2.44
Resort	14	0.07
Village Commercial	108	0.58
Total	**18,577**	**100%**

Source: Data provided by Cities of Laguna Hills, Laguna Niguel, Mission Viejo, Aliso Viejo, and Dana Point

1.6.3 Climate

MNWD's service area weather is characterized as a Mediterranean climate. **Table 1-2** summarizes weather characteristics. Fall, winter, and spring are mild with warmer temperatures experienced during the summer months. The average of the daily maximum temperature year-round is 76.4 °F. Average rainfall is approximately 13.81 inches. Approximately 76 percent of the total annual average precipitation occurs during December through March.

Table 1-2. Representative Weather for MNWD's Service Area

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Maximum Temperature (°F)[1]	70.3	69.9	72.0	73.9	75.7	78.6	83.2	85.3	84.3	79.7	74.6	69.1	76.4
Average Precipitation (inches)[2]	2.92	3.25	2.20	0.87	0.29	0.06	0.05	0.08	0.28	0.67	1.05	2.09	13.81

1. 1980-2012 Santa Ana Fire Station Weather Station (station ID: GHCND:USC00047888).
2. OC Public Works, Historic Rainfall Data, Laguna Niguel (Sulphur Creek Dam), 2017.

1.6.4 Evapotranspiration

Evapotranspiration, or ET, is the combination of water that is lost from the soil through evaporation and through transpiration from plants as a part of their metabolic processes. It is an indicator of the amount of water that must be replaced for plants to stay alive and grow. Reference evapotranspiration, or ETo, is simply the amount of water needed by a plant. ETo varies daily with changes in temperature, relative humidity, solar radiation, and wind. As the days get longer and warmer from March to July, ETo, or the plant's need for water, gradually increases. MNWD service area ranges in elevation from approximately 140 feet above mean sea level (AMSL) to approximately 930 feet ASL. To reflect the significant variation in elevation, approximately 111 micro-zones were created within MNWD, each with distinct water needs that can be derived from ETo. ET is weighted by the counts of accounts in every microzone. The median of evapotranspiration is around 47.68 inches over the past eleven years. The weighted evapotranspiration ranges from 43.9 inches to 49.9 inches annually. Minimum weighted ET in MNWD service area is around 41.4 inches and maximum weighted ET is around 54.41 inches annually. This variability in ETo translates to fluctuating watering needs for landscape irrigation for homes, commercial properties, parks, and golf courses between the various micro-climates.

Section 2 Water Demands

Section 2 Water Demands identifies the methodology used to estimate water demands for the MNWD service area through 2050. These water demands include residential, commercial, and irrigation demands, which represent the full spectrum of water use in the service area. Understanding MNWD's water demands is essential to developing a long-term water supply strategy. Water demands are a function of numerous factors:

- **Demographics** – characteristics of the population living in the area, including number of single-family and multifamily homes, household size, irrigation acreage, and number of employees;
- **Socioeconomics** – income levels, unemployment rates, and price of water;
- **Water Use Efficiency** – efforts to reduce the demand for water and reduce waste of water through water efficiency programs; plumbing codes, ordinances; and
- **Weather** – temperature, evapotranspiration, and rainfall.

Building from recent water use data and future population projections, MNWD water demand forecast is developed to support MNWD's goals to meet the water resources needs reliably and sustainably of the community now and into the future.

2.1 Historical Water Demands

Total water production (imported and recycled) water demands since 2005 have been on an overall decline even as population has increased across the service area, as shown in **Figure 2-1**. Since 2005, MNWD customers have reduced potable water imports by over 12,000 AFY. The total daily use in 2005 was approximately 183 gallons per capita per day (GPCD). By the end of 2019, per capita use declined to 118 GPCD. Weather, drought, and economic conditions play a role in the year-to-year demand fluctuations, however, the overall decline in imported water and GPCD can largely be attributed to active demand management, MNWD water efficiency programs, increased use of recycled water for irrigation, and customer response to drought. MNWD's use of recycled water for irrigation offsets average imported potable demands by approximately 6,700 AFY. In addition, on average the water efficiency programs achieve more than 3,000 AFY in savings since 2008.

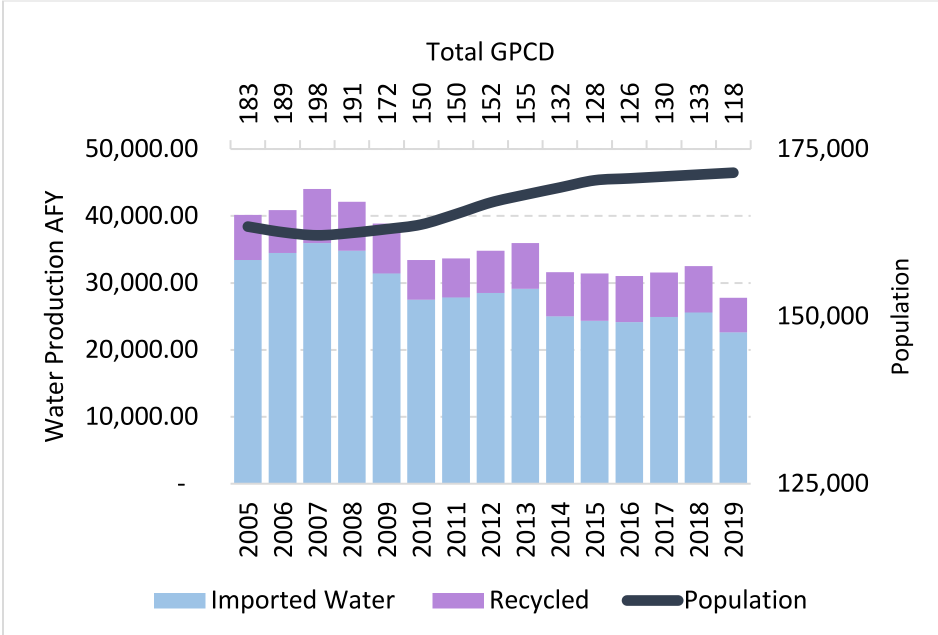


Figure 2-1. Historical Water Production and Population Growth from 2005-2019

2.2 Demand Management

MNWD's Water Efficiency Programs are an important component of the long-range water supply planning efforts, providing supply and demand management benefits. MNWD continues to see water use efficiency gains and seeks to improve upon the associated customer water efficiency-achievements to date.

Water conservation and water use efficiency are key components of MNWD's demand management strategy. Water conservation generally pertains to behavioral practices that reduce water consumption, while water efficiency encompasses a suite of technologies and site improvements that increase efficient water use. Water use efficiency is a voluntary choice by customers but can be incentivized through programming. Increased efficiency allows for the use of the water resources for other purposes. MNWD recognizes the importance of water conservation and has made water use efficiency an integral part of water use planning. Continued integration of demand management strategies into MNWD's 2020 LRWRP Update is essential to the success of maintaining water reliability because the success of MNWD's water efficiency programs in achieving its water-saving goals in the past is a strong indication of its ability to realize new and higher levels of water efficiency in the future. Demand management is a key component of MNWD's Urban Water Management Plan and is consistent with the "Make Conservation A Way of Life" laws (SB 606 and AB 1668) implemented in 2018.

MNWD has implemented several water efficiency programs, most notably the Water Budget-Based Rate Structure. MNWD also created a rebate program to reduce the cost of customer compliance with their individually calculated water budgets. Several rebates are offered including rebates for transforming landscapes to low water use plants, installing irrigation efficient devices and indoor water efficient devices. Customer participation since 2008 has been tremendous with over 21,000 rebates sent out for conservation actions through the end of 2019. MNWD plans to continue to implement these demand management strategies and outreach programs to further reduce water usage in the future. Each of these programs is summarized below.

Water Budgets – On July 1, 2011, MNWD implemented a water budget-based rate structure. MNWD provides each customer with a personalized water budget designed to meet their specific indoor and outdoor water needs. Residential water budgets are calculated based on each customer's landscaped area of their parcel, real-time localized weather data, and the number of residents in each home. Water budgets promote efficient water use by providing enough water for typical, yet efficient, water use indoors and outdoors. Budget-based water rates differ from increasing tiered water rates in that an individual budget for water demand is established for each water customer. When water usage exceeds the budget, a higher water rate is incurred for that portion of use above the budget baseline. The goal of MNWD's rate structure is to incentivize customers to use water efficiently. Customers who use water efficiently and stay within their water budgets pay the lowest rates. MNWD's Water Budget Based Rate Structure allocates costs to customers who place the greatest demands on MNWD's water system. Customers who use more than their total water budget results in additional costs that their higher demand places on the system. MNWD updated the water budget factors in April of 2015 and again in January 2018 to respond to drought conditions and increased needs for water use efficiency. For example, indoor water use factor per individual reduced from 60 GPCD to 55 GPCD.

Advanced Metering Infrastructure – MNWD is upgrading our meter technology to help customers save water and money. The upgraded meter technology will help proactively detect water leaks, improve operations, and enable all customers to monitor their hourly water usage through MyWater MNWD, our online customer portal. This project is expected to save more than 500 million gallons of water every year. As of December 2020, 35,409 customers have signed up for the portal, which represents 64% of our total customers. Customers are encouraged to sign up to monitor their usage.

NatureScape Landscape Workshops and Program – Customers can participate in NatureScape Landscape Workshops to help reimagine a watershed approach to landscaping. Native plants typically use about 83 percent less water, produce about 56 percent less green waste, and require nearly 70 percent less maintenance and provide natural habitat for birds and animals that reside in the area. MNWD's direct-install Turf-to-Native Garden Program makes it easy for customers to take advantage of generous rebates for replacing turf with water-efficient native landscaping.

Irrigation Workshops –MNWD's All Things Irrigation Workshop helps customers identify and resolve common irrigation issues, learn ways to avoid over-watering, and learn about monthly water budgets. Reducing outdoor water waste and staying within water budget promotes conservation and better management of this invaluable resource.

Home Savings Surveys – A Water Efficiency team member is available to visit customers, review outdoor watering practices, discuss indoor water use, and recommend easy ways to save water and money by becoming more efficient. MNWD staff provide helpful outdoor and indoor water saving tips to help customers use water efficiently.

Residential Outdoor Rebates – Several outdoor rebate programs are available to help make customers more water efficient including rebates for rotating sprinkler nozzles, rain barrels and cisterns, weather-based smart sprinkler timer, soil moisture sensor controllers, and the turf removal program.

Residential Indoor Rebates – Several indoor rebate programs are available to help make customers more water efficient including rebates for high efficiency clothes washer and premium high efficiency toilet.

Urban Drool Tool – MNWD worked collaboratively with the Orange County Public Works to develop the Urban Drool Tool. The tool combines water consumption data, account information, and watershed data to match household water use with each neighborhood's urban runoff. The goal of the tool is to motivate water use efficiency by helping customers understand the benefits of staying within their water budgets on watershed health and recreational resources. This tool helps identify areas that would benefit most from water efficiency programs.

Communication - In addition to ongoing demand management and water efficiency programs, MNWD has incorporated an updated outreach strategy to use more electronic communication with customers while also targeting messages based on customer needs and water savings opportunities.

2.3 Water Use Sectors

Total water use in MNWD's service area is comprised of five main billing categories, and one non-revenue category:

- **Single-Family Residential** – Represents single-family detached homes and attached single-family homes and townhomes with individual meters.
- **Multifamily Residential** – Represents apartments, condominiums, and townhomes with master meters for the entire building or complex.
- **Commercial** – Represents businesses, schools, hospitals, and governmental customers.
- **Potable Irrigation** – Represents large landscape users with dedicated irrigation meters such as golf courses, common residential landscaping (e.g., homeowners associations), parks, medians, and greenbelts.
- **Recycled Irrigation**– Represents all users of non-potable recycled water, including golf courses, parks, and large residential common landscaping areas.
- **Non-Revenue** – Represents water that is not billed to customers, and can include fire protection, system flushing, and distribution system losses.

As shown in **Figure 2-2**, residential uses (single-family and multi-family) account for nearly 60 percent of all water use during an average year. Figure 2-2 provides a break-down of water use by MNWD's main water use sectors for years 2005-2019. Single-family use is the largest sector using approximately 17,150 AFY or approximately 52 percent of the total average water use, followed by recycled irrigation use at 6,800 AFY (21 percent), potable irrigation use at 3,800 AFY (11 percent), commercial use at 2,700 AFY (8 percent), and multifamily use at 2,400 AFY (7 percent). Non-revenue water represented less than 1 percent (25 AFY) of the total water use.

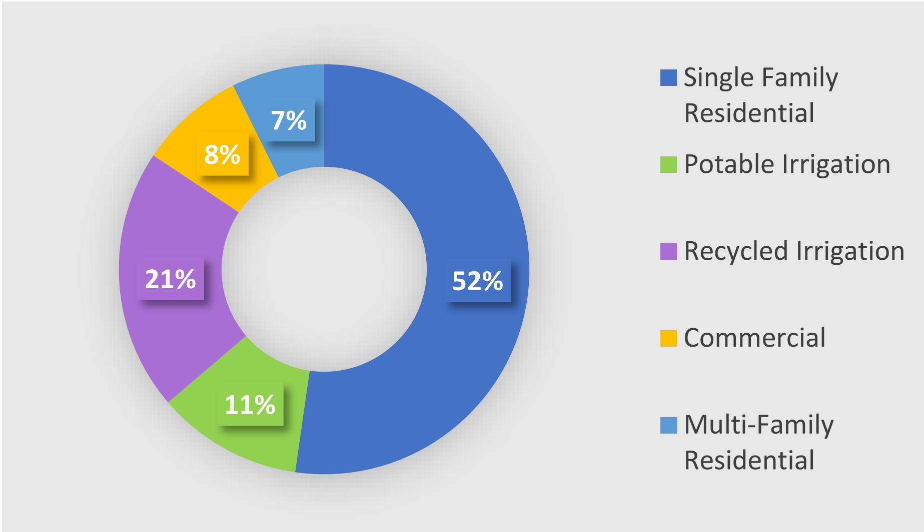


Figure 2-2. Average Water Use by Water Sector from 2005-2019

2.4 Future Water Demands

Long-range water demand forecasting is an essential component of water resources planning. Projections through 2050 provide a basis on which to evaluate the ability of MNWD's water supply and infrastructure capacity to meet existing and future demands. Forecasting is a critical element of MNWD's ability to plan, design, and construct capital-intensive infrastructure, such as new sources of water supply and treatment facilities. Projecting future water demand requires understanding of current uses and a forecast of the driving factors that influence demand. MNWD forecasts are based on the demographic projections available from the Center for Demographic Research as well as the historical use of water by customers. An analysis was performed that combines growth projections with water use data to forecast total water demand in future years.

2.4.1 Water Demand Methodology

To estimate the impacts of major factors that influence water demands, a multivariate statistical forecasting model was developed with forecasts out to 2050. The multivariate model is a statistical tool that uses multiple variables to forecast possible outcomes. The model uses historical total monthly water production (including both imported water for potable use and recycled water for non-potable use) as the dependent (or predictive) variable, and the following independent (or explanatory) variables:

- Annual population of the service area (an indicator of growth)
- Water loss data
- GPCD and plant factors to account for water use efficiency changes in the long term
- Conservation efforts
    - Turf removal (square-feet)
    - Water savings from turf removal and water savings devices (AFY)
- Average evapotranspiration
- Projected new developments in the service area
- Recycled water conversion over time and future water portfolio timelines like direct potable water use.

The forecasting model incorporates the impact of changes in the above factors on water demand over time. The model provides an upper bound and lower bound of demand projections. The upper bound of future demand projections reflect the projections used in the 2015 UWMP. The upper bound demand projections assume an increase in total water demand as both new and existing customers use more outdoor water because of rising temperatures driven by climate variability and other seasonal factors that would affect monthly demand. In April 2015, indoor water allocations were reduced from 65 GPCD to 60 GPCD and outdoor plant factors were reduced from 0.8 to 0.7. MNWD's plant factor is a combination of the crop coefficient and the irrigation efficiency factor. In other words, it is the applicable ETo required to apply to a plant. The indoor water allocations were reduced further in 2018 to 55 GPCD. This upper bound demand projection assumes a continuation of indoor water allocations at 55 GPCD with an outdoor plant factor of 0.7 through 2050.

The lower bound of demand projections is a continuation of existing demand management strategies and implementation of state regulations within MNWD. Because of its reliance on imported water deliveries to meet potable demands, MNWD has developed a comprehensive portfolio of demand management strategies. Major components of this demand management strategy include MNWD's water budget-based rate structure and rebate programs. In order to reflect MNWD's demand management strategies, the Status Quo Demand forecasts were developed to incorporate MNWD's policy approaches for conservation (e.g., budget-based rates and rebate programs), improvements in technology (and adoption and implementation of new water saving technologies), and long term adjustments in demand as customers respond to pricing signals. It was assumed that active indoor and outdoor conservation will continue to occur as the result of ongoing demand management and regulations from the State Water Resources Control Board. Assumed indoor conservation is captured by decreasing the daily gallons per capita from the 2018 indoor water budget factor of 55 GPCD to 45 GPCD through 2050. Assumed outdoor conservation is captured by decreasing the outdoor plant factor for accounts which use potable water. The plant factor was reduced from the current 0.7 to 0.6 through 2050. Additionally, MNWD's turf removal program is assumed to be continued with the removal of 150,000 square feet per year that saves 15 gallons per square foot in the first year after removal and 40 gallons per square foot thereafter. This is below the yearly amount of turf that has been replaced since 2012, which ranged from a low of 183,000 square feet to a high of nearly 2 million square feet. Customers transformed over 6 million square feet of turf to native landscape between 2011 and 2019. Demand projections include savings from all other MNWD water conservation devices resulting in an average savings of at least 30 AF/yr.

The median of the upper-bound and lower-bound of future demand were included as a potential demand scenario. The median demand projections include an indoor water budget factor of 55 GPCD to 50 GPCD through 2050 and an outdoor plant factor of 0.7 through 2050. Refer to **Figure 2-3** for each of the scenario's demand projections. **Table 2-1** lists the demand projections for each demand scenario in 5-year increments and provides the breakdown of demands by each water use sector. Including all three scenarios in the planning process allows MNWD to account for uncertainty and variability in water demands over time. For example, the level of customer conservation and water use efficiency may vary over time. Changes in the level of conservation will affect water use patterns which can affect total demand for supplies. These uncertainties mean that past demand patterns may not necessarily be a good indicator for future demand. Presenting alternate scenarios allows for varying future demands based on uncertainties and provides valuable information related to resiliency planning.

Figure 2-3. Scenario Demand Projections

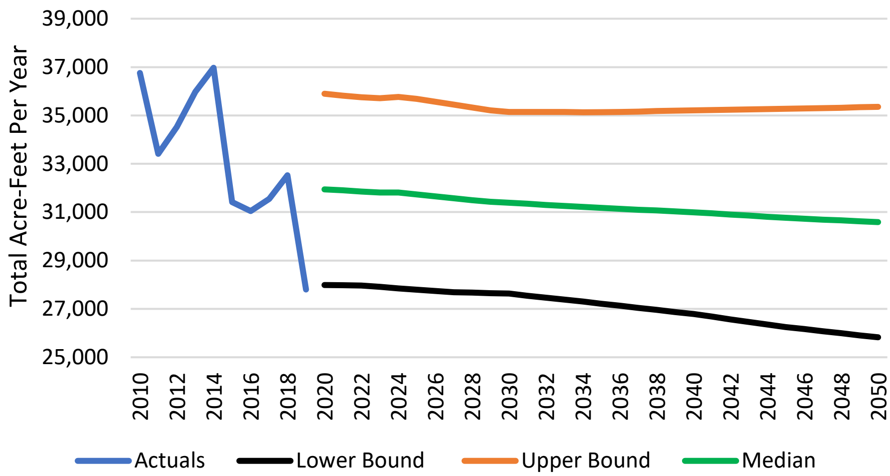


Table 2-1. Future Water Demand Forecast Scenarios for MNWD

Year	2020	2025	2030	2035	2040	2045	2050
Total Upper Bound Demand (AFY)	**35,897**	**35,682**	**35,139**	**35,135**	**35,206**	**35,279**	**35,351**
SFR	18,590	18,479	18,198	18,196	18,233	18,270	18,308
MFR	2,364	2,350	2,314	2,314	2,318	2,323	2,328
Irrigation	3,984	3,960	3,900	3,899	3,907	3,915	3,923
Recycled	7,608	7,563	7,448	7,447	7,462	7,477	7,493
Commercial	3,334	3,314	3,263	3,263	3,270	3,276	3,283
Other	17	17	17	17	17	17	17
Total Median Demand (AFY)	**31,950**	**31,787**	**31,476**	**31,306**	**31,169**	**30,976**	**30,842**
SFR	16,546	16,462	16,301	16,213	16,142	16,042	15,973
MFR	2,104	2,093	2,073	2,061	2,052	2,040	2,031
Irrigation	3,546	3,528	3,493	3,474	3,459	3,437	3,423
Recycled	6,772	6,737	6,671	6,635	6,606	6,565	6,537
Commercial	2,967	2,952	2,923	2,907	2,895	2,877	2,864
Other	15	15	15	15	15	15	15
Total Lower Bound Demand (AFY)	**27,987**	**27,794**	**27,633**	**27,216**	**26,789**	**26,248**	**25,826**
SFR	14,494	14,394	14,311	14,095	13,874	13,593	13,375
MFR	1,843	1,830	1,820	1,792	1,764	1,728	1,701
Irrigation	3,106	3,084	3,066	3,020	2,973	2,913	2,866
Recycled	5,932	5,891	5,857	5,768	5,678	5,563	5,474
Commercial	2,599	2,581	2,566	2,527	2,488	2,438	2,398
Other	13	13	13	13	13	12	12

2.4.2 Potential Climate Variability Effects on Water Demands and Supplies

Climate variability is an uncertainty that MNWD considers in ensuring that current and future water demands for our community are met. Consideration of potential climate variability impacts on local water demands is essential when developing a long-term reliability plan. California recently experienced the 5-year drought event of 2012-2016, and other notable historical droughts included 2007-09, 1987-92, 1976-77, and off-and-on dry conditions spanning more than a decade in the 1920s and 1930s (DWR, 2020). Climate variability is a challenge to water supply reliability for Southern California because it could result in long-term changes in local temperature and precipitation. While it is uncertain as to how the climate is changing in Southern California, the potential outcomes of a variable climate could affect both supplies and demands. Warmer temperatures in Southern California will affect water demands by increasing the water requirements for plant life and landscapes and will also increase evaporation rates in storage reservoirs (MWD, 2016).

According to the 2020 Water Resilience Portfolio, California's climate is warming and becoming even more variable, which reduces winter snowpack, intensifies drought and wildfire, and drives more intense storms that worsen flooding (California Natural Resources Agency, et. al, 2020). The 2020 Water Resilience Portfolio identified rising winter temperatures will reduce mountain snowpack in the Sierra Nevada and Cascade ranges by 65 percent on average by the end of the century, increasing winter runoff and flood risks while reducing spring and summer stream flow (California Natural Resources Agency, et. al, 2020). Warming temperatures increase the severity of our natural drought cycle, which most greatly impacts areas that depend on surface water flows (California Natural Resources Agency, et. al, 2020). The 2020 Water Resilience Portfolio stated historical hydrological patterns can no longer serve water managers as a trustworthy guide around which to plan, and climate science and projections have become increasingly important. Future conditions will continue to change and require ongoing adjustment and adaptation of water management (California Natural Resources Agency, et. al, 2020).

