WATER TOMORROW

Integrated Water Resources Plan

2015 UPDATE

Report No. 1518

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Integrated Water Resources Plan

2015 Update

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WATER TOMORROW

Integrated Water Resources Plan

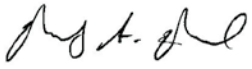
The Metropolitan Water District's decision nearly a generation ago to develop and implement a long-term water vision is benefiting all of Southern California each and every day during this historic drought. The first Integrated Water Resources Plan (IRP) in 1996 anticipated moments of potential shortages. We hope and firmly believe that this updated 2015 IRP Update will prepare the next generation just as capably.

That first IRP embodied the lessons learned from a historic drought in late 1980s and early 1990s that prompted a complete rethinking about Southern California water planning. Expectations of adequate imported supplies regardless of hydrology were set aside. In its place, the inaugural IRP envisioned the diversification of water resources to include water conservation and local resource development. It also envisioned a vast storage network of reservoirs and groundwater banks for Southern California, including Diamond Valley Lake which was completed in 1999. The IRP called for capturing water in wet years, storing those ample supplies for dry years, lowering demand through conservation and developing a more diverse supply portfolio.

Heading into the most recent drought cycle, Metropolitan had developed over 5.5 million acre-feet of storage capacity and had successfully stored over 2.7 million acre-feet. This is a more than 13 times the storage capacity compared to the 1980s, with record quantities of water in reserve. Were it not for the vision of the 1996 IRP and the commitment to implement that vision, Southern California would have not been prepared for this drought. But we were. And to date, significant hardships from drought have been avoided. And with the nation's largest conservation program of its kind, Metropolitan has invested $450 million to remove 175 million square-feet of turf and install tens of thousands of water-saving devices throughout the service area. A cultural shift away from lawns and towards California-Friendly landscapes throughout the Southland is now under way.

Looking ahead, there are challenges facing Metropolitan's imported supplies. The Colorado River essentially has been in drought conditions since the beginning of this century. And the Northern California supplies conveyed via the State Water Project face uncertainties in a changing climate and due to operational constraints in the ecologically struggling Sacramento-San Joaquin Delta. There are plans and initiatives to stabilize these supplies. Locally throughout the service area, there are plans to develop new supplies and lower demands. The 2015 IRP Update starts with some realistic expectations of imported supplies while assuring overall reliability through more conservation, more local supplies and planning for a new generation of supplies should they be needed.

The IRP does not predict the precise water portfolio that Southern California will have in place by the middle of this century. But it does provide both the details and the vision for adaptively managing through the change that is coming. The IRP represents Metropolitan's strategy for navigating the challenging journey that lies ahead.



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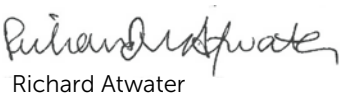