According to the MWD 2015 IRP (MWD, 2016), the past 10 years have given Southern California a glimpse of the challenges that climate change will pose. MWD has been committed to facing the challenge of climate change and have recognized and moved the region towards comprehensive planning and adaptation for climate change impacts. MWD's 2004 IRP Update introduced a planning buffer to the resource planning framework to help the region become more prepared for uncertainties including climate change. The 2010 IRP Update expanded this into a supply buffer consisting of climate-proof conservation and local water recycling and added Foundational Actions to prepare for the longer-term risks of climate change. The 2015 IRP Update continued to include future adaptation actions to respond to future climate change impacts. A key element of the 2015 IRP Update was developing approaches for how MWD will advance conservation and local resources development and maximize its storage reserves in the future. MWD continues to take steps to improve resiliency to climate change impacts (MWD, 2016).

The MWDOC 2018 study (MWDOC, 2019) utilized the Coupled Model Intercomparison Project Phase 5 (CMIP5) climate projections for assessing potential impacts from climate change. The results indicated greater future temperatures for both the Sierra-Nevada Mountain Watershed and Upper Colorado River Basin which would result in lower snowpack volumes, leading to earlier spring runoff flows and less summer runoff flows (when water demands are greatest). The MWDOC 2018 study also showed greater variability in precipitation with some models resulting in less precipitation than historical while others show significantly more precipitation (MWDOC, 2019).

Section 3 Water Supplies and Water Reliability

3.1 Water Supplies and Regional Facilities

MNWD's potable water supply is entirely imported water from MWD that is purchased from the Municipal Water District of Orange County (MWDOC). MWD's main two sources of imported water come from the CRA and SWP, as shown in the inset map. In Fiscal Year 2018-2019, MNWD received on average about 34 percent of import supplies from the CRA and 41 percent of supplies from the SWP. However, imported water ratios from the SWP and CRA varies throughout the year and from year to year based on hydrologic conditions in those regions. Most of MWD's system can switch to 100 percent of either source except a small area in Ventura County and the Chino Basin, which highlights the resiliency of the MWD importation system. The remaining 25 percent of water supplies is made of recycled water produced by MNWD. Imported water delivered to MNWD is currently treated at MWD's Robert B. Diemer Water Treatment Plant (Diemer WTP) located north of Yorba Linda or at the Baker Water Treatment Plant (WTP) located in Lake Forest. The Baker WTP was built to provide a redundant treatment facility in the event of a Diemer WTP outage. On average approximately 70 percent of water supplies are treated at the Diemer WTP and the remaining 30 percent of water supplies are treated at the Baker Treatment Plant. The Diemer WTP is owned and operated by MWD and has a capacity of 520 MGD. Water is conveyed from the Diemer WTP to MNWD via the EOCF2 which connects to the Joint Main Transmission Line (delivering on average approximately 13 percent of supplies) and the Allen McCollough Pipeline (AMP) and the South County Pipeline (SCP) (delivering on average approximately 57 percent of supplies). Water is conveyed from the CRA to Baker WTP via the Baker Pipeline and to MNWD via the SCP. The Baker Pipeline is an untreated line that connects to the Santiago Lateral of MWD's Lower Feeder. The existing imported water supply system serving Orange County is shown on **Figure 3-1**, as well as MNWD's service area.

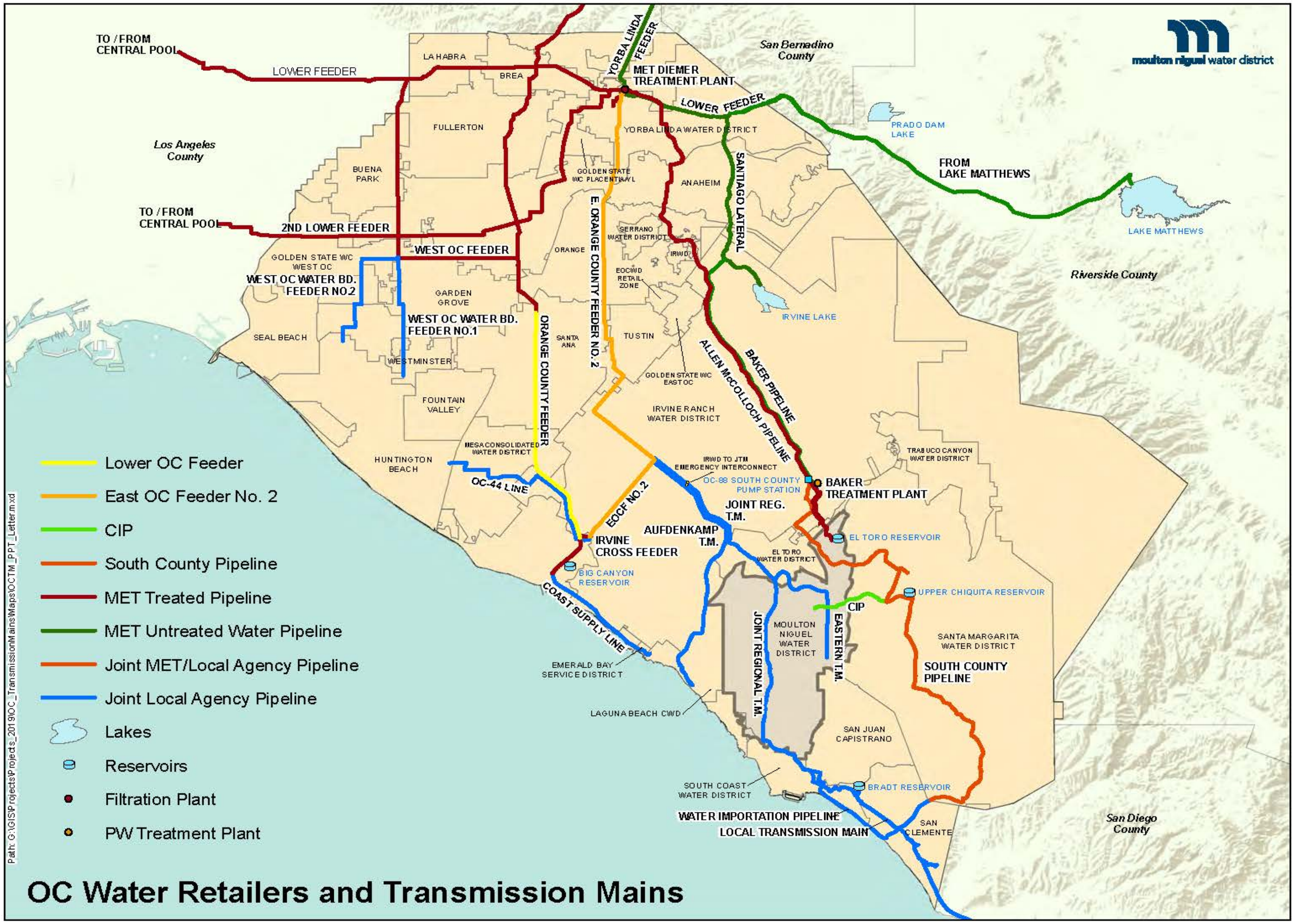


Figure 3-1. Regional and Local Water Supply System

3.1.1 Imported Water Supplies

3.1.1.1 State Water Project (SWP)

The Delta is a unique and valuable resource and an integral part of California's water system. It receives runoff from over 40 percent of the State's land area including flows from the Sacramento, San Joaquin, Mokelumne, Cosumnes, and Calaveras rivers. The Delta provides habitat for many species of fish, birds, mammals, and plants; supports agricultural and recreational activities; and is the focal point for water distribution throughout the State. The SWP system that brings water from northern California to MNWD relies on a viable Delta for its water supply.

Risks to SWP

Reliability of the SWP has decreased over time due to a multitude of factors. The main factors affecting SWP reliability are hydrologic and environmental/regulatory. The source water for the SWP is the mountain snowpack in the Sierra Nevada Mountains, which is highly susceptible to climatic variations. Melted snowpack makes its way through rivers and streams that converge in the Delta, where export pumps move the water southward to meet demands of agricultural and urban water users. Even with storage in the system, prolonged droughts can significantly reduce exports from the Delta.

The other major factor is environmental/regulatory. The Delta is a fragile ecosystem and contains numerous threatened and endangered species of fish. These fish species can be impacted by exporting excessive water from the Delta to agricultural and urban water users of the SWP and Central Valley Water Project (a federally owned and operated water system). In 2007, a federal judge's ruling on the Delta smelt, an endangered fish species, resulted in exports from the Delta being suspended. This, along with drought conditions in the western U.S., resulted in MWD having to implement its Water Supply Allocation Plan to meet reduced imported water. Without a long-term fix to the Delta, including both ecosystem restoration and export delivery improvements, the California Department of Water Resources (DWR) indicates that reliability of the SWP will continue to degrade.

Major seismic activities in the Delta area could result in long term pumping reductions reducing SWP supplies for MWD. Channels in the Delta are constrained via an earthen levee system designed to protect below sea level islands from flooding. Over time, land subsidence has occurred and is expected to continue, further increasing the risk of levee failure and island flooding. A catastrophic earthquake in the region could potentially cause widespread failure of many levees. When levee failure occurs, the flow of water onto an island can draw sea water from the San Francisco Bay into the Delta. Such an event could potentially disrupt export water pumping for an extended period.

DWR is currently working to implement a comprehensive fix to the Delta water supply and environmental issues. Starting in October 2006, various state and federal agencies, water contractors, and other stakeholders initiated a process to develop what became known as the Bay Delta Conservation Plan (BCDC) to advance the objectives of contributing to the restoration of ecological functions in the Delta and improving water supply reliability for the SWP and Central Valley Project Delta operations in the State of California. A Draft Environmental Impact Report/Environmental Impact

Statement (EIR/EIS) was published in December 2013 that evaluated 15 alternatives, including a preferred alternative. In July 2015, DWR released a Partially Recirculated Draft EIR/Supplemental Draft EIS that evaluated the preferred alternative, known as the California WaterFix involving two conveyance tunnels. On July 21, 2017, DWR certified the Final EIR and approved California WaterFix. Following this action, the project was further refined to reduce environmental impacts and a Supplemental EIR was released in July 2018. However, the Supplemental EIR was not completed due to the change in direction dictated by Governor Newsom's State of the State speech and Executive Order N-10-19. The Governor's announcement and Executive Order led to DWR's withdrawal of all approvals and environmental compliance documentation associated with California WaterFix. A new project, known as the Delta Conveyance Project, is currently in review and a new EIR is being prepared to evaluate the impacts of the project. The Delta Conveyance Project would similarly construct and operate new conveyance facilities in the Delta that would add to the existing SWP infrastructure. The new conveyance facilities would include a single tunnel to convey water. Operations of the conveyance facilities are proposed to increase DWR's ability to capture water during high flow events. Construction and commissioning of the overall conveyance project, if approved, would take approximately 13 years.

3.1.1.2 Colorado River Aqueduct (CRA)

Approximately 1,400 miles long and flowing through seven U.S. States and into Mexico, the Colorado River drains roughly one-twelfth of the land area of the contiguous United States. The Colorado River Basin is divided into the Upper and Lower Basins in northern Arizona. The Upper Basin spans portions of Wyoming, Colorado, New Mexico, Utah, and northern Arizona. The Lower Basin covers parts of Nevada, Arizona, California, southwestern Utah, and western New Mexico. The Colorado River also supplies water to parts of the states of Baja California and Sonora in northwestern Mexico. (DOI, 2020).

The Upper Colorado River Basin supplies approximately 90 percent of the water for the entire Basin. This water originates as precipitation and snowmelt in the Rocky and Wasatch Mountains. The Lower Basin is arid, with little tributary runoff reaching the mainstream of the Colorado River except during occasional rain events. Due to year-to-year differences in precipitation and snowmelt, the natural water supply of the Basin is highly variable. Since most of the Basin's water supply comes from the Upper Basin, drought conditions in the Upper Basin impact water supply and resources in both the Upper and Lower Basins of the Colorado River. (DOI, 2020).

Allocations of water supply are based on the "Law of River." Under the Law of the River, various states and Mexico have been allotted portions of the Colorado River water. Unused water may be allocated to other states and agencies but are subject to the U.S. Bureau of Reclamation (Reclamation) approval. Historically, California received available supplies in excess of its apportionment; however, as other users (specifically, Arizona and Nevada) began to use their full apportionments, excess water was no longer available. MWD has a firm apportionment water supply from the Colorado River of 0.63 million acre-feet (MAF). In addition, MWD has water transfers and banking programs that provide additional water supplies in times of droughts and shortages in river supplies. MWD's operation of its CRA and use of river supplies is in full accordance with the Quantification Settlement Agreement (QSA), which established how each of the California water agencies using Colorado River water would be allocated and managed and fall within California's 4.4 MAF apportionment.

Risks to CRA

Drought

Since 2000, the Colorado River Basin (Basin) has been experiencing a historic, extended drought that has impacted regional water supply and other resources, such as hydropower, recreation, and ecologic services . During this time, the Basin has experienced its lowest 16-year period of inflow in over 100 years of record keeping, and reservoir storage in the Colorado River system has declined from nearly full to about half of capacity (DOI, 2020). Concern is growing about the impacts of the ongoing drought and declining reservoir levels, such as decreasing water supply and the possibility of a first-ever shortage condition of drinking water for the Lower Basin; decreasing hydropower capacities at Lake Powell and Lake Mead; the potential for loss of hydroelectric generation at Lake Powell; reduced recreational opportunities; and changes to in-stream flows that support ecosystems (DOI, 2020).

In response to drought conditions, Federal agencies and stakeholders throughout the Basin have been working together to find creative ways to reduce the effects of the drought on the people and resources that rely on water from the Colorado River. The Department of the Interior, Bureau of Reclamation and representatives from all seven Colorado River Basin states signed completed drought contingency plans for the Upper and Lower Colorado River basins. These completed plans are designed to reduce risks from ongoing drought and protect the important water resource in the western United States. The Drought Contingency Plan allows voluntary, proactive conservation measures to be developed to bolster water levels in Lake Powell and Lake Mead and are intended to further the goals of the 2007 Interim Guidelines. California will reduce its use of water when Lake Mead's elevation reaches 1,045 feet. The BOR has indicated that the likelihood of a declared water shortage for the Lower Colorado River Basin states (Arizona, Nevada and California) is 57 percent by 2020, 68 percent by 2021, and 70 percent by 2022 (MWDOC, 2019).

Salinity

Much of the Upper Colorado River Basin is underlain by geologic formations composed of sediments which were deposited or precipitated in ancient inland seas and water ways which concentrated salts in these formations. The passing of water through these formations, both naturally or through human activity, dissolves and mobilizes these salts (Colorado River Basin Salinity Control Forum, 2019). Historically (from 1940-2017), the Colorado River carried an average salt load of approximately 9 million tons annually past Hoover Dam in Nevada (DOI, 2019). EPA has identified that 62 percent of the salt load of the Colorado River above Hoover Dam comes from natural sources. The significant salt load creates environmental and economic damages to its users. Modeling by Reclamation shows that the quantifiable damages from high salinity water are approximately $454 million dollars per year to U.S. users, with projections that damages would rise to more than $574 million by 2035 if the Salinity Control Program were not to continue to be aggressively implemented (Colorado River Basin Salinity Control Forum, 2019). The Colorado River Basin Salinity Control Forum was created by the seven Colorado River Basin states in 1973 to act as a common voice for the states on salinity matters and to coordinate with federal agencies in the implementation of the Salinity Control Program. Through Salinity Control Program efforts, the salt load of the Colorado River has been reduced by more than 1.3 million tons annually, but continuance of the program is required to offset what otherwise would be increases in salinity levels. In 1975 the seven Colorado River Basin states adopted, and subsequently EPA approved, a salinity standard for the Colorado River. That standard is composed of numeric criteria for total dissolved solids and a plan of implementation to meet the criteria. (Colorado River Basin Salinity Control Forum, 2019).

3.1.2 Local Supplies

3.1.2.1 Recycled Water

Recycled water is wastewater that has undergone additional treatment for it to be suitable for a range of beneficial uses. Tertiary-treated recycled water is also known as Title 22 water as defined by the California Title 22 Standards (Title 22, Division, 4, Chapter 3, 4 of the California Code of Regulations). Recycled water that has undergone tertiary treatment can be safely used for many non-potable applications, including landscape irrigation (e.g., golf course, parks, roadway medians). MNWD has been a leader in recycled water use since 1968 for irrigation purposes. Recycled water for non-potable use is delivered to customers in a separate distribution system of "purple pipes"; which are required to keep recycled water separate from drinking water pipelines. MNWD produces approximately 25 percent of its supply by capturing treated water that would normally be sent out to the ocean. Treated water is reused for irrigation and other non-potable or non-drinking uses. Every gallon of recycled water used, saves a gallon of potable drinking water. In total, about 2.1 billion gallons (per FY 2016-17 results) of water is saved each year using recycled water.

Risks with Recycled Water

MNWD completed its Recycled Water Master Plan (RWMP) in June 2017 and the Recycled Water Optimization Study (RWOS) in July 2019. The RWMP study identified 465 potable irrigation meters and 1,695 AFY demand that could feasibly be retrofitted to the recycled water system. Retrofit of all 465 potable irrigation meters to the recycled water system would have required additional seasonal storage. Through its unique partnership with Netflix, MNWD decided not to pursue additional seasonal storage and would limit the number of retrofits made in the future so that a maximum seasonal storage of 1,000 AF will not be exceeded during the high demand periods. MNWD saved $20 million in less than one year by applying predictive modeling tools and analytics used by Netflix. MNWD was able to better forecast recycled water usage and realized that instead of building an expensive reservoir to store water for peak usage, the recycled water usage can be better managed to avoid the cost of building an unneeded infrastructure. MNWD currently owns 1,000 AF of seasonal storage in Santa Margarita Water District's (SMWD) Upper Oso Reservoir. Based on the existing demands and 1,000 AF of seasonal storage capacity, the RWMP determined that about 514 AFY of additional demand could be retrofitted and added to the existing recycled water system. The RWOS identified that if a portion of the sewage that is currently tributary to the JB Latham Treatment Plant (JBLTP) were to be captured and pumped back to either the 3A Treatment Plant (3ATP) or the Joint Regional Treatment Plant (JRTP), about 1,274 AFY of additional demand could be retrofitted to the recycled water system. 208 AFY of the retrofits have been accounted for since the completion of the RWMP. Therefore, 306 AFY (514 AFY – 208 AFY) is the remaining additional potential demand with the current supply and 1,066 AFY (1,274 AFY – 208 AFY) is the remaining additional potential demand with increased supply due to sewage diversion from JBLTP.

The RWOS was performed to determine which potable irrigation customers could be retrofitted to recycled water without triggering the need for additional seasonal storage, while minimizing the cost for capital improvement projects that would be needed within the existing system and the potable make-up water that would be needed for the additional demand. A hydraulic model was developed that evaluated three scenarios, interim, future, and final. The future and final scenarios were based on implementation of long-term improvements at 3ATP and JBLTP. Of the 448 meters evaluated, 30 meters have been prioritized and assigned to the interim scenario. A total of 70 meters have been prioritized and assigned to the future scenario. A total of 204 meters have been prioritized and assigned to the final scenario. The Near-Term Improvement Projects total $1.4M and are planned to be constructed in the next 5 years. The Long-Term Improvement Projects total $11.2 M and are planned to be completed in the next 5 to 10 years.

3.1.3 Local Water Supply System

3.1.3.1 Storage Facilities

In the past few years, MNWD has been developing local water supply improvements in order to be able to comply with MWD's operational goal that water agencies must have 7 days' worth of storage/interconnections to withstand a planned outage of major imported water facilities. These water supply improvements include:

- IRWD/Orange County Water District (OCWD) Emergency Service Agreement – This agreement allows for an emergency supply of 10.6 MGD (16.5 CFS) of water to be supplied by IRWD using its groundwater from the Orange County Basin. This agreement currently expires in 2031. A study is currently underway to determine the potential to expand the capacity of interconnection as well as extend the agreement beyond 2031.

- El Toro Water District R-6 storage – MNWD has storage capacity of 13 million gallons (MG). The total reservoir capacity is 275 MG.

- SMWD Upper Chiquita Reservoir – MNWD has storage capacity of 90 MG. The total reservoir capacity is 244 MG.

- South Coast Water District 5B Reservoir – MNWD has storage capacity of 700,000 gallons.

- MNWD System Storage –MNWD has 28 potable water and 11 recycled water operational storage reservoirs. The total potable water storage capacity within MNWD is approximately 71 MG and the total recycled water storage capacity within the District is approximately 17 MG.

3.1.3.2 Pipelines and Pump Stations

MNWD operates and maintains approximately 655 miles of potable water distribution pipelines and 141 miles of recycled mainline. MNWD owns capacity rights in Joint Transmission Main (a joint powers agreement between MNWD and other water agencies); Eastern Transmission Main jointly owned by MNWD and the City of San Juan Capistrano; and the SCP, which conveys water from the AMP to several south county water agencies. MNWD also operates 25 potable pump stations and 12 recycled water pump stations to pump water from lower pressure zones to the higher-pressure zones and 13 potable water pressure reducing stations and flow control facilities to convey water from high to low zones; along with 13 recycled water pressure reducing stations.

3.2 Water System and Supply Reliability

As discussed in Chapter 1, imported water supplies are susceptible to system and supply reliability disruptions. System reliability disruptions for MNWD are caused by outages of the Diemer WTP and treated imported water pipelines resulting from seismic events and unplanned facility failures. Supply reliability disruptions are caused by droughts, environmental regulations resulting in restrictions in water exports from the Delta, seismic risks to levees in the Delta that protect it from seawater intrusion, and drought restrictions from Lake Mead on the CRA. Both supply and system reliability disruptions impact MNWD's ability to serve its water customers. **Figure 3-2** depicts the potential supply and system disruptions to the MNWD service area.

The following reliability threats are anticipated to result in the most severe impacts to MNWD's supply conditions:

• Severe Droughts

• Climate variability with increased temperatures

• Earthquakes

• Water quality disruptions

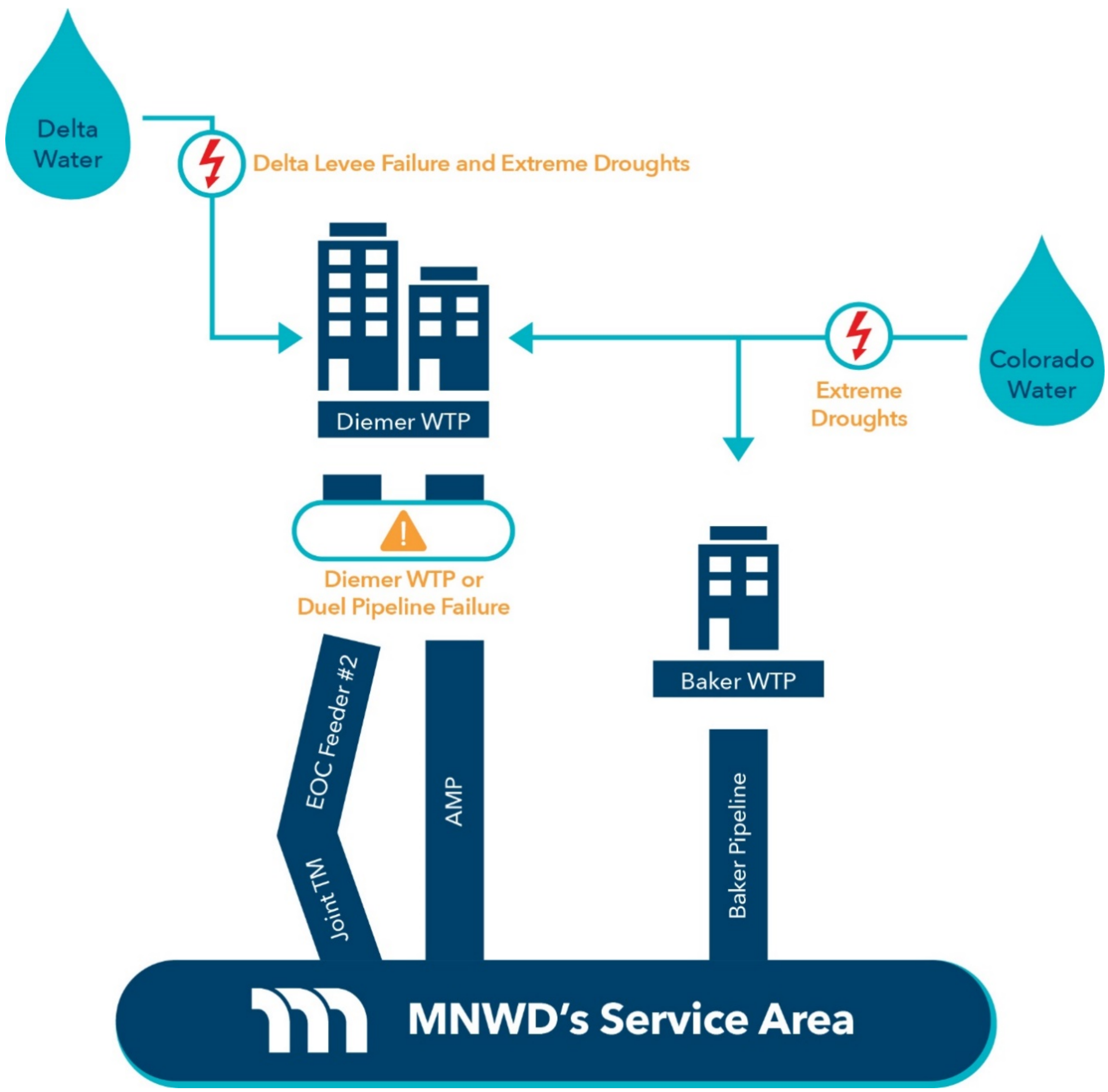


Figure 3-2. Water Delivery Supply and System Risks Representation

3.2.1 System Reliability

For MNWD, the primary system reliability risks are seismic events. 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. The risk of earthquake damage to infrastructure from these active faults is manifested through different seismic hazards, including seismically induced ground shaking, seismically induced ground failure, and surface fault displacement.

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 earthquake faults within California (MWD, 2018). Southern San Andreas Fault was identified as having the highest likelihood (19 percent) of a magnitude 6.7 earthquake or greater in the next 30 years (MWD, 2018). UCERF3 further states that the there is a 93 percent chance of a magnitude 6.7 or greater earthquake occurring on one of the faults within Southern California within the next 30 years, and a 36 percent chance of a magnitude 7.5 or greater earthquake occurring within the next 30 years (MWD, 2018). Earthquakes that have occurred within or near Southern California since 1900 include five strong earthquake events (magnitude 6.0 – 6.9) and three major earthquake events (magnitude 7.0 - 7.9) (MWD, 2020). In 2019, two significant earthquakes events occurred in the region. On July 4, 2019, a magnitude 6.4 earthquake occurred near Ridgecrest, approximately 122 miles north/northeast of Los Angeles. Then on July 5th, a magnitude 7.1 earthquake occurred in the same vicinity (MWD, 2020). While these earthquakes did not cause damage to the MWD service area, these earthquakes are a reminder that earthquake risk is always present, and that the region must take steps to prepare and respond.

Several major earthquake fault lines intersect with the Diemer WTP and treated imported pipelines that convey water to MNWD. Diemer WTP can be impacted by a seismic event from the Whittier Fault, while the EOCF2 and AMP can both be impacted during seismic events from the Puente Hills Fault and the Peralta Hills Fault (MNWD, 2015). The San Joaquin Hills fault can also impact the EOCF2, but treated water can still be delivered through the AMP to supply water to MNWD (MNWD, 2015). In general, pipelines are more resilient and flexible than water treatment plants, so they can tolerate higher ground accelerations (MNWD, 2015). The Baker WTP is located further away from the active fault lines and is less susceptible to earthquake damage compared to Diemer WTP. The Baker WTP was constructed to provide backup capacity in the event of a Diemer WTP outage. **Figure 3-3** shows the probability of an earthquake delivering both a 0.6g ground acceleration (for Diemer WTP outage) and 0.7g ground acceleration (for dual pipeline failure) for the next 25 to 75 years (MNWD, 2015). These values are anticipated to represent professional engineering judgement and understanding of the size of an event that would result in significant interruption to the facility.

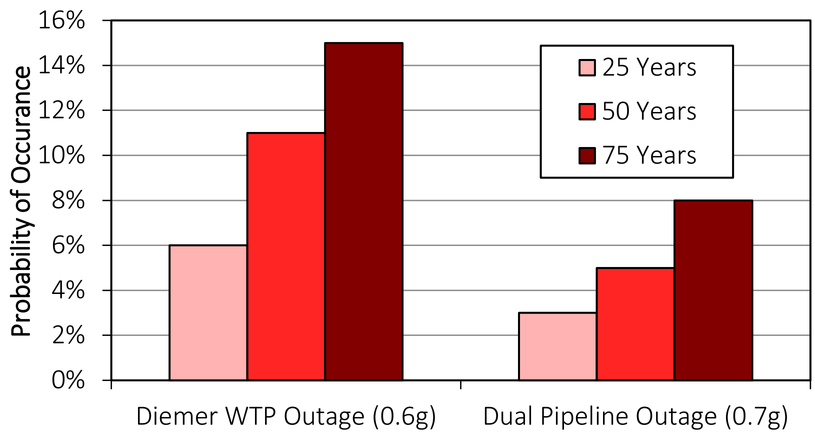


Figure 3-3. Probability of Earthquake Delivering Catastrophic Outage to Key Imported Water Facilities

As detailed in the MWDOC 2018 study, MWD does not have specific recommendations for member agencies regarding planning for the durations of facility outages due to earthquakes or other events, other than MWD requires its agencies to be able to accommodate a planned 7-day outage during periods of annual average demands (MWDOC, 2019). MWD can request longer duration planned shutdowns but must provide a 1-year notice to its agencies of such an outage (MWDOC, 2019). MWD assumes a 25 percent demand curtailment during the shortage event and previously expected all local regional import facilities to be up and operating within 6 months (MWDOC, 2019). MWD and MWDOC worked together several years ago to determine the likely "time to restore" regional import or treatment facilities to partial operations based on the location of earthquake faults in Orange County and the potential maximum considered earthquakes. This information is summarized in **Table 3-1**. Based on these conditions, MWDOC developed the recommendation that its agencies should plan for a 100 percent interruption of MWD supplies for up to 60 days with a concurrent power grid outage for a minimum of 7 days (MWDOC, 2019). MWDOC suggests that retail agencies may be on their own for up to 2 months following a major earthquake that damages MWD facilities (MWDOC, 2019). Following an event, repair work will be prioritized in the MWD system to enable the largest number of people to be served. Table 3-1 provides a summary of the outage durations currently considered by MWD (MWDOC, 2019).

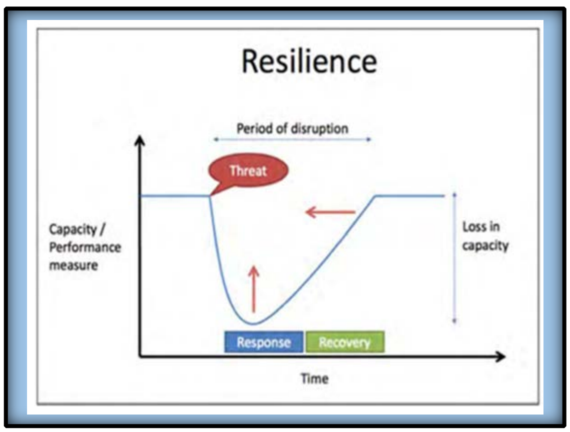
Table 3-1. MWD Seismic Performance Expectations During Maximum Considered Earthquake

MWD Facility	Estimated Outage Durations
MWD – Colorado River Aqueduct	2-6 months
DWR – State Water Project East and West Branches	6-24+ months
MWD – Conveyance and Distribution Pipelines	1 week - 3 months
MWD Treatment Plants	1-2 months (partial flow) Up to 6 months (full capacity)

Source: MWDOC, 2019.

3.2.1.1 MWD Seismic Resilience

MWD owns and operates a complex conveyance, treatment, and distribution system that serves a 5,200-square-mile service area within an active seismic region. Seismic resilience is an essential aspect of MWD's overall reliability strategy. MWD has been proactive in mitigating seismic risks to its infrastructure, as well as improving its ability to maintain (or quickly restore) water deliveries following a major earthquake. In February 2018, MWD published Report No. 1551, Seismic Resilience First Biennial Report, which defined MWD's Seismic Resilience Strategy and identified several near-term goals to improve MWD's seismic resilience. Subsequently, the 2020 Seismic Resilience Report Update was prepared as a supplement to the Seismic Resilience First Biennial Report and includes new performance objectives and goals to further increase the seismic resilience of MWD's system (MWD, 2020).



MWD defines "seismic resilience" as the ability to maintain (or quickly restore) water deliveries following a seismic event. Rather than striving to make an entire water system "earthquake-proof," seismic resilience involves setting reasonable performance goals that provide enough benefits that justify the corresponding investments required by both an agency and its ratepayers (MWD, 2018). MWD developed a Seismic Resilience Strategy to prepare for and respond to seismic events to minimize regional water delivery interruptions and restore interrupted regional deliveries quickly after an earthquake (MWD, 2018). Coordination within MWD 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. As a result, significant improvements have been made in the overall seismic resilience of MWD's water system in several key areas (MWD, 2018):

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.

MWD'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. A significant part of imported water supply reliability is preparing for recovery periods following seismic events. MWD'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. (MWD, 2018).

Through its IRP, MWD 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 MWD'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 Los Angeles Aqueduct (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, MWD'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. (MWD, 2018).

MWD's 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, MWD has based its planning on a 100 percent reduction in these imported supplies for a period of six months (MWD, 2018). Beginning in February 2018, MWD and its member agencies convened a workgroup to evaluate regional storage, including the size and management of MWD's emergency storage program (MWD, 2020). 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 (MWD, 2020).

Since the publication of the 2018 Seismic Resilience First Biennial Report, MWD has initiated multiple studies that will improve planning for earthquake response. Completed studies include an evaluation of MWD's emergency storage requirements and an evaluation of the susceptibility of the conveyance and distribution pipelines to liquefaction. MWD is also nearing completion of an assessment of the potential damage to the conveyance and distribution pipelines from different earthquake events. MWD 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. 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 structures are not generally 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 (MWD, 2020). MWD conducted over 100 emergency response exercises, workshops, and seminars since February 2018, including two large functional exercises. These exercises help to ensure that MWD staff is prepared for when an eventual earthquake occurs. MWD also started a new five-year exercise plan in 2019 that will allow all its member agencies to participate in at least one of MWD's annual emergency exercises during the next five years. (MWD, 2020).

3.2.1.2 MWDOC System Reliability Assessment

The MWDOC 2018 study analyzed several water demand scenarios with the SOC agencies to estimate the additional system reliability needs that would be required to ensure an adequate supply of water was available during an outage of MWD treated water deliveries (MWDOC, 2019). The scenarios evaluated by MWDOC included a 25 percent demand curtailment during an extended emergency event. The MWDOC 2018 study analyzed two methods of estimating water demand needed for public health and safety and to protect businesses were developed. The two methods included a 75 percent of annual average demand for fiscal year 2017-18 (similar to a winter low demand with little irrigation use); and a

2040 indoor residential usage at 55 GPCD and 2040 Commercial, Industrial, Institutional (CII) (business) demands estimated for the MWDOC 2018 study (MWDOC, 2019). The range of additional system recovery needs identified for MNWD are shown for the two water demand methods in **Table 3-2**. The recovery needs also assume:

- Water in emergency storage reservoirs is utilized for at least 60 days.
- Locally produced groundwater and use of emergency storage water can be moved throughout SOC agencies' distribution system.
- Untreated MWD water, and potentially water from Irvine Lake, will be treated to the maximum capacity at the Baker WTP.
- Water from the IRWD SOC Interconnection is not available (MWDOC, 2019).

Table 3-2. MWDOC Summary of Emergency Reliability Needs for MNWD[1]

	75% Normalized Potable (AF)	Recovery Needs (AF)	Recovery Needs (CFS)	2040 Indoor Demands at 55 GPCD (AF)	Recovery Needs (AF)	Recovery Needs (CFS)
MNWD	11,518	4,708	10.5	13,361	6,794	15.1

[1]Assumes no emergency capacity from the SOC Interconnection
"Recovery needs" assumes use of wells, Baker Treatment Capacity, other local production and use of tank and reservoir storage over 60 days.
"Recovery needs" assumes no emergency capacity is available from IRWD; this option is still under investigation.
Source: MWDOC, 2019

The MWDOC 2018 study concluded that MNWD may need between 10.5-15.1 CFS (7,607-10,939 AFY) of additional system reliability capacity assuming no emergency capacity from the existing IRWD SOC Interconnection and a 25 percent demand curtailment (MWDOC, 2019). The MWDOC 2018 study concluded securing additional emergency capacity of 10.5-15.1 CFS (7,607-10,939 AFY) would result in MNWD being able to withstand an MWD outage of treated water deliveries for up to 60 days (MWDOC, 2019). As identified in Table 3-1, this is the assumed outage time required to get MWD's Diemer WTP back to partial flow capacity if it were affected by a significant seismic event (MWDOC, 2019). These system reliability improvements would also enable MNWD to withstand lessor outages of either of the two major pipelines, the EOCF2 or the AMP (MWDOC, 2019).

3.2.1.3 MNWD System Reliability Assessment

For this 2020 LRWRP Update, it was assumed that facility shutdowns at the Diemer WTP could significantly reduce treated water supplies for up to 60 days. It was assumed that failure of any of the treated imported water pipelines would last 7 to 15 days. If treated imported water to MNWD was disrupted due to dual pipeline failure (7 days) or Diemer WTP failure (up to 60 days), MNWD would need to use its emergency supplies to deliver water to its customers. MNWD's 2008 Water Reliability Policy has a goal of up to 31-days of annual average supplies available in our system. The current policy's goal of 31-days may be insufficient to meet demands during a 60-day outage. During emergency situations, such as an earthquake that reduces water supply, demand curtailment may be necessary. During major system outages it is expected that nonessential water uses (e.g., outdoor landscape irrigation) would be minimized or eliminated for the duration of the outage to ensure enough water is available for public health and safety.

MNWD analyzed a similar scenario of system reliability needs with slightly different assumptions than the MWDOC 2018 study. **Figure 3-4** shows the number of days of supply in the MNWD system for its emergency supply sources under an outage of treated imported water based on annual average demands of 2019. As shown in Figure 3-4, MNWD meets the 2008 Water Reliability Policy goal of a 31-day annual average supply. This assessment also shows that supply reliability varies throughout the year based on the changes in seasonal demands. Figure 3-4 further shows that in the winter months there is nearly 55 days of supply available given demands are less for outdoor water use. However, in the summer months when demands for outdoor water use are higher, there is approximately 23 days of supply. Based on this assessment, MNWD would need to obtain additional emergency supplies to provide up to 60 days of demands in the event of a facility outage. This assessment also assumes that the IRWD SOC Interconnection is available for use. However, per the current agreement, no supply is available during the summer months and this agreement ends in 2031. In the event the SOC Interconnection emergency supply is not available during the summer when an emergency occurs, MNWD may have approximately 15 days of supply available during summer months. As such, MNWD would be unable to meet full demands with these summer outage conditions.

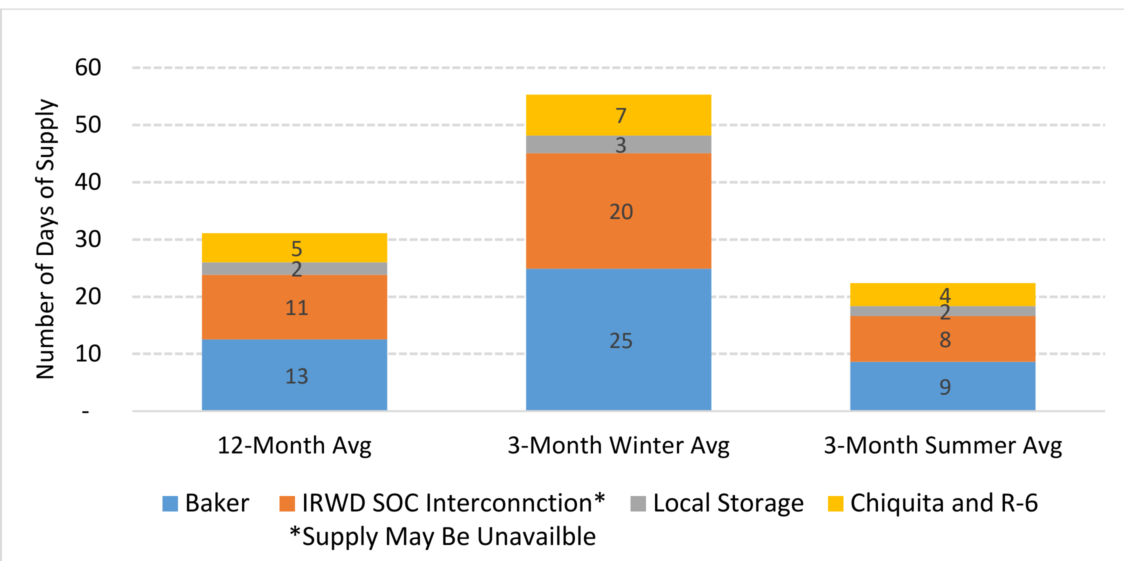


Figure 3-4. Comparison of Annual and Seasonal System Reliability

It is assumed that during a catastrophic outage of imported water, MNWD would impose emergency water restrictions asking customers to curtail all outdoor water use and conservatively assuming that customers response would be approximately 20 percent. MNWD would make efforts to reduce all outdoor water use should an emergency outage be anticipated to last up to 60 days or longer. Should all outdoor water use be curtailed, this would represent closer to a 50 percent in demand curtailment. However, for conservative planning purposes, it is anticipated that customer response would be approximately 20 percent in demand curtailment. **Figure 3-5** shows the number of days of supply in the MNWD system for its emergency supply sources under an outage of imported water with a 20 percent demand curtailment and assuming the IRWD SOC Interconnection is available to provide supply.

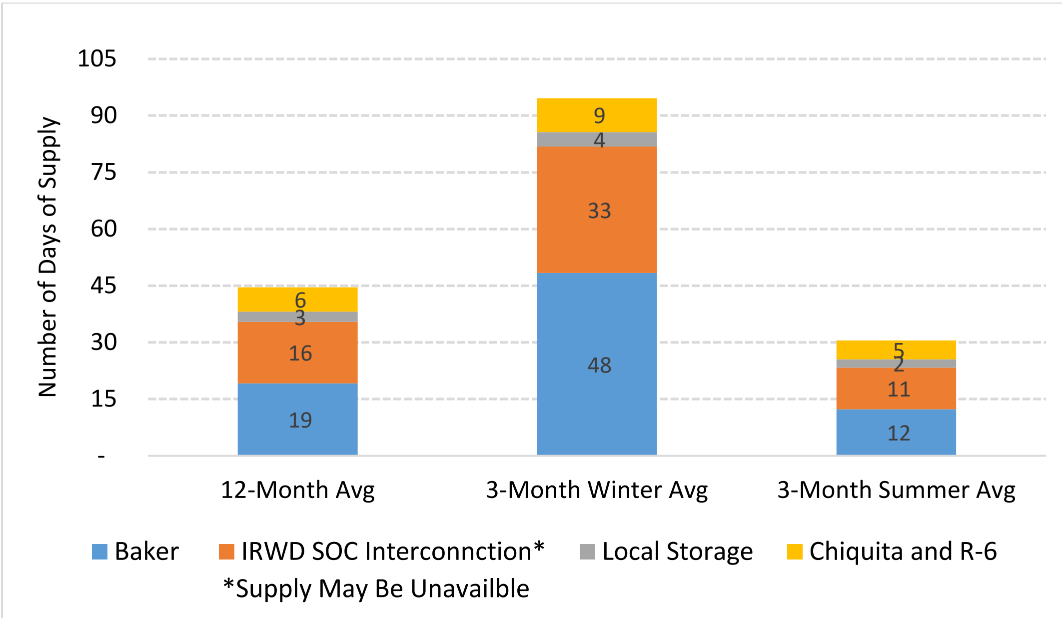


Figure 3-5. Comparison of Annual and Seasonal System Reliability with 20 Percent Demand Curtailment

As shown in Figure 3-5, emergency restrictions of 20 percent demands would provide up to 44 days of average annual supply. Figure 3-5 also shows in the winter months there is over 90 days of supply and 30 days of supply in the summer months with a 20 percent demand curtailment. This assessment assumes the IRWD SOC Interconnection (11 CFS) and the Baker WTP (13 CFS) would be available during these outages. However, there is no guarantee the IRWD SOC Interconnection (11 CFS) would be available or only a portion thereof could be available. Should the IRWD SOC Interconnection be completely unavailable, MNWD would have fewer supplies during an outage. This magnitude of water shortage would significantly impact MNWD's customers, as it was assumed that they would already be conserving 20 percent of their normal water demand.

Since up to 60 days of supply may be needed during an emergency outage, MNWD may need up to 16 days of additional supply to meet 60 days under an annual average of water supplies. 16 days of additional water supply would require an additional 10 CFS (7,245 AFY) of emergency water sources to be added to the MNWD system during an outage. Therefore, total MNWD shortages during an emergency outage could range from 0 CFS to 10 CFS depending on the time of year, duration of the emergency outage of imported water, and availability of the IRWD SOC Interconnection supplies. With no IRWD SOC Interconnection supplies available, shortages could then be as high as 21 CFS (15,213 AFY). The SOC Interconnection agreement is in place through 2031 but could be extended, as detailed further in Section 4. **Table 3-3** summarizes the system shortages for MNWD, assuming mandatory restrictions are in place—meaning the shortages in this table are net (or on top) of the 20 percent reduction in demands that are assumed to be achieved during these outage scenarios. To ensure water reliability for up to 60 days during an emergency outage, MNWD would need to add new emergency water supplies to the system. **Figure 3-6** shows emergency demand curtailment of 20 percent during annual average demands with a new supply of 10 CFS (7,245 AFY) being available. As shown, with 20 percent demand curtailment and a new supply of at least 10 CFS, MNWD would have up to 60 days of annual average supply to meet water supply demands during a potential facility outage. This is assuming that the IRWD SOC Interconnection remains available. An additional 5 CFS (3,622 AFY) is also recommended to be added to the system to provide supply flexibility in the event the IRWD SOC Interconnection is only partially available or potentially unavailable.