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Executive Summary

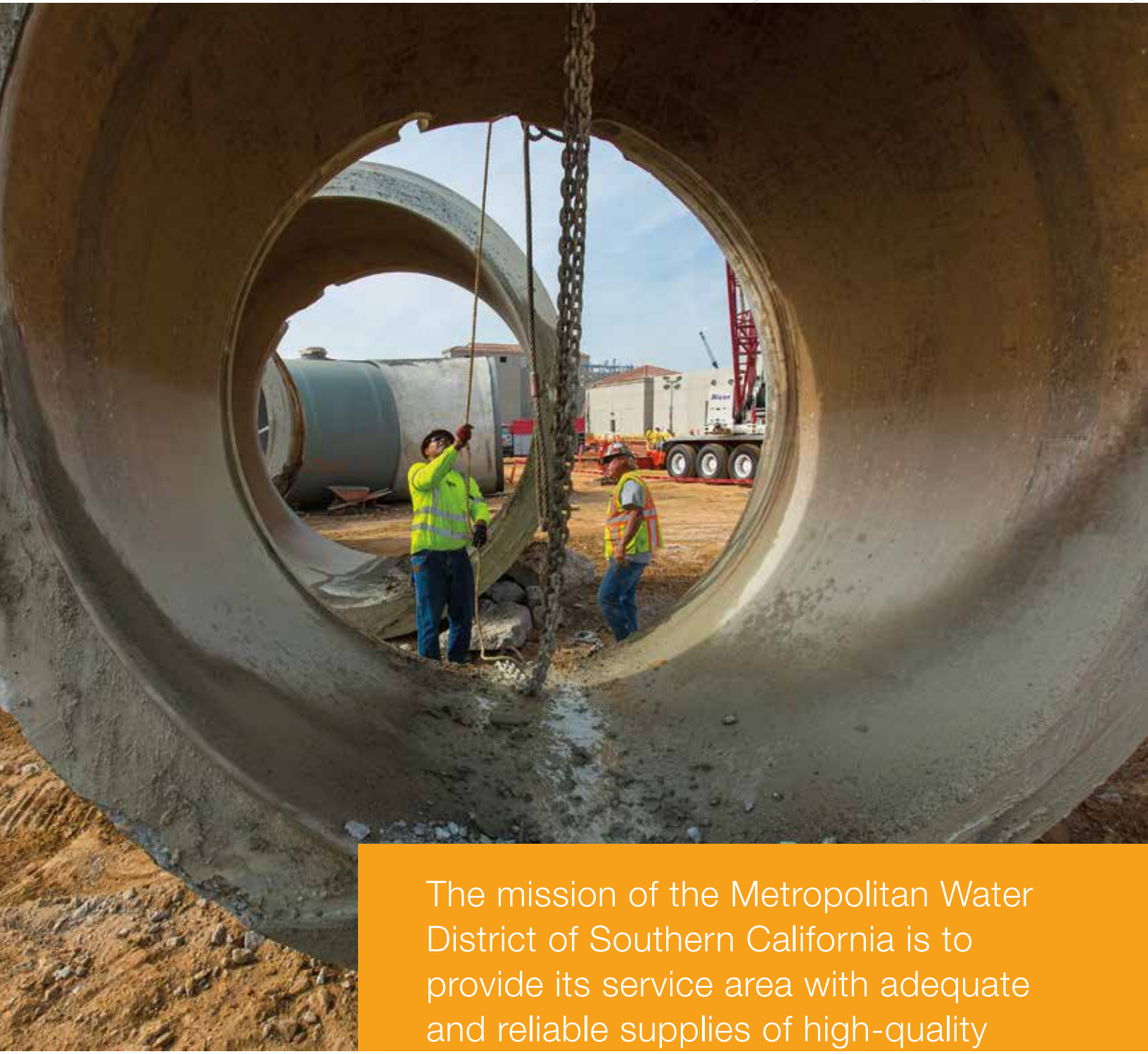
In California water, uncertainty comes with the territory. Being unprepared for tomorrow, however, is simply not an option. The Metropolitan Water District of Southern California prepares for tomorrow with an evolving long-term water strategy known as its Integrated Water Resources Plan, or IRP. The inaugural IRP was adopted in 1996, with updates in 2004 and 2010. The 2015 IRP Update continues the tradition of assessing and adapting to changing conditions facing Southern California.

The fundamental goal of the IRP is for Southern California to have as reliable a water system for tomorrow as the region has enjoyed for decades, regardless of the challenges that emerge along the way. Metropolitan plans to meet this goal through an adaptive management strategy that is the cornerstone of the 2015 IRP Update.

Metropolitan was authorized by the California Legislature in 1928 to advance a regional approach to water supply in Southern California. Metropolitan's initial mission was to construct the 242-mile Colorado River Aqueduct to its service area on the Southern California coastal plain. Metropolitan's service area had an assessed property valuation of approximately $2 billion at the time. Now Metropolitan serves a six-county service area with a property valuation of approximately $2 trillion. Metropolitan imports supplies from both the Colorado River and Northern California via the State Water Project while investing in a variety of storage, local supply and conservation initiatives.

Metropolitan has a long record of promoting alternatives to imported water supplies, dating back to the 1980s. With the IRP, that process became more formalized as a long-term strategy and official policy. Metropolitan has steadily diversified the future water portfolio for Southern California with each revision to the IRP. This update is no exception. Investments to maintain the reliability of imported supplies are complemented by an expansion of local supply development along with a reduction in demand through a variety of conservation and water-use efficiency initiatives.

The necessary suite of actions evolves over time based on the water conditions of tomorrow. Updating the IRP creates a new baseline for managing into the future.



The mission of the Metropolitan Water District of Southern California is to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way.

SETTING THE 2015 IRP UPDATE RELIABILITY TARGETS

The 2015 IRP Update reliability targets identify developments in imported and local water supply and in water conservation that, if successful, would provide a future without water shortages and mandatory restrictions under planned conditions. For imported supplies, Metropolitan looks to make investments in additional partnerships and initiatives to maximize Colorado River Aqueduct deliveries in dry years. On the State Water Project, Metropolitan is looking to make ecologically-sound infrastructure investments so that the water system can capture sufficient supplies to help meet average year demands and to refill Metropolitan's storage network in above-average and wet years. Lowering regional residential per capita demand by 20 percent by the year 2020 (compared to a baseline established in 2009 state legislation), reducing water use from outdoor landscapes and advancing additional local supplies are among the planned actions to keep supplies and demands in balance. Today's best estimates about future conditions are a sound basis for establishing reliability targets. Table ES-1 shows the 2015 IRP Update supply reliability and conservation targets. These targets represent a combined total of 723,000 acre-feet of increased conservation savings and supply production by the end of the forecast period; 485,000 acre-feet from the total conservation target and 238,000 acre-feet from the total supply reliability target. These targets represent the projected levels of imported supplies, local supplies and water conservation necessary to meet the 2015 IRP Update reliability goals.

TABLE ES-1

2015 IRP Update Total Level of Average-Year Supply Targeted (Acre-Feet)

	2016	2020	2025	2030	2035	2040
Retail Demands before Conservation	4,878,000	5,219,000	5,393,000	5,533,000	5,663,000	5,792,000
Total Conservation Target	1,034,000	1,096,000	1,197,000	1,310,000	1,403,000	1,519,000
Retail Demands after Conservation	3,844,000	4,123,000	4,196,000	4,223,000	4,260,000	4,273,000
Minimum CRA Diversion Target	900,000	900,000	900,000	900,000	900,000	900,000
Average Year SWP Target	1,202,000	984,000	984,000	1,213,000	1,213,000	1,213,000
Total Local Supply Target	2,199,000	2,307,000	2,356,000	2,386,000	2,408,000	2,426,000
Total Supply Reliability Target	4,301,000	4,191,000	4,240,000	4,499,000	4,521,000	4,539,000

CONSIDERING RISKS/FACTORING IN CHANGES

Uncertainty is a given in today's water world. Planning for reliability has to take uncertainty into consideration. Metropolitan cannot with absolute certainty predict what supply initiatives will fare perfectly or miss the mark, but the 2015 IRP Update process does consider the many potential risks. Diversifying the water portfolio provides an important hedge against risk, but also adds complexity to the process of considering the many positive and negative scenarios of how supplies may be affected by future conditions. Through the 2015 IRP Update process, foreseeable challenges and risk scenarios were identified that point to the potential of 200,000 acre-feet of additional water conservation and local supplies needed to address these risks.

FUTURE SUPPLY ACTIONS

Future water supply and demand conditions may be beyond any reasonable estimate that can be made today. That said, water agencies can take actions in the coming years to position themselves for what could be a very different future. Metropolitan's 2015 IRP Update calls for considering Future Supply Actions, which are important steps to prepare the region to adapt to water supply condition changes that are different than what is currently anticipated. These steps range from exploring the feasibility of new local supply options, investing in water-saving technologies, acquiring land and proposing ways to reduce regulatory impediments to supply development. The 2010 IRP Update referred to these forward-looking steps as Foundational Actions.