Table 3-3. Summary of Emergency Water Shortages for MNWD[1]

Shortage Type	30-Day Outage	60-Day Outage	MWDOC Assessment
System Shortage from Diemer WTP Outage	0 CFS[2]	0-15 CFS[3] (0-10,867 AFY)	10.5-15.1 CFS[4] (7,607-10,939 AFY)

[1] Shortages are net (or on top) of assumed mandatory demand restrictions of 20 percent utilizing annual average demands of 2019.
[2] Shortages are only anticipated in the event the IRWD SOC Interconnection is unavailable, which represents up to 11 CFS (7,969 AFY). If the SOC Interconnection is available, no shortages would occur.
[3] Shortages are anticipated up to 10 CFS (7,245 AFY) to meet a 60-day outage. An additional 11 CFS (7,969 AFY) shortage would occur if supplies were unavailable from the SOC Interconnection (for a total of up to 21 CFS [15,213 AFY).
[4] Assumes no capacity available from SOC Interconnection. Utilizes 75 percent of annual average demand for fiscal year 2017-2018.

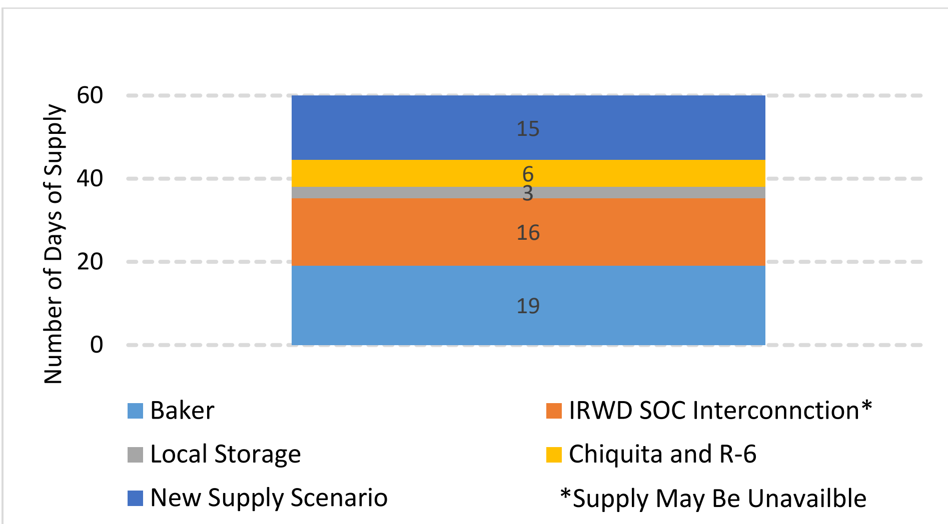


Figure 3-6. System Reliability with 20 Percent Demand Curtailment and New Supply

3.2.2 Supply Reliability

Water supply reliability is having an adequate amount of water supplies to meet water demands under different hydrologic environments, measured in terms of frequency (probability of occurrence), duration (length of occurrence), and magnitude (size) of water shortages (MWDOC, 2019). These water shortages can be caused by hydrologic droughts, limitations in supply availability due to regulatory constraints (e.g., Endangered Species Act) or Delta vulnerability from seismic events (MWDOC, 2019).

3.2.2.1 Climate Variability

Imported water is highly variable due to climate and hydrology. Precipitation is the primary source of California’s water supply. Most of the state’s precipitation occurs in only 5 to 15 days, and that rain and snowfall result in an annual supply that is ample in average years, too little in dry ones, and too much in wet years (Delta Stewardship Council, 2018). Potential climate change is forecasted to alter the historical hydrology of the Sierra Nevada Mountains (the main source of water that flows through the Delta and SWP) and Rocky Mountains (the main source of water for the Colorado River) (MWDOC, 2016). Increases in temperatures are estimated to significantly reduce mountain snowpack, which acts as storage for the region's imported water (MWDOC, 2016). Extended, intense droughts and more extreme floods are expected to occur more frequently in the future due to climate change (Delta Stewardship Council, 2018). Warmer temperatures throughout the state will cause higher evaporation rates, particularly during the hot summer and early fall months, contributing to reduced stream flows, drier soils, reduced groundwater infiltration, higher losses of water from surface reservoirs, increased urban and agricultural demand for irrigation water, and more water needed for ecosystem protection (Delta Stewardship Council, 2018).

Environmental regulation concerning endangered fish species can significantly restrict Delta water exports. The minimum seaward flows to be maintained in Delta channels are set by the State Water Resources Control Board, according to season and year type (wet, above normal, below normal, dry, or critical). These required flows help fish, prevent saltwater intrusion, and limit the amount of water that can be exported through the pumps (Delta Stewardship Council, 2018). The growing demands for water deliveries from the Delta and declining health of the Delta ecosystem have resulted in numerous complex and legal challenges that have increasingly shifted critical Delta water management decisions to the courts (Delta Stewardship Council, 2018). A fundamental conflict exists today between water operations for ecosystem management (temperature and flow), water quality (both in-Delta and for water exported from the Delta), and water supply reliability (Delta Stewardship Council, 2018). This conflict is magnified during critically dry periods and periods of lower flow when the ecosystem is under increased stress and water suppliers are most vulnerable to shortages (Delta Stewardship Council, 2018).

3.2.2.2 Delta Levee Failure

Delta levees face potential threats such as large runoff events, extreme high tides, wind-generated waves, earthquakes, subsidence, and sea level rise. Individually, each of these threats is enough to cause serious concern; together, they represent the potential for catastrophic disruption of the Delta and its economic and ecological services (Delta Stewardship Council, 2018). Delta flooding could interrupt the conveyance of water through the Delta for the SWP. Unplanned levee failure could also degrade water quality in the Delta because tidewaters would flood into the depressions created by subsidence of Delta islands. These failures would draw saltwater from San Francisco Bay and impair Delta water with flood debris, farm chemicals, and other pollutants (Delta Stewardship Council, 2018). The Delta’s levees are also threatened by the active seismic zones west of the Delta, including the San Andreas and Hayward faults (Delta Stewardship Council, 2018). Less active faults underlie the Delta. A strong earthquake could damage Delta levees because of the potential for deformation or cracking of levees or liquefaction of levee embankments and foundations during strong ground shaking (Delta Stewardship Council, 2018). The DWR Delta Risk Management Strategy Phase 1 study evaluated the performance of Delta levees under various seismic threat scenarios, and analyzed potential consequences for water supply, water quality, ecosystem values, and public health and safety. The study concluded that a major earthquake of magnitude 6.7 or greater in the vicinity of the Delta Region has a 62 percent probability of occurring sometime between 2003 and 2032 (Delta Stewardship Council, 2018). More recent investigations suggest earthquake-induced ground shaking affecting Delta levees may be less serious, but still of concern (Delta Stewardship Council, 2018).

3.2.2.3 MWDOC 2018 Orange County Water Reliability Study

As identified in Section 1, MWDOC prepared the MWDOC 2018 study to provide information on current and future water supply conditions in Orange County. The MWDOC 2018 study identified that SOC has a relatively low percentage of local water supplies and has a higher dependence on imported water facilities (i.e., most of the water imported into SOC comes from MWD's Diemer Water Filtration Plant and two pipelines). Thus, SOC is more vulnerable to both system outages of these facilities and droughts (due to few local supplies) (MWDOC, 2019).

The MWDOC 2018 study estimated water demands and supplies in Orange County which required an understanding and evaluation of MWD's regional water demands, supplies and delivery system. This understanding of MWD's opportunities and constraints includes MWD's goals for future water investments, including Local Resources Program funding for local water projects; and MWD's policies and operations regarding regional storage, banking and water transfer programs, and local groundwater replenishment. Evaluating water reliability for Orange County also required an understanding of what other MWD member agencies are planning in terms of future water projects (MWDOC, 2019). Southern California's water reliability falls under MWD's IRP and MWD's WSAP. The MWD IRP forecasts future regional water demands and local water supplies to determine future needs for regional water through the year 2050. Additionally, MWD's WSAP is used during droughts to help balance water demands with limited water supplies by allocating imported water to its member agencies. (MWDOC, 2019). In the event water supply conditions necessitate a potential supply gap, implementation of MWD's WSAP may be triggered. The actual decision regarding declaring a shortage by the MWD Board begins to be considered as SWP and CRA supplies become more limited and accumulated storage in reservoirs and groundwater basins decline (MWDOC, 2019). The MWD Board then evaluates its likely supplies and demands over the next year, along with a projected use of water being pulled from storage reserves (MWDOC, 2019). MWD then makes one of the following decisions:

- If the MWD Board sees the dry year storage reserves in their system dropping below about 1.5 MAF, they typically would initiate the early stages of their WSAP; which involves either calling upon water agencies and general public to voluntarily reduce water demand, or requesting its member agencies for a more formal reduction in water usage (on the order of 10 to 15 percent), depending on the next year's supply forecasts (MWDOC, 2019).

- If the hydrology in the shortage year turns out to be average to wet, MWD can terminate the WSAP request prior to the end of the fiscal year in which the request was made. Historically, when this has occurred, MWD has canceled the reconciliation of use of water over the amounts allocated (MWDOC, 2019).

- If the drought event is more severe and/or it rolls over to a second year, it is likely that the formal reductions under the WSAP would increase to between 20 to 40 percent depending on the actual conditions. The MWD service area has never experienced this second consecutive year of an allocation, although it has been on the verge several times, in 1990-91 and 2015-16, both times sufficient rains occurred to fill reservoirs and improve the water supply situation, allowing termination of the second year of the WSAP (MWDOC, 2019).

Should MWD's WSAP be triggered, MNWD would likely implement our Water Shortage Contingency Plan. The contingency plan uses a phased approach to ease customers into increased levels of water use efficiency based on the availability of water supplies. Each stage requires heightened levels of water conservation. MNWD's elected Board of Directors is responsible for evaluating the severity of supply shortages and, in the event of worsened or improved conditions, may vote to increase water use reductions to preserve water supplies for the health and safety of our community.

The MWDOC 2018 study examined a range of potential water supply gaps between future water demands and existing water supplies under a range of planning scenarios, and assessed potential new water supplies that could be developed by MWD, MWD member agencies, and Orange County water agencies (MWDOC, 2019). Four planning scenarios were developed for the MWDOC 2018 study. The scenarios included two dimensions: (1) two climate change scenarios, both coupled with the Drought Contingency Plan for CRA; and (2) two different levels of new MWD investments, low-cost and high cost. The high-cost MWD investments are intended to improve supply reliability in both climate change scenarios. To illustrate the full range of possible climate change impacts for planning analysis, one of the climate change scenarios only included minimal impacts to the SWP supplies, while the other climate scenario resulted in significant impacts to both MWD's SWP and CRA supplies. For both climate scenarios it was assumed that there would be additional MWD and member agency investments to improve supply reliability (MWDOC, 2019). The four planning scenarios are defined as:

- 1A – Minimal Climate Change with Low-Cost MWD investments (including the Delta Conveyance Project)
- 1B – Minimal Climate Change with High-Cost MWD Investments (additional to 1A)
- 2A – Significant Climate Change with Low-Cost MWD investments (including the Delta Conveyance Project)
- 2B – Significant Climate Change with High-Cost MWD investments (additional to 2A)

For the MWDOC 2018 study, supply reliability was estimated using a regional Water Evaluation and Planning (WEAP) model to provide an indication of the likelihood (probability) that regional water supply gaps would occur and the magnitude of those water supply gaps for each year they occur. Supply gaps are estimated when MWD cannot supply enough water from its SWP, CRA, storage and water transfer sources to meet its water demands (MWDOC, 2019). The model uses historical hydrology from 1922 to 2016 superimposed on future water demands. The model also simulates storage operations, with additions to storage occurring when MWD has excess SWP and CRA supplies and uses occurring when SWP and CRA supplies are not enough to meet demands. **Table 3-4** summarizes the supply reliability for MWD's entire service area for years 2020, 2030, 2040 and 2050 for the four scenarios. The MWDOC model estimated a very small potential for an MWD shortage in 2020. However, based on current 2020 conditions, no such shortages will occur in 2020. As such, the model estimates used in this 2020 LRWRP Update for MNWD were revised to represent zero supply gaps in 2020. Table 3-4 below however, includes the original data from the MWDOC 2018 study. This discrepancy with 2020 projections and actuals for 2020 demonstrates that while supply gaps may be projected to occur, they are based on worst case conditions that are not necessarily reflective of what will occur.

Table 3-4. MWD Supply Reliability for MWDOC 2018 Study Planning Scenarios

MWD Shortages	2020[1]	2030	2040	2050
Scenario 1A				
Probability of Any Shortage (%)	1%	6%	8%	11%
Maximum Shortage (AFY)	18,400	541,300	497,600	570,130
Average Shortage (AFY)	190	11,803	19,800	29,400
Scenario 1B				
Probability of Any Shortage (%)	1%	2%	0%	1%
Maximum Shortage (AFY)	18,400	373,500	0	88,130
Average Shortage (AFY)	190	4,000	0	920
Scenario 2A				
Probability of Any Shortage (%)	2%	27%	24%	35%
Maximum Shortage (AFY)	211,700	1,269,600	1,284,070	1,511,700
Average Shortage (AFY)	2,371	93,580	128,120	186,470
Scenario 2B				
Probability of Any Shortage (%)	2%	18%	8%	15%
Maximum Shortage (AFY)	211,700	1,101,900	527,700	853,130
Average Shortage (AFY)	2,371	56,620	16,300	53,600

[1]The model estimates used in this 2020 LRWRP Update were revised to represent zero supply gaps in 2020, consistent with current hydrologic conditions.
Note: Average MWD water demands start from 1.85 to 1.95 million acre-feet/year (MAF) in 2020 and increase to 2.13 to 2.23
MAF by 2050, depending on climate scenarios.
Source: MWDOC, 2019

The MWDOC 2018 study estimated the probability and size of potential MWD shortages, and then modeled estimates of water shortages to SOC. SOC water demands are forecasted to increase from 117,000 AFY in 2020 to 125,000 AFY in 2050. Allocating the MWD water shortages for the four planning scenarios to SOC results in projected water supply needs for SOC in 2030, 2040, and 2050, as summarized in **Table 3-5**.

Table 3-5. Summary of Maximum Water Supply Needs for South Orange County (AFY)

MWD Shortages	2030	2040	2050	Max Supply Need Over Entire Period	Assumed 10% Demand Curtailment	Remaining Supply Need
Scenario 1A	27,000	24,000	28,000	28,000	12,000	16,000
Scenario 1B	22,000	0	5,000	22,000	12,000	10,000
Scenario 2A	57,000	53,000	53,000	57,000	12,000	45,000
Scenario 2B	56,000	26,000	37,000	56,000	12,000	44,000
Range of Four Scenarios after Demand Curtailment: 10,000 to 45,000 AFY						
Source: MWDOC, 2019						

3.2.2.4 MNWD Supply Reliability Assessment

To estimate the reliability of imported water delivered to MNWD, the frequency and magnitude of regional water supply gap (expressed as percentages) from MWDOC's 2018 study was applied directly to MNWD—meaning if there is a 20 percent regional water supply gap for a given hydrologic year, then for that same hydrologic year there would be a 20 percent supply gap for MNWD. While MWD does not necessarily allocate water to its member and sub-member agencies in this manner, this simplified assumption was considered to be fairly representative given MWD's overall drought management allocation goal of "retail-level" reliability and the fact that all of MNWD's potable water is provided by MWD. **Table 3-6** summarizes the maximum potential percentage of supply gaps identified for MNWD under the MWDOC planning scenarios with updated 2020 conditions. **Table 3-7** identifies the amount of water that supply gap represents. The potential supply gaps for years 2025, 2035, and 2045 were extrapolated from the MWD supply gaps and SOC supply gaps identified in the MWDOC 2018 study (Tables 3-4 and 3-5). These supply gaps assume no demand curtailment and represent the maximum shortage condition. Supply gaps could be much smaller depending on hydrologic conditions, demand management, storage reserves, and local projects being implemented. These scenarios represent worst case conditions for supply gaps and as seen for 2020 conditions, could result in no shortages compared to the projections.

Table 3-6. Percentage of Maximum Water Supply Gaps for MNWD[1]

Supply Gaps[1]	2020	2025	2030	2035	2040	2045	2050
Scenario 1A	0%	14%	21%	20%	19%	21%	22%
Scenario 1B	0%	10%	17%	9%	0%	2%	4%
Scenario 2A	0%	33%	45%	43%	42%	42%	42%
Scenario 2B	0%	29%	44%	32%	21%	25%	30%

[1]Extrapolated results based on MWDOC 2018 study results from Tables 3-4 and 3-5.
Source: MNWD, 2019

Table 3-7. Summary of Maximum Water Supply Gaps (AFY) for MNWD*[1]*

Supply Gaps[1]	2020	2025	2030	2035	2040	2045	2050
Scenario 1A	0	3,431	5,142	4,891	4,641	5,044	5,446
Scenario 1B	0	2,367	4,190	2,095	0	486	973
Scenario 2A	0	8,047	10,855	10,552	10,249	10,279	10,309
Scenario 2B	0	6,984	10,664	7,846	5,028	6,112	7,197

[1]Based on MWDOC 2018 study results from Tables 3-4 and 3-5.
Source: MNWD, 2019

Based on this analysis of imported water reliability, for 2030, the range of probability of a water supply gap is between 2-27 percent depending on the implementation of MWD reliability measures and the impact of climate variability. This results in a potential water supply gap of 4,190 AFY up to 10,855 AFY, representing between 17-45 percent of imported supplies. For 2040, the range of probability of a water supply gap is between 0-24 percent, resulting in a potential water supply gap of up to 10,249 AFY, representing between 0-42 percent of imported supplies. For 2050, the range of probability of a water supply gap is between 1-35 percent, resulting in a potential water shortage of 973 AFY up to 10,309 AFY, representing between 4-42 percent of imported supplies. These supply gap ranges would be decreased with varying levels of demand curtailment, if implemented, and based on fluctuating levels of MNWD demands for imported water.

It is important to state that while Tables 3-4 through 3-7 identifies potential MWD supply gaps into 2050, MWD has always been able to provide the imported water needed to MNWD. In that sense, MWD has been a reliable source of imported water to serve MNWD's customers. It is expected that MWD would be able to continue to provide a reliable source of imported water to MNWD consistent with the MWD WSAP. As such, the supply gaps identified for MNWD in Table 3-7 do not necessarily represent lack of supply but rather the amount of supply that would be substantially more costly to purchase consistent with the MWD's WSAP penalty fees. Refer to Section 1.4.4., MWD WSAP for additional discussion regarding allocation surcharges. And given the drought conditions experienced in 2015-2016 that are anticipated to be more commonplace in the future, these potential supply gaps represent a risk to MNWD's future water supply costs that may be better balanced with more cost-effective local supplies that would also increase water reliability. Section 4, Future Water Supply, explores how adding a new source of water supply may increase water reliability across these supply scenarios.

3.2.2.5 MWD Demand Shifts

MWD's 2019 water transactions (sales, exchanges, and wheeling) were the lowest in nearly 40 years. Population growth and water demands (in large part due to tremendous strides in efficiency) are far less than once predicted by MWD. Given MWD's record high storage levels and the prospect of major new investments in large-scale local supply projects, demands will likely remain low for at least the near term. (MWD, 2019a). If fewer demands are placed on MWD than currently projected, this could result in fewer supply gaps than what has been identified for the region through 2050. And if future local water supply projects in the region are fully implemented as currently planned, demand for imported water in an average year would be less than 1.2 MAF in 2040, which is less than 60 percent of what MWD projected in the 2015 IRP (MWD, 2019b). The average MWD water demands identified in Table 3-4 range from 1.85 to 1.95 MAF in 2020 and increase to 2.13 to 2.23 MAF by 2050, depending on climate scenarios. However, MWD identified that based on recent demands and implementation of local supply projects, demands could range from 1.67 MAF in 2020 to 1.2 MAF in 2040 (MWD, 2019b). Assuming the decrease in water demands could be directly applied to the average and maximum supply gaps identified for each scenario, the maximum supply gap could be substantially lessened for each of the scenarios. This is not intended to represent actual supply conditions based on these revised demands but rather represent how the decrease in demands could substantially influence supply reliability. As shown in **Table 3-8**, the maximum supply gap identified for Scenarios 1A, 1B, and most years of 2B could be eliminated. The maximum supply gap identified for Scenario 2A would also be reduced. The current maximum shortage under Scenario 2A could be as great as 63 percent of demands in 2040 and 68 percent of demands in 2050. With demands as low as 1.2 MAF and 1.25 MAF, respectively, supply gaps under Scenario 2A would be reduced to approximately 36 percent in 2040 and 45 percent in 2050. Table 3-8 represents how much demand fluctuation has the potential to impact supply reliability. With decreasing demand trends continuing, supply reliability is greatly increased through 2050. This is an important consideration to balance when evaluating future supply needs and the costs of bringing new local supply projects online. While there is no certainty in future outcomes for water supply, it is a plausible scenario that should be weighed against risks to avoid over building expensive new sources of water supply.

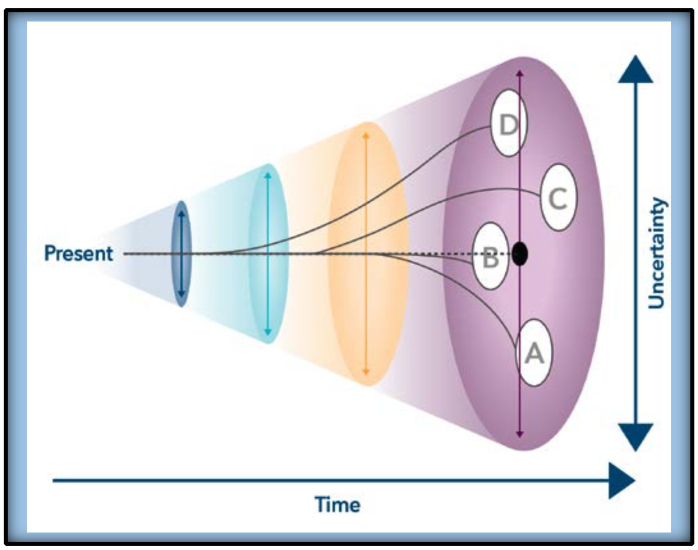
Table 3-8. Potential Reduction of Water Shortages under Decreased MWD Demands

MWD Theoretical Shortages	2020	2030	2040	2050
Scenario 1A				
Maximum Shortage (AFY)	0	0	0	0
Average Shortage (AFY)	0	0	0	0
Scenario 1B				
Maximum Shortage (AFY)	0	0	0	0
Average Shortage (AFY)	0	0	0	0
Scenario 2A				
Maximum Shortage (AFY)	0	610,600	436,070	531,700
Average Shortage (AFY)	0	0	0	0
Scenario 2B				
Maximum Shortage (AFY)	0	442,900	0	0
Average Shortage (AFY)	0	0	0	0

4.0 Future Water Supply

As described in Section 3, the assessment of system and supply reliability indicates that without future investments by MNWD, water supply gaps could occur during emergency events or droughts. However, both emergency events and droughts are unpredictable, and the extent of the water needs during these times would vary depending on the situation and customer response. With earlier snowmelt and greater volatility in precipitation, supply gaps could happen more frequently and with greater magnitude. There are also other risks and uncertainties that may affect future supplies and demands. Some of these risks and uncertainties can include regulatory and operational changes, technological changes, permitting constraints, public acceptance, opportunities for grant funding, project construction and implementation issues, and infrastructure reliability and maintenance. While this is not a complete list of risks and uncertainties, they could occur individually or collectively and result in a negative impact to water reliability. Some of these uncertainties will be resolved in the coming years, such as regulations for direct potable reuse, while others, such as implementation of the Delta Conveyance Project and weather pattern variation effects may take longer to impact water supply. To increase water supply and system reliability, additional supplies of water would be required either locally by MNWD or regionally by MWD or other agencies. New water resource projects can provide both supply and system reliability improvements. While it is impossible to know how much risk and uncertainty to guard against, MNWD's reliability will be more secure with a long-term plan that recognizes risk and provides resource development to offset that risk.

4.1 Scenario Planning: Planning for Multiple Futures



To analyze future water reliability for MNWD, projections of water supply and demand are necessary. These projections must be sufficiently broad to capture the plausible ranges of uncertainty in future water supply and water demand to ensure that water reliability is adequately analyzed. This 2020 LRWRP Update is forecasting 30 years into the future, which lends to a level of uncertainty forecasting water demands and supplies that far out. To address this uncertainty, this 2020 LRWRP Update identified several water supply and demand planning scenarios. The use of planning scenarios assumes that the future is unknown and provides flexibility in responding to various future conditions. The approach embraces uncertainties in future climate conditions, social conditions, and supply-demand conditions. Scenarios are alternative views of how the future might unfold. Scenarios are not predictions or forecasts of the future. Rather, a set of well-constructed scenarios represents a range of plausible futures that assists in the assessment of future risks and the development of adaptation measures and strategies that are needed across multiple scenarios. This LRWRP is not meant to be a 100 percent certain but is made with best available information known at the time.

Four planning scenarios were developed for the 2020 LRWRP Update. Three scenarios are based on varying levels of imported potable water demands affected by water use efficiency, evapotranspiration, and customer behavior in response to budget-based rates. The fourth scenario is based on varying levels of imported water supplies affected by decreasing regional demands. The first scenario (Upper Bound Demands) is considered the upper bound demand projection and is based on the methodology used in the 2015 UWMP demand projections that were extended into 2050. This scenario is considered the upper bound of demand projections because MNWD's actual water usage was below the 2015 UWMP projected water use for 2015-2019. The second scenario (Status Quo Demands) is a continuation of existing MNWD demand levels into 2050. This scenario assumes that demand levels that have decreased since the last drought would not rebound to levels that occurred prior to the drought. The third scenario (Median Demands) is a median water use demand that is the mid-point of the Status Quo Demand scenario and the Upper Bound Demand scenario. The fourth scenario (MWD Demand Shift) represents an alternative evaluation of supply levels assuming there is an overall decrease in regional water demands on MWD. This is considered a plausible scenario given MWD's water use has been lower than what was projected in their 2015 IRP, as discussed in Section 3. These four scenarios represent different views of what the future imported water supply and demand situations could look like. Each planning scenario is then evaluated against different water supply portfolios to determine the reliability in meeting projected demands in MNWD's service area. These scenarios are described in more detail below.

4.1.1 Scenario 1: Upper Bound Demands

Scenario 1, Upper Bound Demands, utilizes the methodology approach to projections from the 2015 UWMP and extended into 2050. This demand projection was previously the mean of demand projections from the upper bound demand projections and the active demand management demand projections used in the 2015 UWMP. The actual water usage from 2015-2019 was below the 2015 UWMP projected water demands. As such, this demand projection is now considered the upper bound of anticipated demands through 2050. The Upper Bound Demand scenario was compared against the MWDOC forecasted imported water supplies under the four scenarios identified in Section 3. The Upper Bound Demand scenario could potentially result in the maximum imported water supply gaps shown in **Figure 4-1** through 2050.

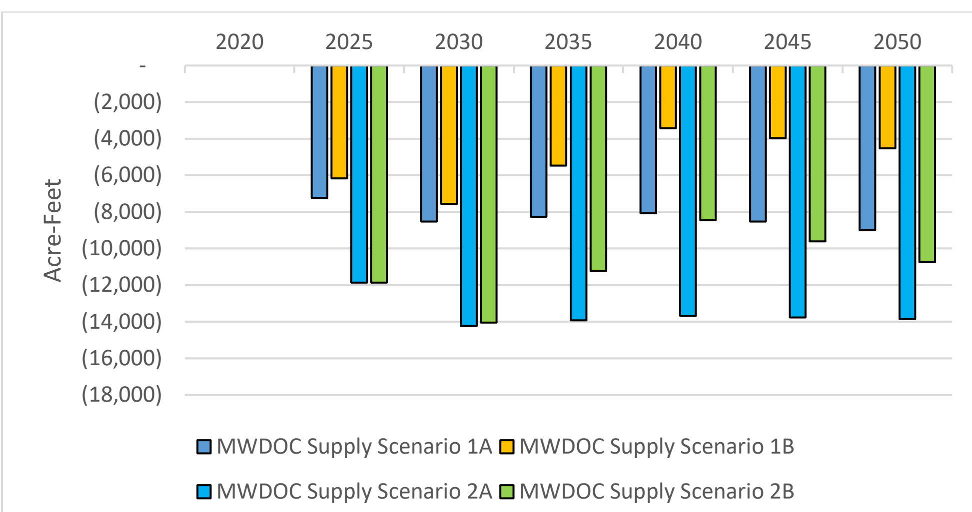


Figure 4-1. Upper Bound Demand Scenario Potential Supply Gaps

4.1.2 Scenario 2: Status Quo Demands

Scenario 2, Status Quo, is based on recent water use efficiency trends continuing their trajectories into 2050. In this scenario, water use efficiency efforts continue to be implemented by MNWD customers resulting in a slightly lower use of GPCD (starting with 55 GPCD in 2020 and decreasing to 45 GPCD in 2050). The Status Quo scenario builds on recent water use trends following the increased efficiencies achieved because of customers drought response actions. The Status Quo scenario is considered to result in lower water usage due to implementation of conservation practices into 2050. Scenario 2 is also consistent with Make Conservation a Way of Life (Executive Order B-37-16). SB 606 and AB 1668 emphasize efficiency and stretching existing water supplies. Efficient water use is the most cost-effective way to achieve long term conservation goals, as well as provide the imported water supply reliability needed to adapt to the longer and more intense droughts climate variability is causing in California. The Status Quo scenario demands were compared against the MWDOC forecasted imported supplies under the four MWDOC supply scenarios identified in Section 3. The Status Quo scenario could potentially result in the maximum water supply gaps shown in **Figure 4-2** through 2050.

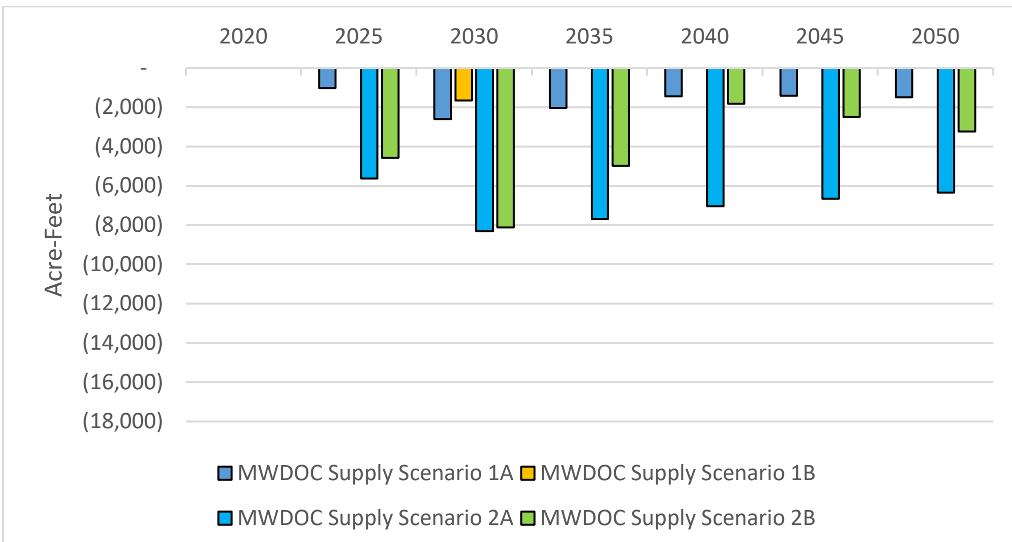


Figure 4-2. Status Quo Demand Scenario Potential Supply Gaps

4.1.3 Scenario 3: Median Demands

Scenario 3, Median Demands, is based on a median demand projection between Scenarios 1 and 2. The Median Demands are considered a plausible scenario because demands would potentially increase from the Status Quo scenario in the event of multiple dry years or changing customer behaviors. Dry years would likely result in increasing temperatures that would have a corresponding increase in outdoor water use for landscaping. The Median Demands were compared against the MWDOC forecasted imported supplies under the four MWDOC supply scenarios identified in Section 3. The Median Demands scenario would potentially result in the maximum water supply gaps shown in **Figure 4-3** through 2050.

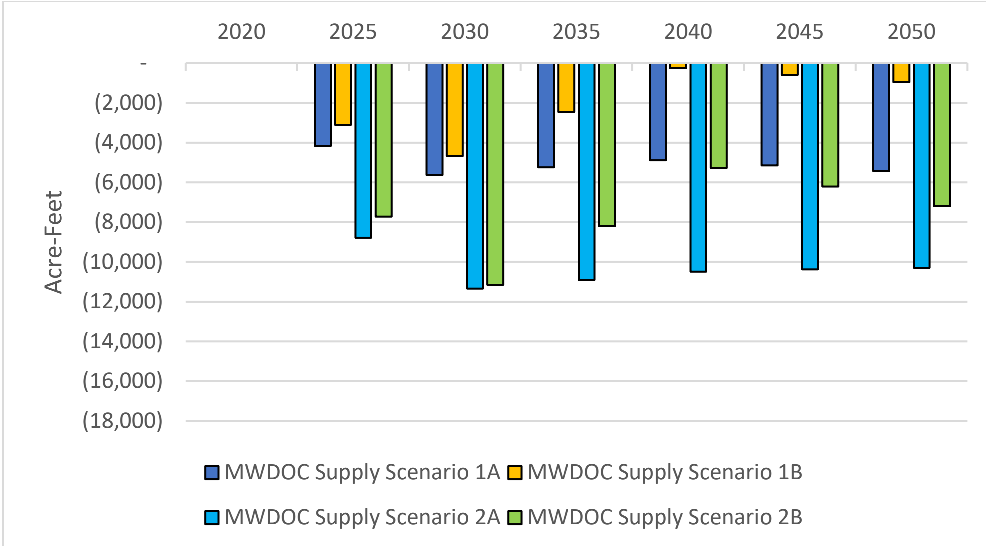


Figure 4-3. Median Demand Scenario Potential Supply Gaps

4.1.4 Scenario 4: MWD Demand Shift

Scenario 4, MWD Demand Shift, is a hypothetical view of how MWD supplies could be affected by fewer potable demands from the region. MWD's 2019 Board of Directors retreat identify that even as the population of Southern California has grown over the past several decades, demand for imported water has remained flat or declined (MWD, 2019b). Southern California has increased water use efficiency, anticipates significant new investments in local water supply projects, and estimates slowing population growth in the region. As a result, by 2040, if future local water supply projects in the region are fully implemented, demand for imported water in an average year would be less than 1.2 million acre feet per year—less than 60 percent of what MWD projected in the 2015 IRP (MWD, 2019b). In this scenario, demands on MWD could range from 1.67 MAF in 2020 to 1.2 MAF in 2040 (MWD, 2019b). For this 2020 LRWRP Update, it was assumed demands could increase to 1.5 MAF in 2050. To estimate the potential impact to supplies available to MWD, the decrease in water demands was directly applied to the average and maximum supply gaps identified by MWDOC for each of the water supply planning scenarios for the region and then extrapolated out to MNWD's potential share of the supply gap. This is not intended to reflect what actual supplies would be available in the event demands do continue to regionally decrease but rather a high-level view of how supplies could be impacted by decreased demands, thus resulting in potentially fewer supply gaps for the region. The MWD Demand Shift scenario would potentially result in the water supply gaps shown in **Figure 4-4** through 2050. As shown, this scenario could potentially eliminate supply gaps under Scenarios 1A and 1B, as well as 2B beginning in 2040.

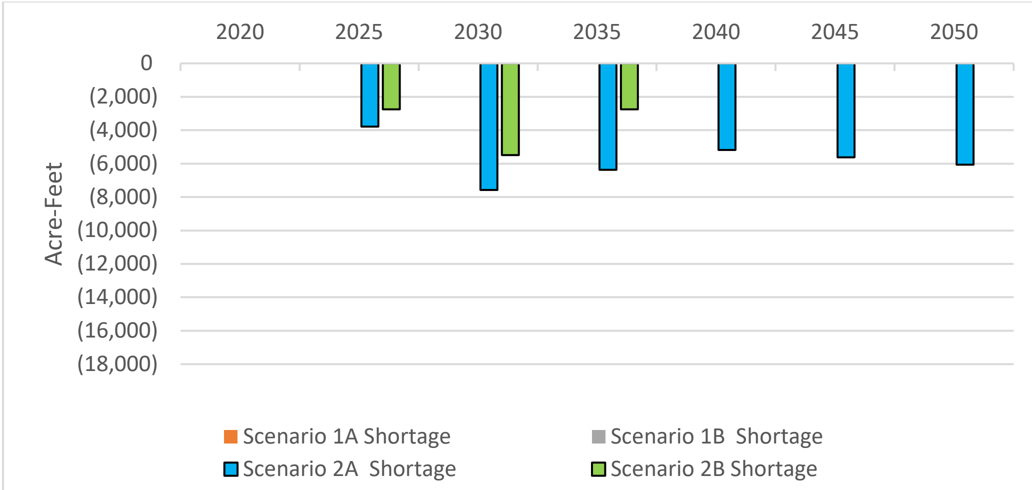


Figure 4-4. MWD Demand Shift Scenario Supply Gaps

4.2 Supply Options to Improve Resiliency

This section presents the full range of water supply options that were considered in the 2020 LRWRP Update. In describing conceptual options, it is important to recognize that the 2020 LRWRP Update is a high-level planning document and does not make recommendations on specific supply projects. Specific project recommendations will come in subsequent, detailed project level studies. However, to identify options to develop the long-term strategy, conceptual projects were characterized based on planning-level analyses. The data used to characterize these options were based on previous and/or ongoing studies conducted by MNWD, other regional water agencies, and similar projects that have been implemented. For long-term planning purposes, water supplies and facilities will be added on an incremental basis and ahead of need. It would be economically unsound to in the near-term install and implement all the facilities and water supplies needed for the next twenty to thirty years. This would unfairly burden existing customers with costs that should be borne by future customers.

4.2.1 Water Supply Portfolios

No single water supply option available to MNWD will meet all the planning goals identified in Section 1 for the 2020 LRWRP Update. Therefore, water supply portfolios were developed from various combinations of water supply options. Water supplies can be added into the system at a relatively constant supply rate through the year compared to projects that provide supplies only during specific peak periods or during droughts or dry years. A constant source is referred to as base-loaded supplies while the latter type is referred to as storage or on-demand supplies. Storage supply projects are only operated when needed. Water storage programs create a reserved supply of water that can be recovered during droughts, emergencies, system outages, or other periods of heightened demand or reduced supply. Thus, storage or on-demand projects can be used to augment supplies when needed. When considering which type of supply is best suited for MNWD, it is important to balance the risk of potential water supply gaps against the risk of potential over-investment given the historical reliability of MWD water supplies.

The water supply portfolio themes are based on the concepts of base-loaded and on-demand supplies. The water supply projects identified for each of the water portfolio themes are based partly on the previously identified projects in the 2015 LRWRP, MWDOC 2018 study, and ongoing project efforts by

MNWD staff. The options were conceptually reviewed for implementation feasibility, cost and other factors related to MNWD system capacity. Descriptions of the portfolio themes are described below, and **Table 4-1** shows which individual project options could be considered in each portfolio. A narrative for each project is included further below. However, no specific project is evaluated for the 2020 LRWRP Update.

- **Existing Supply**: The existing supply portfolio would include current water supply programs, including imported water supplies and recycled water. No new water supply projects would be included in this portfolio.
- **Base-Loaded Supply**: Options included in this portfolio include those in the existing supply portfolio and the addition of a base-loaded supply type, such as direct potable reuse and/or seawater desalination.
- **On-Demand Supply**: Options included in this portfolio include those in the existing supply portfolio and the addition of an on-demand supply type, such as the OCWD emergency storage program, SOC expanded Interconnection, Strand Ranch groundwater banking, Irvine Lake storage, and/or additional MWD treated imported water.
- **Hybrid Supply – Base-Loaded and On-Demand**: This portfolio combines a supply from both base-loaded and on-demand water supply types and could include any combination of the projects identified.

Table 4-1. Potential Water Resource Projects for Consideration in Supply Portfolios

Existing Supplies	Base-Loaded	On-Demand	Hybrid Supply
MWD Imported Water	Existing Supply	Existing Supply	Existing Supply
Existing Reuse	Direct Potable Reuse (DPR)	OCWD Groundwater Banking Program	Direct Potable Reuse (DPR)
Existing Storage	Seawater Desalination	SOC Expanded Emergency Interconnection	Seawater Desalination
Water Use Efficiency Programs		Strand Ranch Groundwater Banking	OCWD Groundwater Banking Program
Planned Expanded Non-Potable Reuse		Irvine Lake	SOC Expanded Emergency Interconnection
		Additional MWD Treated Imported Water	Strand Ranch Groundwater Banking
			Irvine Lake
			Additional MWD Treated Imported Water

4.2.1.1 Existing Supply Portfolio

The existing supply portfolio would include existing water supply programs. No new water supply projects would be included in this portfolio. The existing water supply programs include imported water supply, non-potable reuse water, water use efficiency programs, and existing storage capabilities.

Since the 2015 LRWRP, MNWD has implemented recycled water and water use efficiency no/low regret options to increase water reliability. MNWD has made and continues to make significant investments in water use efficiency and water recycling because MNWD recognizes the tremendous value of water. As previously identified in Section 3.0, MNWD prepared the RWMP and RWOS to identify ways to expand use of recycled water. Since completion of the RWMP, 208 AFY has been added to the recycled water system (MNWD, 2019). Therefore, 306 AFY is the remaining additional potential demand with the current recycled water supply (MNWD, 2019). This supply portfolio includes adding the remaining recycled water capacity to the system. In addition, water use efficiency programs are continuously promoted to customers to encourage participation in various types of programs to use water wisely. For example, MNWD's turf replacement program has resulted in over 6 million square feet of turf grass converted to California friendly vegetation saving over 250 million gallons of water annually. MNWD's water efficiency programs past successes are a strong indication of our ability to realize new and higher levels of water efficiency in the future. The remaining expansion of the recycled water system and water efficiency programs would continue to be implemented as part of the existing supply portfolio to increase water supply reliability.

4.2.1.2 Base-Loaded Portfolio

The base-loaded portfolio could include one or more base-loaded projects which is operated at a relatively constant supply rate throughout the year. The base-loaded supply projects could include evaluation of regional and local seawater desalination projects and a direct potable reuse project currently being evaluated for feasibility by MNWD. Base-loaded supplies capacity accounts for the level of demands that can be satisfied with a new local project without having to be cut back in the low winter demand months.

Direct Potable Reuse (Sulphur Creek Reservoir)

Direct potable reuse (DPR) may offer an opportunity for MNWD to expand the use of recycled water. The planned replenishment of groundwater basins with recycled water, a form of indirect potable reuse (IPR), has been practiced in the State for over 50 years (SWRCB, 2019). OCWD has operated a system of groundwater injection wells at the Talbert Gap to keep seawater out of the groundwater basin underlying Orange County since 1965, and in 1976 started supplementing imported water with recycled water as a source of injection water (SWRCB, 2019). In 2018, the SWRCB adopted regulations for another form of IPR, surface water augmentation. Surface water augmentation allows for recycled water to be added to a surface water reservoir that is used as a source of drinking water. The first two projects proposed, both in San Diego County, are expected to be completed in the 2022-time frame (SWRCB, 2019).

DPR means the planned introduction of highly treated recycled water either directly into a public water system, as defined in Section 116275 of the Health and Safety Code, or into a raw water supply immediately upstream of a water treatment plant. AB 574 requires the SWRCB to adopt uniform water recycling criteria for DPR through raw water augmentation by December 31, 2023, with provisions for extension of the deadline. Raw water augmentation means the planned placement of recycled water into a system of pipelines or aqueducts that deliver raw water to a drinking water treatment plant that provides water to a public water system, as defined in Section 116275 of the Health and Safety Code. DPR is the use of recycled water as a source of drinking water where the influence of an environmental buffer is small, minimal, or absent. DPR regulations will include additional criteria to compensate for the loss of the protective benefits assured by the presence of a meaningful environmental buffer in IPR projects. DPR projects might be regulated with both Waste Discharge Requirements and public drinking water system permits, or simply a public drinking water system permit. With the establishment of DPR Regulations, protection of public health would be addressed via compliance with the regulations, as well as permits issued to public water systems. (SWRCB, 2019).

Currently a portion of municipal wastewater from MNWD is collected and treated by South Orange County Wastewater Authority (SOCWA) at the Regional Treatment Plant (RTP) in Laguna Niguel. Two treatment stages are employed, secondary undisinfected and tertiary, depending on the end use of the treated water. Wastewater is treated to tertiary standards when it is recycled for irrigation uses. MNWD desires to maximize reuse of water from the RTP to diversify our water supply portfolio. To do this, MNWD is conducting a feasibility study to determine the potential to increase beneficial use of recycled water for implementation of a DPR Project at the RTP.

Poseidon Desal

Poseidon Water, a private enterprise, has proposed construction of a 50 MGD or 56,000 AFY seawater desalination plant using reverse osmosis in Huntington Beach co-located at the AES Huntington Beach Power Station. The project would intake seawater through the AES generating station seawater cooling intake. The desalination process consists of source water screening, coagulation, filtration, pH adjustment, chlorination, de-chlorination, reverse osmosis membrane separation, and product water chlorination and chemical conditioning. The brine produced by removal of seawater constituents would be mixed with seawater and discharged back to the Pacific Ocean through a modified brine discharge diffuser which would meet the State Water Resource Control Board's adopted Ocean Plan Amendment requirements. The Huntington Beach Water Desalination Facility has received the following permits (Poseidon, 2020):

- Conditional Use and Coastal Development Permits from the Huntington Beach City Council.
- Discharge Permits from the California Regional Water Quality Control Board, Santa Ana Region.
- Drinking Water Permit from the California Department of Health Services to allow facility water to enter the potable water distribution system.

Poseidon Resources is currently seeking a renewal of its State Lands Commission lease agreement, a renewal of its National Pollution Discharge Elimination System permit with the Santa Ana Regional Water Quality Control Board and its Coastal Development Permit from the California Coastal

Commission. If the project receives all its required permits in 2020, it could be producing drinking water for Orange County by as soon as 2022 (Poseidon, 2020).

MNWD has expressed interest in the project but has not committed to participation in the project, should it be constructed. This decision will await determination of the final cost of the product water, timing of implementation, and integration with regional water systems and supplies.