ADAPTIVE MANAGEMENT

Adaptive water management, as opposed to a rigid set of planned actions over the coming decades, is the most nimble and cost-effective manner for Metropolitan and local water districts throughout Southern California to effectively prepare for the future. An adaptive management approach is nothing new. It began to evolve with Metropolitan's first IRP in 1996, after drought-related shortages in 1991 prompted a rethinking of Southern California's long-term water strategy. Reliance on imported supplies to meet future water needs has decreased steadily over time, replaced by plans for local actions to meet new demands. The 2015 IRP Update continues to build a robust portfolio approach to water management.

The 2015 IRP Update Process

Developing a long-term water strategy for a region as complex as Southern California does not happen in a vacuum. Metropolitan is the largest regional water cooperative of its kind in the nation. The development of the 2015 IRP Update reflects the intensely collaborative nature of water planning in Southern California, involving member agencies and numerous stakeholders.

The 2015 IRP Update focuses on ascertaining how conditions have changed in the region since the last IRP update in 2010. This involves developing new reliability targets to meet the evolving outlook of the region's reliability needs, assessing strategies for managing short and long-term uncertainty and communicating technical findings. The 2015 IRP Update also identifies areas where policy development and implementation approaches are needed. These discussions will follow the adoption of this report, and involve extensive interaction with Metropolitan's Board of Directors and member agencies.

Metropolitan faces challenging circumstances with its traditional sources of imported supplies from Northern California and the Colorado River. Using feedback and input from numerous stakeholders, Metropolitan makes projections of the availability of these supplies from a range of potential scenarios. Water agencies throughout the region also offer visions of their futures through their Urban Water Management Plans. These and other planning documents provide important insight into both

local supplies that are likely to come on line in the near future, as well as supplies with a more uncertain future. Any robust outlook about supplies must take into account the many variables that face all the potential sources of water for the region.

Future demands are largely a function of Southern California's projected population growth and the amount of water that each person uses, commonly known as per-capita water use. These two factors have been shifting lower over time. Population growth estimates are not as high as previously forecasted, along with per-capita water use. The 2015 IRP Update reflects the latest and best estimates of these patterns.

A rigorous modeling analysis of supply and demand scenarios under the 2015 IRP Update points to two fundamental findings:

First, if Southern California stopped adapting and rested on its existing supply assets and achievements in conservation, shortages would likely occur at an unacceptable level of frequency in the years ahead. This finding is not a surprise. It is a reminder that working to maintain a reliable water supply is never complete.

Second, if Southern California continued to implement its existing long-term plan as described in the 2010 IRP Update, potential future shortages would be significantly addressed, but not entirely. This finding is equally not a surprise as the 2010 IRP Update provided a robust plan for future reliability. Perhaps the more important piece of this finding is that, although drought conditions in Southern California and throughout the West have dramatically shifted the baseline, maintaining existing water resources will be just as important as developing new approaches.

Together, these findings point to the need for a refinement – not an overhaul – of the adaptive management strategy.

Reliability Strategy

Effective modeling of supply and demand can point out the need to take action. Crafting the right strategy is an entirely different exercise. Lessons from history are to be learned. New possibilities are to be realized.

Overall, the 2015 IRP Update represents a refinement – not an overhaul – of Southern California's water management strategy. Similar to the 2010 IRP Update, the 2015 IRP Update looks to local solutions to close any potential gap between supply and demand. In this refinement, the 2015 IRP Update projects a need for more than 723,000 acre-feet of growth in imported and local supplies and reduced water demands from conservation. This reliability target encompasses the 25-year horizon of the plan and it frames the upcoming Implementation Policy discussion process with Metropolitan's Board of Directors and member agencies.

Within the overall strategy, there are potential new planning shifts for the years to come. The potential completion of the California WaterFix and a modernized water system in the Delta, for example, would create a new physical ability to move additional supplies in average and above-average years. In addition to providing water for storage management, this could also create opportunities for new markets and partnerships. Likewise, the long-time success of Metropolitan's land management program on the Colorado River in the Palo Verde Valley points to the potential of new partnerships with farming communities on the river to stabilize the supply/demand future on the Colorado River.

The 2015 IRP Update represents an evolving point of Southern California's future water strategy that will undoubtedly adapt in expected and perhaps surprising ways in the years to come.

Conclusions

The mission of the Metropolitan Water District is to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way. This is not a singular mission. It reflects the diversity of the challenges of balanced water management and the many facets of any successful IRP.

Overall, Southern California is in an enviable position to approach tomorrow. A generation of diversification of the region's water portfolio provides an asset base and choices on how to adapt to changes ahead.

The Delta water system and ecosystem improvements being advanced by the state and federal administrations, for example, would advance California's official co-equal goals of improving the Delta ecosystem and providing a more reliable water supply for the state. Shoring up the reliability of Metropolitan's baseline imported supplies has proven to be a highly cost-effective investment that protects broad public interests as well as Southland ratepayers.

Looking locally to close the gap between supplies and demands, while making the necessary investments and initiatives to maintain the reliability of imported supplies, is a responsible approach from a regional and statewide perspective. This achieves California's policy for all regions to reduce their reliance on the Delta to meet future needs, while building upon imported supplies in ways that further diversify the Southern California water portfolio.

This vital planning exercise has served Southern California well for a generation. The 2015 IRP Update represents a further step in the iterative planning process of a "living" strategic plan that evolves and adapts as needed to address the needs of the next generation.

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Acronyms and Abbreviations

CII	Commercial, Industrial and Institutional
CPP	Conservation Credits Program
CRA	Colorado River Aqueduct
CVP	Central Valley Project
DWR	California Department of Water Resources
FAF Program	Foundational Actions Funding Program
GHG	Greenhouse Gas
GPCD	Gallons per Capita per Day
HECW	High-Efficiency Clothes Washer
HET	High-Efficiency Toilet
ICP	Innovative Conservation Program
IID	Imperial Irrigation District
IRP	Integrated Water Resources Plan
IRPSIM	Integrated Resources Planning Simulation Model
LAA	Los Angeles Aqueduct
LADWP	City of Los Angeles Department of Water and Power
LRP	Local Resources Program
M&I	Retail Municipal and Industrial
Metropolitan/MWD	The Metropolitan Water District of Southern California
MFR	Multifamily Residential
MOU	Memorandum of Understanding
MW	Megawatt
MWD-EDM	Metropolitan Water District-Econometric Demand Model
MWELO	Model Water Efficient Landscape Ordinance
PVID	Palo Verde Irrigation District
RDM	Robust Decision Making
RFP	Request for Proposals
RTP	Regional Transportation Plan
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SDCWA	San Diego County Water Authority
SDGE	San Diego Gas and Electric
SFR	Single-Family Residential
SNWA	Southern Nevada Water Authority
SoCal Gas	Southern California Gas Company
SWP	California State Water Project
USBR	United States Bureau of Reclamation
UWMP	Urban Water Management Plan
WSAP	Water Supply Allocation Plan
WSDM Plan	Water Surplus and Drought Management Plan
WUCA	Water Utility Climate Alliance