Doheny Desal

South Coast Water District (SCWD) proposes to develop an ocean water desalination facility in Dana Point, at Doheny State Beach. As proposed, this project would desalinate saline groundwater pumped from slant beach intake wells at the mouth of San Juan Creek at Doheny State Beach. The brine would be combined with treated wastewater in the existing San Juan Creek Ocean Outfall pipeline and discharged to the ocean. The proposed project will require land, treatment facilities, and an outfall. The preferred site is a 5-acre property already owned by SCWD that is near the Joint Transmission Main and the adjacent existing San Juan Creek Ocean Outfall that has enough capacity available for brine disposal. As proposed, the project consists of five major components: Feedwater Supply System, Desalination, Brine Concentrate Disposal, Power Supply, and System Integration. Based on information contained in the MWDOC 2018 study, SCWD intends to construct a facility with an initial capacity of 5 MGD (annual production of 5,321 AFY, 7.3 CFS, 4.74 MGD actual capacity), with potential for future expansions up to a capacity of 15 MGD (annual production of 15,963 AFY, 22.05 CFS, 14.22 MGD actual capacity). (MWDOC, 2019). MNWD has not expressed interest in participating in the project at this time.

4.2.1.3 On-Demand Portfolio

The on-demand portfolio would include one or more on-demand/storage projects that provide supplies only during an emergency or during droughts or dry-years. The on-demand/storage supply projects could include the emergency storage program with OCWD, evaluation of the SOC Interconnection and EOCF2 Pump-In, Strand Ranch Banking, Irvine Lake and MWD Tier 2 water.

Emergency Storage Program (OCWD Groundwater Exchange/Banking)

Orange County Water District (OCWD) and MNWD are considering developing a short-term pilot storage program enabling MNWD and potentially other South County Agencies to store imported water purchased from MWD in the Orange County Groundwater Basin. The stored water would be recovered and delivered to MNWD for use during drought periods and/or emergencies (e.g., system and supply reliability). For MNWD, storage in the Orange County Groundwater Basin may represent one cost effective approach to improving water supply reliability. OCWD and MNWD have discussed a relatively small short-term (5-10 years) pilot storage program. The storage would rely on existing available recharge capacity and would not impact the operations of OCWD or the other basin producers. The potential pilot program would enable

OCWD to test the concept of storage in the Orange County Groundwater Basin for SOC water agencies and help to establish the necessary institutional arrangements for such storage. OCWD and MNWD are currently conducting a conveyance study to review potential conveyance options from the Orange County Groundwater Basin to MNWD. The goal of the conveyance study is to evaluate the potential infrastructure required to convey water from the Orange County Groundwater Basin to MNWD's system. This information will be used by OCWD and MNWD to assist in the potential development of the pilot storage program. The study is ongoing and anticipated to be completed in 2020-2021.

SOC Emergency Interconnection Extension & EOCF2 Pump-In

In 2006, multiple SOC water agencies entered into a 25-year agreement with IRWD and OCWD to receive water from the IRWD system with subsequent conveyance into the distribution system serving SOC. The program was developed to deal with emergency water system outages, or planned shutdown scenarios in which imported supplies normally delivered into SOC are curtailed, eliminated, or unavailable for up to 30 days. The initial term of the Emergency Services Agreement expires in 2031. The Emergency Services Agreement calls for IRWD to provide up to 30 CFS to SOC water agencies during emergency events (MWDOC, 2019). IRWD's annual groundwater production must still comply with OCWD's annual Basin Production Percentage and Basin Equity Assessment calculations. MNWD has an emergency interconnection agreement with IRWD to supply treated water at 10.6 MGD with a maximum flow rate of 15.6 CFS for 30 days (MNWD, 2015). The maximum incident volume IRWD will supply is 1,768 AF (MNWD, 2015). The agreement also provides emergency water to the City of San Clemente, Laguna Beach County Water District, SMWD, and SCWD.

Under the agreement, IRWD and the participating agencies jointly constructed various projects to transfer water to the Aufdenkamp Transmission Main and the Joint Transmission Main. MNWD has capacity rights of 55 percent and is responsible for the same percentage of project costs and ongoing operations and maintenance (MNWD, 2015). Water delivered through the interconnection is MWD water or locally produced water exchanged for MWD water. The option is not designed to address droughts, but only to be used during emergency conditions when MWD facilities are disrupted due to seismic events or unplanned outages. Recent conversations involving MWDOC and SOC agencies indicates an interest in exploring with IRWD the possibilities of providing more flow than the existing agreement provides for, and/or extending the agreement past the current expiration year of 2031. The amount of water IRWD can make available to SOC water agencies during emergencies is diminishing over time as water demands within IRWD increase. MWDOC and IRWD are currently studying an expansion of the current program.

Included in the study efforts with IRWD is the EOCF2, which will be examined as an alternative facility whereby groundwater wells near EOCF2 could be pumped into EOCF2 at such times when MWD water is unavailable (MWDOC, 2019). The EOCF2 is a major pipeline that runs from the Diemer Water Treatment Plant in Yorba Linda to central Orange County where it connects to other pipelines that convey water into SOC (i.e. the Joint Regional Water Supply System and the Aufdenkamp Transmission Main). MWDOC conceptualized an expanded and scalable emergency groundwater program that would include new groundwater production wells or simply connections from local water systems to the EOCF2, with chloramination facilities and booster pumps to convey local groundwater in the EOCF2 (MWDOC, 2019). The concept would be that pumpers in the OC Basin would be able to use these production wells in non-emergency periods, while SOC agencies would be able to use the wells during an unplanned system outage. SOC agencies would be responsible for the cost of the chloramination facilities, pump stations and conveyance facilities to EOCF2, and a portion of the cost for the groundwater wells (with OC Basin pumpers responsible for the other portion of well costs). In addition, SOC would be responsible for replenishing any groundwater that is utilized during the emergency as a water exchange. This project would not be used by SOC for water supply reliability needs during dry years or droughts. (MWDOC, 2019).

Strand Ranch Banking

Rosedale-Rio Bravo Water Storage District and IRWD developed groundwater banking facilities on the Strand Ranch in Kern County for use by both districts. All groundwater banking facilities on the Strand Ranch are owned by IRWD and operated and maintained by Rosedale for the duration of the project. IRWD purchased approximately 661 acres at Strand Ranch in western Kern County and entered into a 30-year water banking and exchange agreement with Rosedale-Rio Bravo Water Storage District (Rosedale). IRWD constructed approximately 502 acres of recharge basins and extraction wells on the property. Storage capacity is 50,000 AFY with recharge and recovery capacities of 17,500 AFY. In return for every 3 AF of water banked, 2 AF remains for benefit of Kern County Water Agency and IRWD can withdraw 1 AF. IRWD is limited to extracting amounts recharged minus losses as dictated in the Memorandum of Understanding.

MWDOC and IRWD entered into discussions regarding MWDOC offering participation in the IRWD Strand Ranch Water Banking Program. MWDOC plans to conduct further work on the proposed terms and conditions for MWDOC's agencies to participate in the program. The initial proposed terms and conditions as a pilot program included MWDOC paying IRWD a $25/AF annual reservation charge over the life of the agreement for up to a maximum of 5,000 AF to be reserved. If MWDOC reserved the entire 5,000 AF, the fixed cost payment would be $125,000 per year; the pilot program was suggested to extend over the next seven years; the total fixed payments over this period would be $875,000. During a MWD water allocation scenario, the water can be called at an additional cost of approximately $1,776/AF in 2025, consisting of an IRWD charge of $533/AF for facilities, the cost of water and extraction costs, plus a MWD wheeling payment of $1,243/AF (total cost is approximately $1,952/AF if the reservation fee is included). The cost of this water is about $771/AF less than the cost of purchasing MWD water at the allocation surcharge water rate in 2025. MWDOC will be studying these terms and conditions to determine if this pilot program meets the needs of its agencies. This program would only provide supply reliability benefits. (MWDOC, 2019).

Irvine Lake (Emergency)

Since it was originally constructed in 1933, the primary purpose of Irvine Lake (Santiago Creek Reservoir) is to store water for the benefit of the surrounding communities – initially to provide irrigation water for local farms, and more recently to satisfy water demands primarily for urban needs. IRWD utilizes water from Irvine Lake for two purposes: 1) as a source of water for non-drinking purposes, such as irrigation for avocado orchards, and 2) as a source of water for the Baker WTP which creates drinking water for an estimated 85,000 homes in Orange County. Serrano Water District (SWD), a co-owner of Irvine Lake with IRWD, also uses water from Irvine Lake to provide treated drinking water to its customers in the City of Villa Park and some parts of the City of Orange (IRWD, 2020). IRWD owns 75 percent of the water rights with SWD owning the remaining 25 percent. In the event of an emergency, water from Irvine Lake could be treated to the maximum capacity of the Baker WTP currently 43.5 CFS to continue delivering water into SOC.

MWD Treated Imported Water (Tier 1 and Tier 2)

Purchasing additional supply from MWD would be used to fill any gaps between projected water demands and existing/new local supplies. Water can be purchased from MWDOC/MWD above a member agency's annual allocation amount but is charged in addition to MWD's standard rates for water service. Each member agency has a predetermined amount of water that can be purchased at the lower Tier 1 supply rate. Purchases more than this limit will be made at the higher Tier 2 supply rate. The Tier 2 supply rate is charged on MWD water sales that exceed a member agency's Tier 1 maximum. During periods of extreme water supply shortages, MWD utilizes its WSAP to allocate a specific reduced level of MWD supplies as determined by the MWD Board. If MWD member agencies need and purchase water above their allocation amount, substantial allocation surcharges are imposed. Allocation surcharges are only assessed to the extent that an agency's total annual usage exceeds its total annual allocation. 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. Water use between 100 percent and 115 percent of WSAP supply allocations is currently charged with the allocation surcharge of $1,480 per acre-foot. Water use greater than 115 percent of WSAP supply allocations is currently charged at two times the allocation surcharge or $2,960 per acre-foot. However, these allocation surcharges are not static and are subject to increase in the future as the WSAP is implemented. Tier 2 water from MWD is often considered to be the marginal cost of imported water, since it reflects the costs for MWD in securing higher-cost water to meet demands in excess of its baseline demands, and thus is used to compare other local investments against. The Tier 2 supply rate encourages the member agencies and their customers to maintain existing local supplies and develop cost-effective local supply resources and implement water efficiency and conservation programs.

4.2.1.4 Hybrid Portfolio – Base-Loaded and On-Demand

The base-loaded and on-demand hybrid portfolio includes the existing supply portfolio and includes a supply mix of the base-loaded and on-demand portfolios described above. This portfolio balances the increasing need for a base-loaded water supply with the potential for variable increased demands due to unknown or unexpected conditions.

4.3 Supply Portofolio Evaluation

To assess the future reliability for MNWD, the planning scenarios and water supply portfolios compared demand to supplies. Each planning scenario will be combined with each water supply portfolio to capture a more complete description of the range of future uncertainty influencing water reliability for MWND. At present, all combinations of planning scenarios and water supply portfolios appear plausible. The demand and supply balance used to estimate supply gaps do not account for reduction in demand by imposing mandatory water rationing because having to regularly impose mandatory water restrictions can be detrimental on the economy and quality of life. In addition, it is important to note that the analyses provided below is based on the maximum potential supply gaps and could be much lower depending on climate conditions, local investments, and regional demands. The probability of any supply gap varies across each supply scenario, as identified previously in Table 3-4. While the probability of supply gaps under supply Scenario 2A is greatest, this is also considered to be the least likely scenario to carry out given all the regional plans anticipated to implement local supply projects.

Any new base-loaded supply that would be integrated into the MNWD water system must account for the customer demands, which varies day to day and month to month. There is a limitation on system capacity for base-loaded supplies during winter demands. While the demand for water supplies increases in summer, if base-loaded supplies are greater than winter demands, the water resource project may have to cut-back production in winter. Constructing projects and not fully utilizing its capacity is inefficient and results in over investing in resources. During the low demand months of January to April, MNWD's total imported water averaged approximately 27 CFS per month (or 1,627 acre-feet per month) from 2017-2019. MNWD is committed to receive approximately 13 CFS (or 783 from acre-feet per month) from Baker WTP, leaving on average approximately 14 CFS (or 843 from acre-feet per month) of headroom capacity for new base-loaded supplies to be added to the system on average. Headroom capacity is defined as the level of demands that can be satisfied with a new local project without having to be cut back in the low winter demand months. However, during rainy years the system demands can be even lower because outdoor water use decreases further during winter months. For example, in February of 2019, total potable water use was approximately 18 CFS (or 1,107 acre-feet per month). Similarly, in the rainy year of February 2017, total potable water use was approximately 19 CFS (or 1,165 acre-feet per month). As a result, the headroom capacity during these winter rainy months would have been 5 CFS (or 302 acre-feet per month or 3,622 AFY) in 2017 and 6 CFS (or 362 acre-feet per month or 4,347 AFY) in 2019. As indicated in Chapter 3, extended, intense droughts and more extreme floods are expected to occur more frequently in the future due to climate change (Delta Stewardship Council, 2018). As a result, infrastructure sizing must consider not only headroom capacity during average winter months when demand is low but also during rainy years when demand is even lower. The demand and supply analyses provided for each scenario takes into consideration both headroom capacity scenarios, a 4-month winter average and lowest-winter month to identify how each affects water reliability throughout the year.

In addition, the potential headroom capacity must be balanced with water quality concerns of imported water and costs associated with new base-loaded supplies versus the costs of imported water. Increasing the local production of water in SOC will decrease water flows through existing transmission mains, most notably the EOCF2, Joint Transmission Main, and AMP. The cost-benefit analysis of local projects will need to evaluate any necessary facilities to ensure that water quality regulations are met, especially during the winter months (December through February). The decreased flows through those pipelines would potentially impact the disinfection degradation and create necessary improvements at additional costs which would need to be evaluated. There are also contractual flow obligations which need to be accounted for in specific project cost evaluations. These water quality considerations would need to be evaluated for future specific projects when planning level studies are prepared.

4.3.1 Existing Supply Portfolio

Each of the three demand scenarios (Upper Bound, Status Quo, and Median) were compared with the existing supply portfolio described previously. **Figure 4-5** presents how existing supplies would compare against each of the three demand scenarios assuming no new water supplies are implemented by MNWD. As shown in Figure 4-5, MNWD could experience potential supply gaps through 2050 for all three demand scenarios if no new water supplies are added to the supply portfolio. However, the severity of the supply gaps also varies by water supply scenario, which is based on climate variability and implementation of water supply investments. Higher climate variability (e.g., increased temperature and droughts) and lower investments in water supply projects, results in the least amount of water reliability for MNWD. Water supply scenarios 1A and 1B nearly meets or exceeds the Status Quo Demand projections in all years but would not meet the higher demand scenarios. Water supply scenarios 2A and 2B would not meet all demand projections starting in 2025. Implementation of the existing supply portfolio could potentially result in moderate supply gap risks under water supply scenarios 1A and 1B and significant supply gap risks to MNWD water reliability under water supply scenarios 2A and 2B.

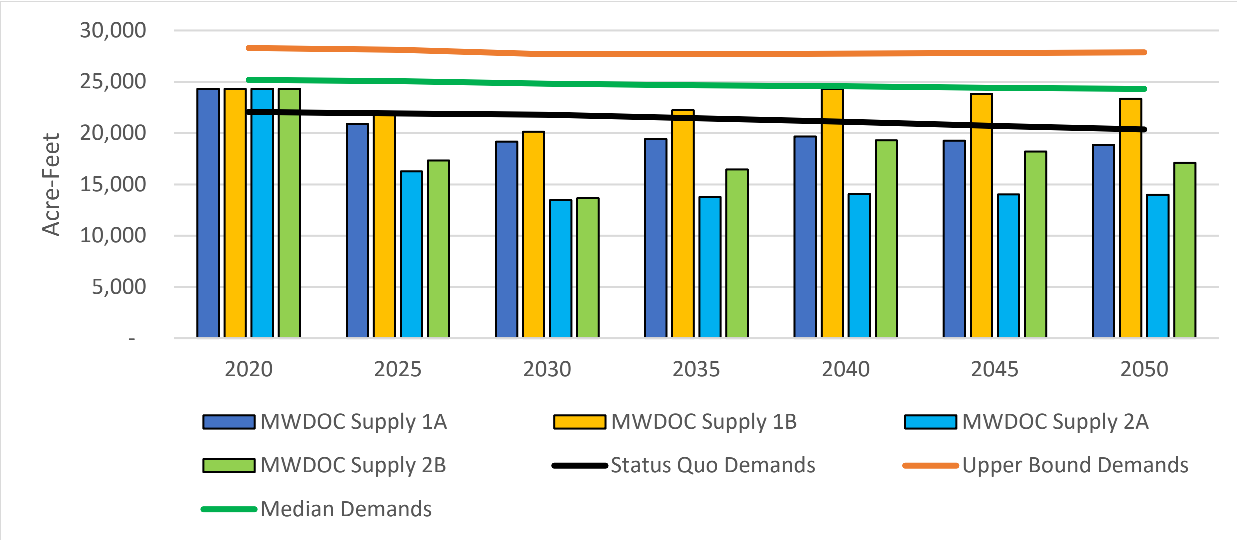


Figure 4-5. Existing Supply Portfolio Reliability

As identified in Scenario 4, MWD demands have decreased from what was projected in the MWD 2015 IRP. This scenario analyzes what potential supplies could be available to MWND should regional demands decrease over the next thirty years compared to what was previously projected by MWD. The decreased MWD demands were compared against the revised water supply scenarios detailed in Section 3 to identify how this could change supplies available to MNWD. **Figure 4-6** presents how supplies would compare against each of the three demand scenarios assuming reduced regional demands and no new water supplies are implemented by MNWD. As shown in Figure 4-6, water supply scenarios 1A and 1B meet Status Quo and Median demands through 2050, providing a potentially reliable source of water for MNWD. In addition, post 2035, water supply scenario 2B also meets Status Quo demands and post 2040 meets Median demands. However, water supply scenario 2A could result in supply gaps for all three scenarios starting in 2025 but the supply gap is much smaller compared to the previous scenario. This reduced demand scenario highlights the water reliability variation that can occur based on lower regional demands. Should regional demands continue trending below MWD projections, supply reliability for MNWD significantly increases, decreasing the need to significantly increase local water supplies. However, as Figure 4-6 identifies, there would still be potential supply gaps for the Upper Bound Demand and Median Demand scenarios under water supply scenarios 2A and 2B, representing moderate supply gap risk to MNWD water reliability.

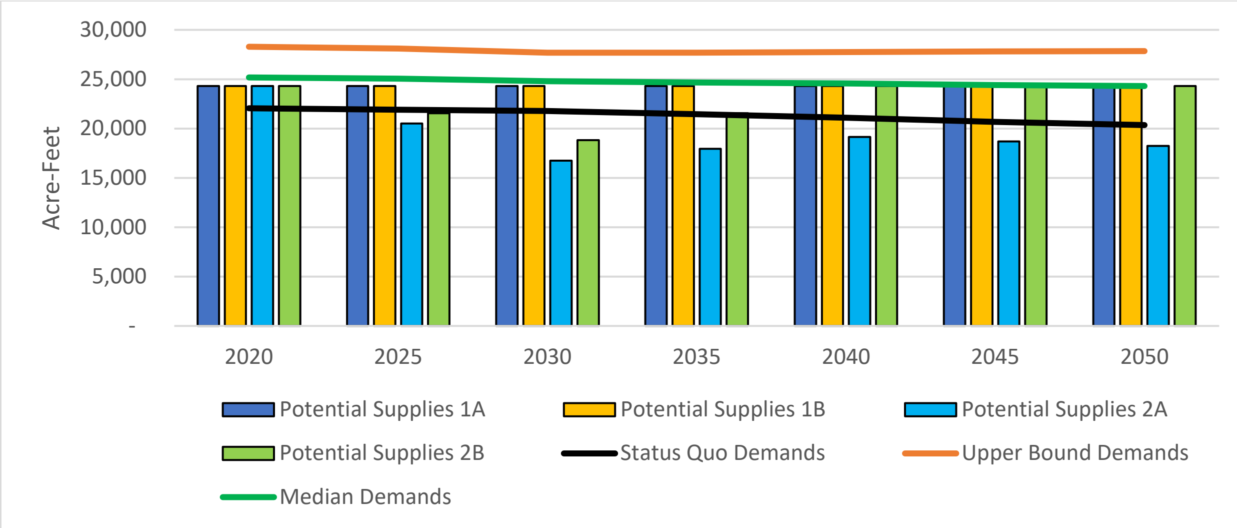


Figure 4-6. MWD Reduced Demands – Existing Supply Portfolio Reliability

4.3.2 Base-Loaded Supply Portfolio

Each of the demand scenarios (Upper Bound, Status Quo, and Median) were compared with the base-loaded supply portfolio described previously. Two base-loaded supply portfolios were evaluated, the winter minimum headroom capacity and 4-month average winter headroom capacity, both described above. As previously identified, the headroom capacity during a low demand rainy month is approximately 5 CFS (3,622 AFY). The headroom capacity during a 4-month winter average demand is approximately 14 CFS. However, this scenario evaluates half of the 4-month winter average headroom capacity at 7 CFS (5,071 AFY). **Figure 4-7** presents how adding a winter minimum base-loaded supply (5 CFS [3,622 AFY]) and average winter base-loaded supply (total of 7 CFS [5,071 AFY]) would compare against each of the demand scenarios. As shown in Figure 4-7, MNWD could still experience potential supply gaps particularly for the Upper Bound and Median demand projection under water supply scenarios 2A and 2B through 2050. The Status Quo demand projections would be meet with the winter minimum base-loaded capacity under water supply scenarios 1A and 1B. The Median demand projections would also generally be meet with the winter minimum base-loaded capacity under water supply scenarios 1A and 2B with the average base-loaded capacity needed in 2030. The potential supply gap is decreased compared to the existing supply portfolio but still could result in moderate to significant supply gap risk to MNWD water reliability under water supply scenarios 2A and 2B.

Figure 4-7 also presents how adding an average winter base-loaded water supplies (7 CFS [5,071 AFY]) would compare against each of the demand scenarios. As shown in Figure 4-7, MNWD could still experience potential supply gaps particularly for water supply scenarios 2A and 2B for all demand scenarios post 2030. Water supply scenario 1B with the average winter base-loaded water supply meets Median demands through 2050 and exceeds Upper Bound demands post 2035. The potential supply gap is further decreased compared to the minimum base-loaded supply portfolio but still could result in moderate to significant risk to MNWD water reliability under water supply scenarios 2A and 2B.

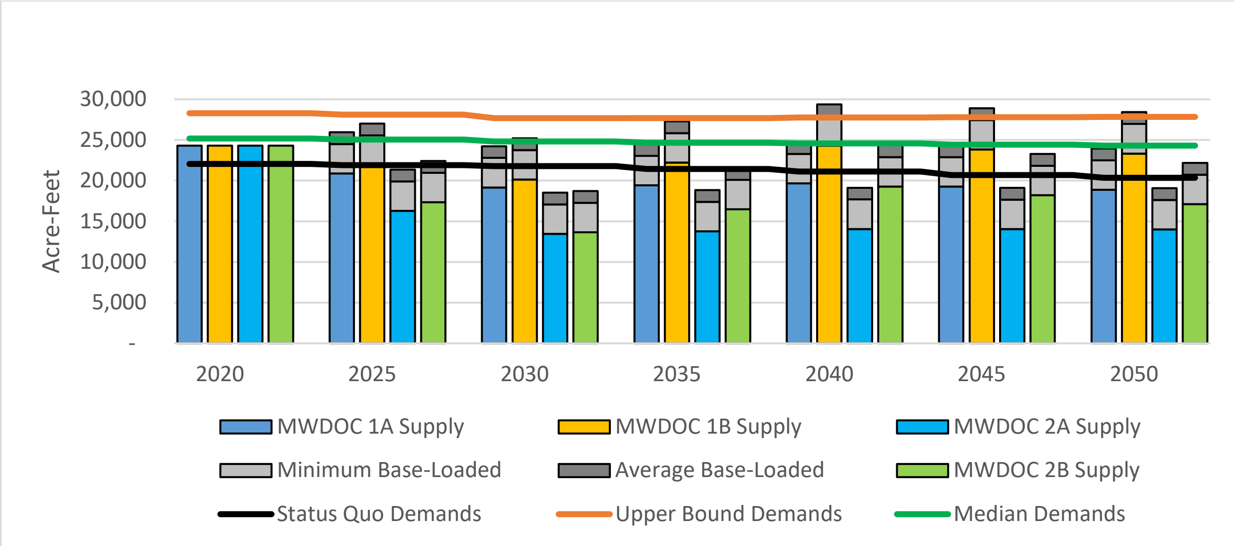


Figure 4-7. Base-Loaded Supplies Portfolio Reliability

Figure 4-8 presents how adding a winter minimum base-loaded supply (5 CFS [3,622 AFY]) and average winter base-loaded supply (total of 7 CFS [5,071 AFY]) with MWD reduced demands would compare against each of the demand scenarios. As shown in Figure 4-8, MNWD would experience supply reliability in water supply scenarios 1A and 1B for all demand projections with the minimum base-loaded supply and exceeds Upper Demands with the average base-loaded supply post 2025. Water supply scenario 2B meets supply reliability for all demand scenarios post 2040. Water supply scenario 2A meets Status Quo demand projections and nearly meets Median demand projections through 2050. The supply gap for water supply scenario 2A is substantially lessened as well for the Upper Bound demand projections, but MNWD could still experience potential supply gaps. Overall, the potential supply gap is largely decreased but still could result in low risk to MNWD water reliability for water supply scenario 2A.

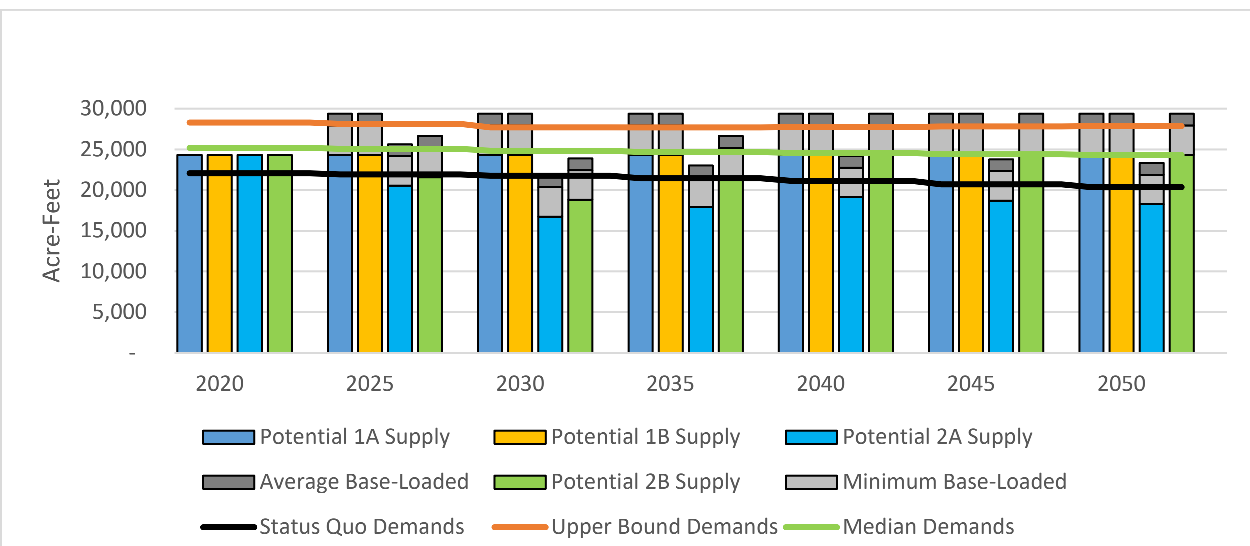


Figure 4-8. MWD Reduced Demands –Base-Loaded Supply Portfolio Reliability

4.3.3 On-Demand Portfolio

Each of the demand scenarios (Upper Bound, Status Quo, and Median) were compared with the on-demand supply portfolio described previously. **Figure 4-9** presents how adding an on-demand supply (6.9 CFS [5,000 AFY]) would compare against each of the demand scenarios. As shown in Figure 4-9, MNWD could still experience potential supply gaps particularly in water supply scenarios 2A and 2B for all three demand projection scenarios. However, water supply scenarios 1A meets Status Quo demands through 2050. Water supply scenario 1B meets Median demands through 2050 and exceeds Upper Bound demands post 2040. The potential supply gap is further decreased compared to the existing supply portfolio but still could result in moderate risk to significant risk to MNWD water reliability for water supply scenarios 2A and 2B.

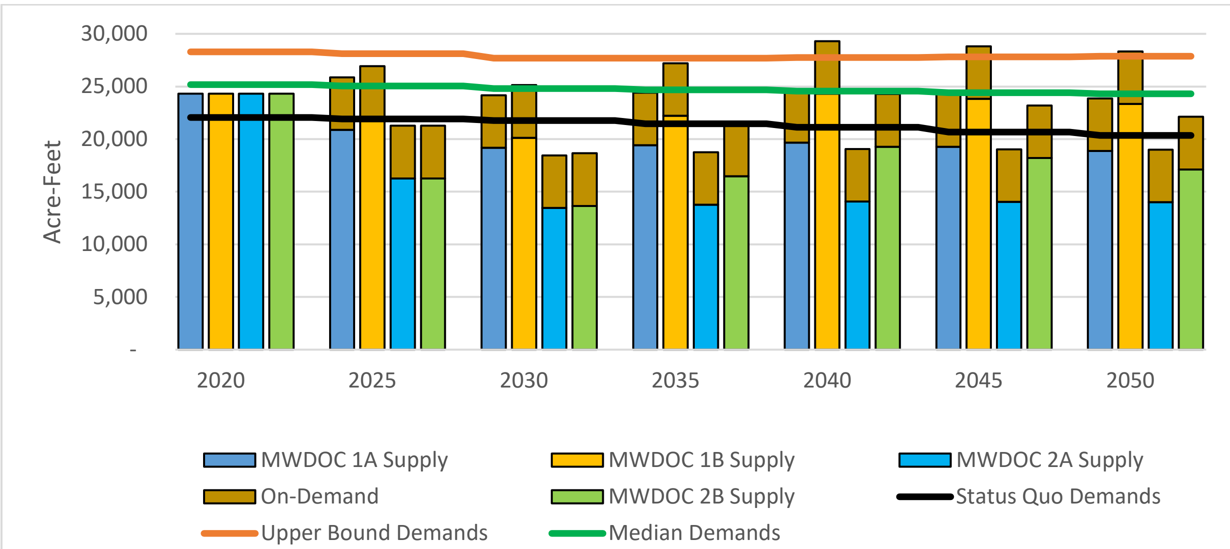


Figure 4-9. On-Demand Supply Portfolio Reliability

Figure 4-10 presents how adding an on-demand supply (6.9 CFS [5,000 AFY]) with MWD reduced demands would compare against each of the demand scenarios. As shown in Figure 4-10, MNWD supply reliability would be substantially improved with reduce regional demands and the addition of an on-demand supply. Water supply scenarios 1A and 1B would exceed Upper Bound demand projections starting in 2025. Water supply scenario 2B would exceed Upper Bound demand projections post 2035. However, MNWD could still experience potential supply gaps under water supply scenario 2A for Median and Upper Bound demand projections through 2050. The potential supply gap is further decreased compared to the previous on-demand portfolio due to the decreased MWD demands. This scenario and supply portfolio could result in moderate risk to MNWD water reliability for Median and Upper Bound demand projections under water supply scenario 2A.

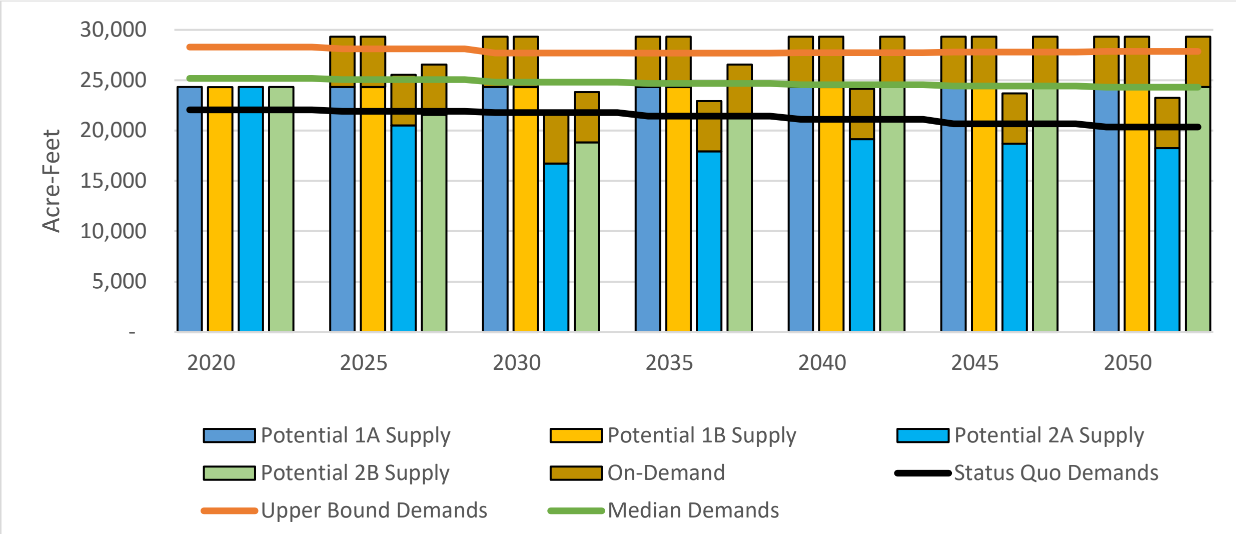


Figure 4-10. MWD Reduced Demands – On-Demand Supply Portfolio Reliability

4.3.4 Hybrid Portfolio – Base-Loaded and On-Demand

Each of the demand scenarios (Upper Bound, Status Quo, and Median) were compared with the hybrid supply portfolio described previously. The base-loaded supply portion of the portfolio evaluates the lowest demand month headroom capacity of approximately 5 CFS (3,622 AFY). The on-demand supply portion of the portfolio evaluates adding 6.9 CFS (5,000 AFY) of supply. **Figure 4-11** presents how adding a base-loaded and on-demand supply would compare against each of the demand scenarios. As shown in Figure 4-11, the hybrid portfolio meets and, in some years, exceeds the Upper Bound Demands in water supply scenarios 1A and 1B. Water supply scenario 2B nearly meets Median demand projections through 2050. Water supply scenario 2A meets Status Quo demands through 2050. The potential supply gap is decreased substantially compared to the existing supply portfolio but still could result in moderate risk to MNWD water reliability for the Upper Bound and Median demand projections under water supply scenario 2A.

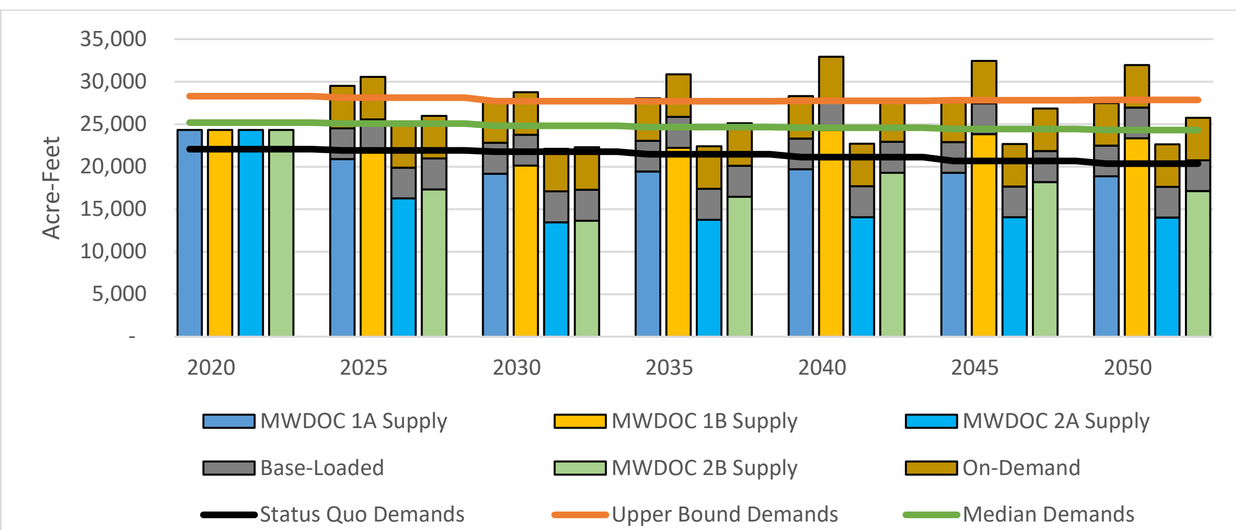


Figure 4-11. Base-Loaded and On-Demand Hybrid Supply Portfolio Reliability

Figure 4-12 presents how adding a minimum base-loaded supply 5 CFS (3,622 AFY) and on-demand supply of 6.9 CFS (5,000 AFY) with MWD reduced demands would compare against each of the demand scenarios. As shown in Figure 4-12, MNWD supply reliability would be nearly 100 percent in all supply and demand scenarios, with potential for very low risk supply gaps in water supply scenario 2A for the Upper Bound demand projections. This scenario and portfolio would result in high water reliability for MNWD.

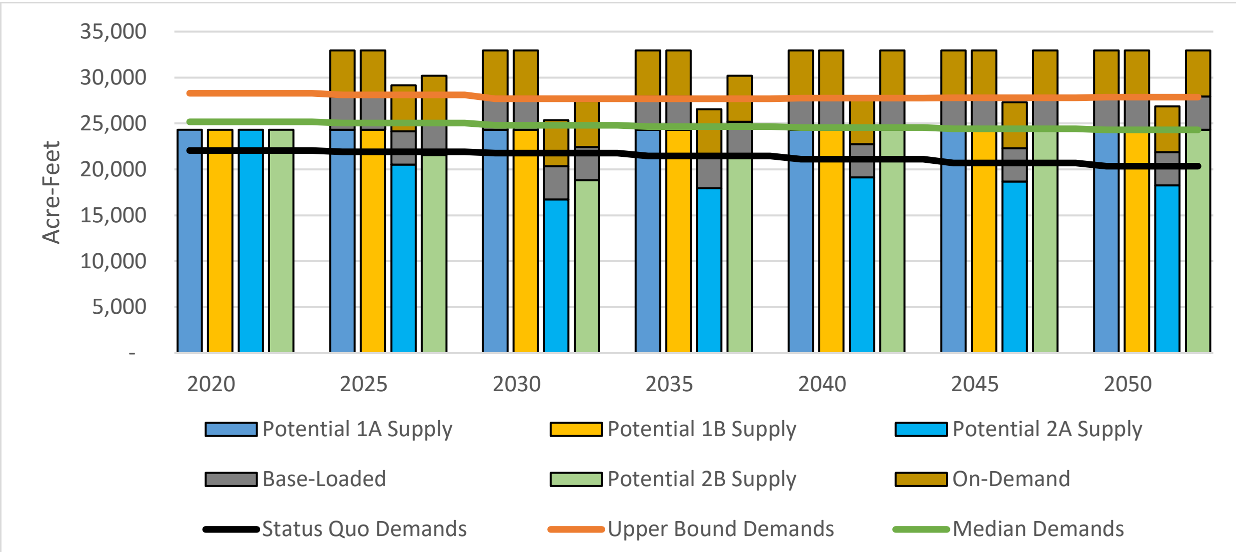


Figure 4-12. MWD Reduced Demands – Base-Loaded and On-Demand Hybrid Supply Portfolio Reliability

4.3.5 Supply Portfolio Summary and Recommendations

Eight different supply and demand scenarios have been evaluated in this section. The results indicate regional MWD demands have the potential to substantially impact water reliability for MNWD. Should demands continue to decrease below previous MWD projections, the need for additional water supplies proportionally decreases because water reliability is improved. Because of these uncertainties, this results in on-demand supplies making more sense to implement prior to base-loaded supplies. But as shown in the figures above for MWD reduced demand scenarios, there remains a potential for supply gap risks even with fewer demands on MWD depending on supply conditions, future local supply projects implemented and forecast year. The various supply and demand scenarios indicate that if MWD demands do not continue to decrease, additional water supplies may be necessary to increase supply reliability. However, the amount and type of supply would be driven by other local water supply projects being implemented, climate variability impacts, gains in water use efficiency, and customer response to the cost of water. As such, new water supply should be implemented in a phased approach based on need.

Supply through 2025 is anticipated to be sufficient given MWD's record storage levels, downward trending demands and continued implementation of water use efficiency measures throughout Southern California. The supply portfolios analyzed in these scenarios are consistent with the new supply amounts evaluated to also improve system reliability, which is needed regardless of future water supply scenarios. The system reliability assessment in Section 3.2.1, System Reliability, recommended an additional 10-15 CFS (7,245-10,867 AFY) be added to the MNWD system. This is similar to the Hybrid Portfolio, Figure 4-11 that evaluates adding nearly 12 CFS (8,622 AFY) of supply reliability. With the addition of a new supply that would improve both system and supply reliability, MNWD water supply reliability would be significantly enhanced. This would meet median demands through 2025, at which time, the water supply demands, and supply reliability would be reassessed to determine if additional supply reliability is needed for 2030 and beyond. This 2020 LRWRP Update recommends continued evaluation of the potential to maximize reuse of recycled water from the RTP through implementation of a DPR Project should it later be determined that additional supplies are needed for 2030 or beyond. Based on these findings, a long-term strategy for MNWD is needed that can adapt to changing conditions to ensure MNWD invests in supplies that best fit our customer's water reliability needs now and into the future. MNWD will need to closely monitor changes in demands and determine how other factors will affect future water reliability. The following section outlines such an adaptive strategy to provide a resiliency plan for MNWD.

Section 5 Implementation Plan

5.1 Water Reliability Over Planning Horizon

Water Reliability – Ability to minimize water shortages caused by droughts, climate variability, system capacity limitations, and catastrophic system outages.

Water supply reliability was analyzed over several scenarios by evaluating variations in supplies and demands through 2050. The variability in supply was based on changes in hydrology and implementation of State and local supply projects. The variability in projected demands was also partly based on hydrology and implementation of varying levels of conservation (or demand management activities). Water demands fluctuate since outdoor irrigation demands are typically higher in drier, hotter years, and generally lower in cooler, wetter years. Weather conditions that typically drive demands upward, conversely, tend to drive local supply generated from rainfall and runoff downward. In addition to fluctuating local water demands and supplies, imported water supplies also vary from year to year.

As described in Section 3, MNWD's supply assessment identified there could be projected imported water supply gaps to meet future water demands that would vary in magnitude based on changing conditions and implementation of State and local water supply projects. This is not to suggest that MWDOC (and in turn MWD) would not be able to provide water supply to MNWD, but rather that water conditions could be scarcer, potentially resulting in implementation of MWD's and MWDOC's WSAP. Implementation of the WSAPs could mean fewer supplies allocated to MNWD and substantially higher costs of imported water should MNWD need to import supplies above the decreased allocations. This 2020 LRWRP Update looks to balance the potential for future supply gaps with higher costs of imported water with new local supplies that increase water system and supply reliability for MNWD and are competitive with costs of imported water. The system and supply reliability assessments provided in Chapters 3 and 4 are summarized here.

5.1.1 System Reliabilty

As described in Section 3, system reliability disruptions for MNWD could be caused by outages of the Diemer WTP and treated imported water pipelines resulting from seismic events and unplanned facility failures. Based on the MWDOC and MWD recommendation that its member agencies plan for a 100 percent interruption of MWD imported water supplies for up to 60 days, this indicates MNWD should plan to provide local water supply to our customers for up to 2 months following an event that could result in temporary loss of imported water supply. Based on the system reliability evaluations conducted in Section 3, depending on the time of year this event could occur and the length of the event, MNWD may not have sufficient supplies to meet demands and may need to direct customers to eliminate outdoor water use to temporarily maximize local supplies. The 2020 LRWRP Update recommends updating MNWD's Water Reliability Policy to plan to provide between 31-days and 60-days of average annual potable water supply to meet demands in the event the MWD supply source temporarily interrupted. In addition, the 2020 LRWRP Update recommends updating MNWD's Water Reliability Policy to plan for water use restrictions of up to 20 percent during a system outage. Lastly, the 2020 LRWRP Update recommends adding a supplemental supply of up to 15 CFS (10,867 AFY) to meet extended system outages. This is assuming that the IRWD SOC Interconnection is available. Another 5 CFS (3,622 AFY) of supplemental supply is also recommended to provide additional reliability in the event the IRWD SOC Interconnection is unavailable or for when the agreement expires in 2031.

5.1.2 Supply Reliability

As described in Section 3, supply reliability disruptions are caused by droughts, environmental regulations resulting in restrictions in water exports from the Delta, seismic risks to levees in the Delta that protect it from seawater intrusion, and drought restrictions from Lake Mead on the CRA. In Chapter 4, several water supply and demand scenarios were compared against four water supply portfolios that evaluated how existing or new supplies could meet reliability goals into 2050. The goal of the 2020 LRWRP Update is not to provide 100 percent reliability under all water supply and demand scenarios but rather to identify a water supply approach that reduces the overall risk to MNWD water reliability and increases resiliency during times of low water supply and high water demands. As shown in Chapter 4, the existing supply portfolio is not sufficient to meet all demands under several years and demand scenarios. However, this must be balanced with the consideration that the MWD reduced demand scenario may provide an additional level of water reliability should regional demands continue to trend below previous MWD projections. While this downward demand trend could continue to occur, there is still a potential for supply gaps into 2050 and no guarantee that regional demands will continue to decrease much beyond 2020 levels. At the very least, water reliability is anticipated to be stable for the next five years given MWD's 2020 record storage levels, downward trending demands and continued implementation of water use efficiency measures at MNWD and throughout Southern California. Therefore, supply reliability issues are anticipated at least five years out. And with the addition of a supplemental supply that would serve to improve not just system reliability but also supply reliability, MNWD's water reliability would be significantly enhanced during this time. The hybrid portfolio results in the addition of water supply amounts that would be similar to the water supply recommendation for system reliability. The hybrid portfolio results in a low level of risk for MWND while providing sufficient water reliability under the Status Quo demand scenario. The hybrid portfolio includes considering phasing an on-demand supply of 7 CFS (5,000 AFY) and potentially adding at a later date in time a base-loaded supply of approximately 5 CFS (3,622 AFY), for a total of approximately 12 CFS (8,693 AFY). Because the future uncertainties impact supply reliability, this results in on-demand supplies making more sense to implement prior to base-loaded supplies. The ultimate mix of supply provided is not static and could be revised depending on the specific project, timing of implementation, and MNWD operational changes. This portfolio supply amount, regardless of supply mix, would meet median demands through 2025, at which time, the water supply demands, and supply reliability would be reassessed. This provides time to evaluate how changing regional demands and implementation of other local agency projects will influence water reliability for MNWD over the next 5 years. The 2025 LRWRP Update will help inform plans on other water supply planning projects that could be implemented by 2030 and based on updated information, determine whether additional projects and supplies are needed to support water reliability goals out to 2050. This approach balances future supply needs with the risks of over building expensive new sources of water supply that may not be needed given changing conditions.

5.1.3 Summary of Recomendations

The analysis conducted in support of this 2020 LRWRP Update has determined that MNWD's current supply portfolio may not be sufficient to meet system and supply reliability goals into 2050. To continue strengthening MNWD's water system and supply resiliency, the following near-term and mid-to-long-term actions are recommended. **Figure 5-1** outlines the timeline for implementation of the 2020 LRWRP Update recommendations.

Near-Term:

- Update the Water Reliability Policy to include a statement to:
  - Continue to engage with MWD, MWDOC and other local water agencies to identify opportunities to enhance water reliability;
  - provide at least 31-days and up to 60-days of annual average supply for emergency response;
  - identify requesting customer demand curtailment during emergency events; and
  - addition of dry-year storage supplies to increase supply reliability.
- Continue to implement and expand upon water use efficiency programs based on customer interest and regular evaluation of cost effectiveness.
- Continue to build-out the recycled water system per the Recycled Water Optimization Study.
- Move forward with evaluating implementation of up to 15 CFS (10,867 AFY) of new emergency water reliability project.
- Identify opportunities for on-demand dry-year storage and consider phasing-in 2,000 to 4,000 acre-feet of storage.
- Annually assess progress made on implementation of new supply projects and re-assess supply and demand to determine changes to timing of water reliability needs.

Mid-to-Long-Term:

- Continue to monitor the development of DPR regulations for the potential to implement a potable reuse project into the MNWD water system based on future regulations.
- Expand dry-year storage up to 10,000 acre-feet as necessary based on water supply and demand conditions.
- Update the LRWRP in 2025 (and every 5 years thereafter) to identify changes in demand trends, reliability of imported water, and additional resource options.

It is recommended that MNWD continue to implement existing water efficiency programs and look to phasing in a new source of water supply that would support both system and supply reliability into 2050. MNWD currently has a portfolio of active demand management programs throughout the service area and has committed to continuing this investment in conservation and water use efficiency efforts in the future. This approach is also consistent with the Making Conservation a Way of Life initiative, as required by Assembly Bill (AB) 1668 and Senate Bill (SB) 606. As detailed above, system reliability needs range from 10-15 CFS (7,245-10,867 AFY) that could also serve to support supply reliability needs. A new water supply source should benefit both system and supply reliability needs. The implementation of this new water supply will have numerous benefits for MNWD and its customers. These include greater system and supply reliability and greater resiliency against climate variability and emergency situations. The future may very well evolve somewhat differently than assumed but the best information available suggests it will lie somewhere within the bounds of the scenarios analyzed. However, conditions will continue to be monitored, and water supply reliability would be reassessed as changing conditions warrant, such as updated MWD and MWDOC water reliability analyses or implementation of key water supply projects, such as the Delta Conveyance Project and other local projects. An adaptive management approach will be implemented updating the framework for the 2015 LRWRP that will continually assess progress made on implementation of the 2020 LRWRP Update recommendations and risk triggers.

5.1.4 Adaptive Management

The 2015 LRWRP adopted and implemented an adaptive management approach because the future was uncertain. Any long-term plan is subject to some degree of uncertainty, but uncertainty is not a reason not to plan and can be a useful tool for adaptive implementation. The adaptive management strategy remains a valid approach for this 2020 LRWRP Update. Adaptive management is a process in which options are implemented in a phased and incremental manner based on the outcome of identified future conditions or risk triggers. Adaptive management is a valuable tool that can help MNWD proactively respond to changing conditions. It is an iterative process that aims to reduce uncertainty over time through periodic monitoring. An adaptive management approach will be used to monitor the need for implementation of future water supply projects and plan performance based on the outcomes of risk triggers. The risk triggers are points of uncertainty that result in projected possible outcomes to determine future alternative paths of implementation based on changing conditions. MNWD will monitor risk triggers such as changes in water demands, imported water supplies, climate variability, success or failure of the Delta Conveyance Project in Northern California, implementation of other regional/local water supply projects, evolving regulations, and other factors that could impact water reliability for MNWD. The 2020 LRWRP Update recommendations would then be reevaluated and updated based on the status of risk triggers or decision points that help to reveal whether past uncertainties now have more clarity. As part of this adaptive management approach, MNWD will update the 2020 LRWRP Update recommendations based on changing conditions, as needed. The adaptive management approach is an important tool for MNWD to continuously assess its current water supplies, demands, and progress of implementation of the 2020 LRWRP Update water supply recommendations and to evaluate the next steps if milestones are not met or potentially no longer needed.

5.1.5 Risk Triggers

Risk triggers, such as climate variability, regulatory change, and consumer behavior are not predictable forecasts and can be uncertain factors that can and will greatly affect the actual outcomes of the future water supply reliability for MNWD. These risk triggers will be monitored over time to identify the direction and trends and evaluate their impact on water supply reliability. The associated measurable data and information may give early indications as to the future direction of water reliability. Risk triggers can result in either a positive or negative impact on water supply reliability. Should directions indicate a negative impact on water supply reliability, actions that are considered long-term strategies may be needed sooner rather than later. Whereas a positive impact on water supply reliability may indicate additional actions are no longer needed or may be delayed to a later time, depending on how the future unfolds.

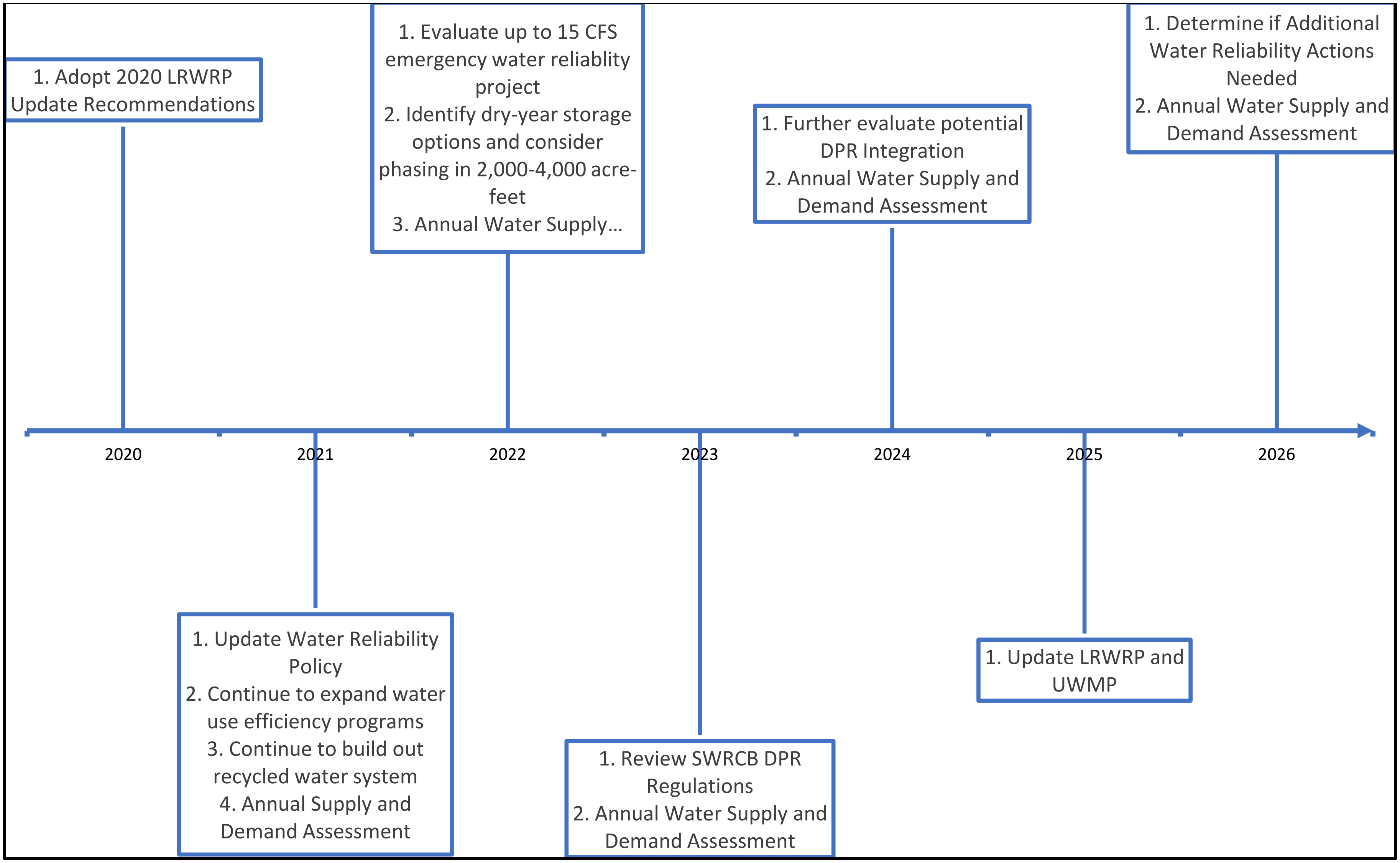


Figure 5-1. 2020 LRWRP Update Recommendations Timeline

Table 5-1 identifies the risk triggers for this 2020 LRWRP Update. Some of these uncertainties will be known or resolved in the coming years while others, such as the Delta Conveyance Project, and climate variability impacts on water supply may not be known or evident for a decade or more. The risk triggers presented in Table 5-1 can be updated, changed, or new triggers added, depending on future circumstances. A primary purpose of the adaptive management approach is to inform investment decisions; therefore, a critical piece of the plan is the monitoring of risk triggers. Risk trigger monitoring would form the basis of an adaptive management approach that the Board could utilize over time to make better informed resource investments and policy direction. Monitoring will identify where adjustments to the adaptive management approach might be needed to respond to changed conditions. Such adjustments could include accelerating or delaying projects due to changes in the demand trend, changing projects due to implementation challenges, adding projects due to lower than expected supply trends, etc.

Table 5-1. Summary of Risk Triggers

Major Risk Trigger	Uncertainty	Potential Impact
Water Use Efficiency	Customer response of water use and implementation of water use efficiency programs	Decrease/increase in water demands
Cost	Increased cost of imported water from MWD and MWDOC	Rate increases; potential competitiveness of local water supply projects
	Grant funding	Grants could lower costs of capital improvements for new water supply projects
Climate Variability	Recurring drought conditions	Increase in water demands/decrease in water supply
Sacramento–San Joaquin River Delta	Implementation and timing of the Delta Conveyance Project	Increase/decrease supply reliability
Regulatory	DPR Regulations	Ability to obtain regulatory approval for a DPR project
	Delta Flow Reductions	Fewer imported supplies
Public Acceptance	DPR Tolerance	Key to implementation of potable reuse project
Technology Advance	DPR	Technology advances that makes treatment costs more competitive
	Advances in water use efficiency devices/new technology	Decrease water demands

5.1.6 Future Supply Project Summary

Table 5-2 provides a summary of the potential new water supply projects outlined in Chapter 4 that could be considered for implementation including potential range of supply yields, development timeline, regulatory requirements, and type of reliability benefits, if known at this time. The data used to characterize these options were based on previous and/or ongoing studies conducted by MNWD, other regional water agencies, and similar projects that have been implemented. The information presented in this table for the water supply projects should not be misconstrued as commitments by MNWD for implementation. They were developed solely for the purpose of evaluating high-level planning options to develop a long-term water resources strategy. Specific project recommendations will come in subsequent, detailed project level studies. Future supply projects will be evaluated according to the criteria detailed in Section 5.2.3, Future Supply Project Evaluation Criteria.

Table 5-2. Summary of Water Supply Projects Considered

Supply Source	Potential Range Supply Yields	Potential Development Timeline	Regulatory Requirements	Reliability Benefits	Level of Stakeholder Involvement
Status Quo Portfolio					
Recycled Water Expansion	306 AF	2030	Minimal	Supply, System	Low
Base-Loaded Portfolio					
Direct Potable Reuse (DPR)	2,000-4,000 AFY	2030-2035	Significant	Supply, System	High
Desalination (Regional – Poseidon) For all SOC[1]	15,964 AFY	2023	Moderate	Supply, System	High
Desalination (Local – Doheny) For all SOC[1]	10,642 AFY	2026	Moderate	Supply, System	High
On-Demand Portfolio					
OCWD Groundwater Banking Program	5,000-10,000 AF	TBD	Minimal	Supply, System	Low
SOC Expanded Emergency Interconnection	TBD	TBD	Minimal	System	Low
Strand Ranch Groundwater Banking	TBD	TBD	Minimal	Supply	Low
Irvine Lake	As Needed	TBD	Minimal	System	Low
MWD Treated Imported Water under WSAP Penalty (Tiers 1 and 2)	As Needed	2020	Minimal	Supply	Low

TBD: To be determined
Sources: [1]MWDODC, 2019.

5.1.7 Future Supply Project Evaluation Criteria

The 2020 LRWRP Update recommends adding up to 15 CFS (10,867 AFY) of new water supplies to increase system and supply reliability but does not make recommendations on specific projects because project implementation recommendations will require more in-depth planning and engineering studies. Specific project recommendations will come in subsequent, detailed project level studies. Future water supply projects will be independently evaluated to determine how each project meets MNWD's water reliability needs and project success criteria. Future water supply projects will be evaluated using both quantitative and qualitative criteria to inform which projects could provide the greatest benefit to water reliability and resiliency. These evaluation criteria would include, but not be limited to:

- **Reliability benefit** – Qualitatively assesses the contribution to improving ability to reliably meet water demands during dry or emergency conditions. Quantitatively assesses the potential yield (in AFY or MGD) expected upon implementation of the project.
- **Costs** – Quantitatively assesses the cost of new supply compared to cost of imported water.
- **Supply sustainability** – qualitatively assess the impact of the new water supply on the natural environment and evaluate if the project is environmentally responsible use.
- **System integration** – Quantitatively assesses how the new supply would integrate into existing operations (e.g., capacity and water quality).
- **Implementation complexity** – Qualitatively assesses how easy or difficult the project is to achieve project approvals (regulatory and public acceptance) and how that is balanced with reliability benefit.
- **Project timeline** – Qualitatively assesses the timeframe for project implementation and realizing its potential benefits compared to the timeline of reliability needs.

Each of these criteria are described further below.

Reliability Benefit

Although the meaning and measurement of water reliability can vary widely, it has been defined for the purposes of this report as the ability to meet water demands consistently. More specifically, this means consistently meeting demands across the full range of climatic conditions (e.g., wet, normal, dry) and meeting acceptable service standards during catastrophic events (i.e., levels of service may be slightly reduced to less than 100 percent of water demand on a temporary basis during severe droughts or catastrophic events). Southern California's water supply is increasingly less reliable given climate variability impacts to imported water, environmental and regulatory decisions that impact supply availability, reoccurring and prolonged droughts, and other factors that indicate more preparation is needed to be prepared to serve our customers well into the future under a range of conditions. Any future water supply project will be evaluated to determine how this new supply would positively impact MNWD's ability to provide system and supply water resiliency. Water supply projects that provide high benefit and low cost will be prioritized over projects that are low benefit and high cost and high benefit and high cost. The reliability benefit should result in a proportional increase of water supply reliability to increased cost.

Costs

The economic aspects of future water supply projects will be a key component in determining which projects to proceed with implementation. Determining what effect new supply projects will have on existing rates and what customers would be willing to pay are important components of the financial analysis that would be undertaken as part of each project's evaluation. Costs for new water supply projects represent the incremental planning, new capital, and operational costs.

The overall unit cost of imported water supply for MNWD includes the cost to purchase untreated and treated water from MWDOC/MWD, treatment at the Baker drinking water treatment plant, and distribution to customers. Continued reliance on imported water to meet future demands is anticipated to increase the costs for MNWD to provide water in the future because as more water supply investments are needed to maintain reliability, the imported water rates are projected to rise (MWD, 2018; MWDOC, 2019). Over the next 30 years, projected water rates for imported water are expected to increase as a result of increasing investments for the SWP and the Delta, investments to maintain the conveyance and distribution system, and increasing operating and maintenance costs (MWD, 2018).

MWD, as part of its Biennial Budget, provides an estimate of their projected water rates and charges over a 10-year period. In the recently adopted Biennial Budget for Fiscal Year 2018-2019 & 2019-2020, MWD published rate projections from 2018 to 2028. Included in the Ten–Year Financial Forecast is MWD's forecasted share of the cost of the Delta Conveyance Project as the project moves forward. Rate increases from FY 2018/19 through FY 2027/28 are projected to be approximately 4.0 percent each year (MWD, 2018). **Table 5-3** shows the Tier 1 and 2 Volumetric Costs for Treated and Untreated Water as identified by MWD (MWD, 2018).

Table 5-3. Tier 1 and 2 Volumetric Costs for Treated and Untreated Water

Rates & Charges Effective January 1st	Untreated Tier 1	Untreated Tier 2	Treated Tier 1	Treated Tier 2
2020	$755	$842	$1,078	$1,165
2021	$784	$861	$1,107	$1,184
2022	$818	$885	$1,141	$1,208
2023	$853	$914	$1,176	$1,237
2024	$885	$941	$1,208	$1,264
2025	$920	$971	$1,243	$1,294
2026	$956	$999	$1,279	$1,322
2027	$994	$1,030	$1,317	$1,353
2028	$1,033	$1,061	$1,356	$1,384
Source: MWD, Biennial Budget, FYs 2018/2019 and 2019/2020.				

Using MWD's published rate projections through 2028, MWDOC estimated the anticipated future costs associated with the MWD supplies to 2050, as shown in **Table 5-4**. However, it is possible MWD's current rate structure and allocation of costs will change over time. Table 5-4 shows the volumetric cost per acre–foot for Tier 1 full service treated water through 2050. Water supply scenario 1A is anticipated to escalate 3.0 percent from 2028 to 2050. Water supply scenario 1B is anticipated to escalate 3.6 percent from 2028 to 2050. Water supply scenario 2A is anticipated to escalate 3.2 percent from 2028 to 2050. Water supply scenario 2B is anticipated to escalate 4.2 percent from 2028 to 2050. As shown, the potential costs of MWD water is anticipated to greatly increase into 2050.

A new supply project costs would be compared to costs of obtaining water from MWD under both Tier 1 and Tier 2 rates. For example, a new water supply project that is comparable in cost to MWD Tier 1 rates would be a reasonable investment and would not significantly alter customer rates. However, if a new water supply is only needed once every seven years, it may be more cost effective to purchase MWD water at the much higher Tier 2 rates because the overall cost of the water would be cheaper in the long-run compared to long-term capital costs of a new supply project. Future water supply projects would be compared against the projected MWD rates in place at the time the project is brought forward for consideration. As the cost of imported water increases, implementation of new local supply projects may become more cost competitive and result in greater reliability.

Table 5-4. Tier 1 Volumetric Costs for Treated Water for the Four Supply Scenarios

Project	2030 Costs	2040 Costs	2050 Costs
MWD Scenario 1A	$1,679	$2,261	$3,029
MWD Scenario 1B	$1,925	$2,551	$3,373
MWD Scenario 2A	$1,715	$2,276	$3,045
MWD Scenario 2B	$1,967	$2,787	$3,649
Source: MWDOC, 2019.			

Supply Sustainability

Sustainable water supply means to find reliable and resilient approaches to various human needs for water that does not exhaust the water sources and the local economy nor have long term negative impact on the environment. Achieving sustainable water management requires a multidisciplinary and holistic approach to implementing new water supply projects. Water sustainability also means effective and holistic management of water resources. There are now multiple demands on water resources, which drive the need for sustainable, integrated, and holistic water management. To decide if a water supply is sustainable, various economic, social, and ecological considerations must be considered. A thorough evaluation of all these factors would be completed when assessing implementation of future water supply projects. In addition, it is anticipated that water supply projects that are sustainable will also be more competitive to receive grant funding support to reduce the cost of project implementation.

System Integration

Projects will be evaluated to determine how projects would integrate into the MNWD system. The project capacity, location, design/construction, would all be evaluated to determine feasibility of implementing the project. An engineering feasibility study would be conducted to provide an in-depth analysis of the project. The evaluation looks at the complete picture of the costs required to complete the project as well as the potential benefits of completion. When the engineering feasibility study indicates that the benefits are significant enough, the project may move forward to the final engineering and construction phases. Should MNWD Board elect to implement a project, an appropriate level of environmental review would be completed along with obtaining any required regulatory approvals.

Implementation Complexity

Project complexity can vary according to engineering obstacles, regulatory permitting constraints, construction hurdles, public acceptance issues, institutional arrangements, as well as project timing conflicts. The varying level of challenges posed by specific water supply projects could impact how a project affects water reliability and costs of implementation. Each of these issues together or separately could severely impact MNWD's ability to implement the project when it is needed. As water supply projects are brought forward, these complexities will be evaluated to determine if these issues would present obstacles that would prevent or substantially delay project implementation. This is not to suggest that projects with challenges cannot be implemented but rather it must be balanced with the necessity to provide water reliability when it is needed.

Project timeline

The project timeframe is another important consideration. Timeframe refers to the point in time when the new water supply would be available to serve our customers. The strategy for implementing a water supply project must maximize the likelihood that MNWD can provide the water when it is needed. Participation in specific water supply projects may be hindered by the timing of the project, either too soon or not soon enough depending on the type of supply and when the supply is needed.

5.1.8 Conclusions

The 2020 LRWRP Update is a strategic planning document that outlines a long-term water resources strategy for MNWD. The 2020 LRWRP Update recommended water supply and system actions based on the best information at the time. The 2020 LRWRP Update analysis indicates that MNWD's water supply and system reliability needs require the addition of a supplemental water supply to ensure enhanced reliability and resiliency through the 2050 planning period. In addition, the 2020 LRWRP Update analysis identifies the need for continued implementation of water use efficiency measures to maximize demand management. The 2020 LRWRP Update will be implemented through an adaptive management approach that will provide MNWD with the information needed to make informed decisions regarding implementation of specific water supply projects. Using the information obtained through the adaptive management approach will help to inform the MNWD Board on what level of investment, and at what time, is desired to achieve enhanced water reliability and resiliency needed to serve our customers into the future.

The one certainty in planning for and providing a reliable supply of water is that supply challenges and uncertainties will continue to exist. Adaptive management is key to balancing insufficient supplies with stranding significant investments if there is too much water. Adaptive management also requires periodic re-assessment over time. Through long-term planning, MNWD will continually examine our water reliability strategies and supply goals, accounting for uncertainties. MNWD will reconsider, and update as needed, the 2020 LRWRP Update every five years, consistent with its Urban Water Management Plan update. The reason for this timing is twofold: (1) a key part of the 2020 LRWRP Update and adaptive management approach will involve re-assessing the status of customer demands and water use efficiency successes, which drives demands on the system, and (2) periodic review and update will allow MNWD to capture newly identified risks as well as supply options without ending up in a position whereby too much time has passed between updates to make meaningful and proactive course corrections. The update will focus on additions of new water sources or improvements to water system facilities that may significantly reduce vulnerability.

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