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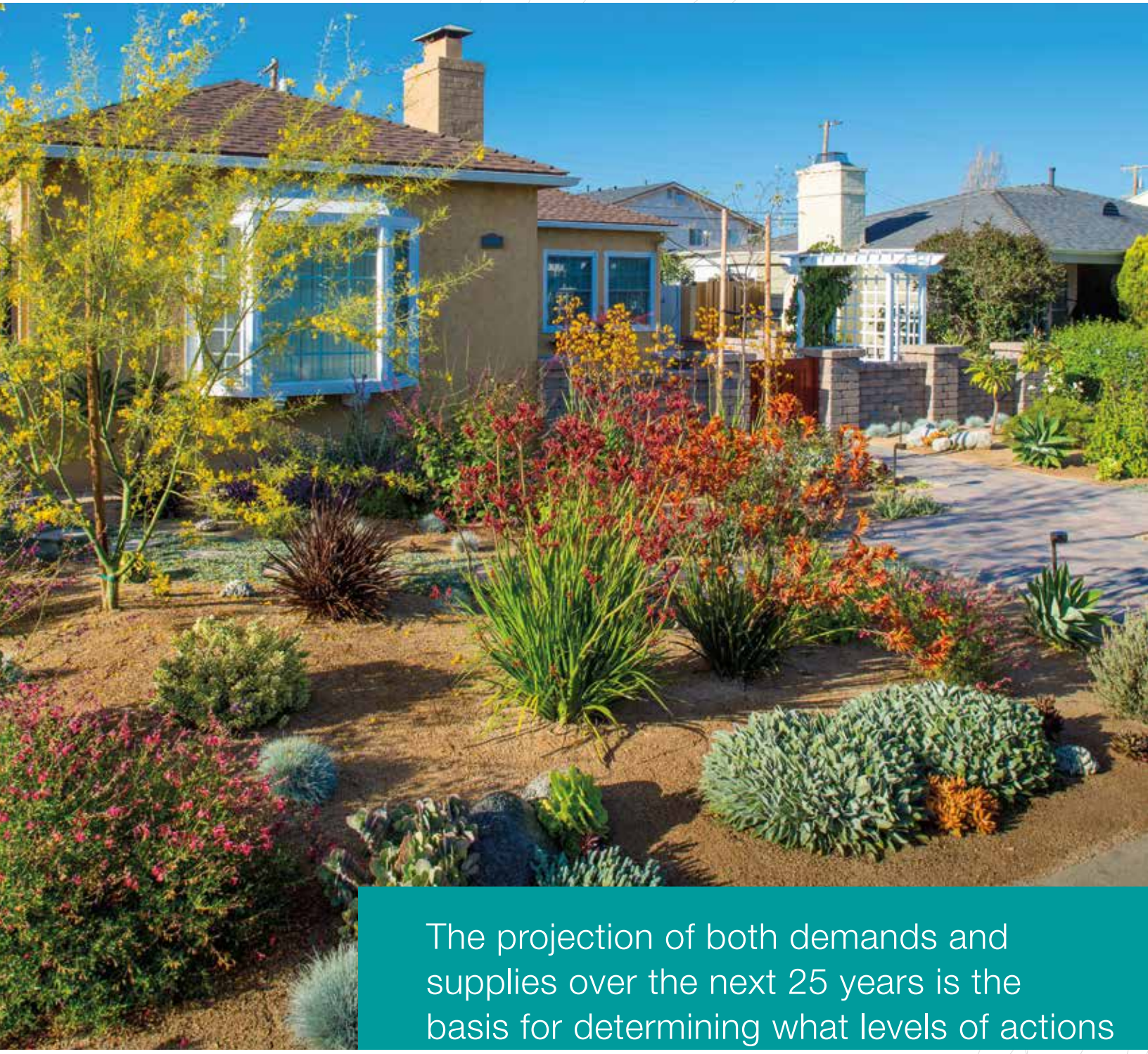
Outlook of Demands and Supplies

The first step in assessing regional needs is to evaluate the outlook of existing regional water supplies and demands and evaluate what water supply reliability would look like without new investment. Metropolitan and its member agencies have developed a wide array of water supplies, both local and imported, and a large portfolio of water storage programs. Even without investment in new water supplies or water conservation, these existing water supplies and programs will continue to provide water and water management. The question is whether they are sufficient to meet future demands.

Retail-level water demands are largely a function of Southern California's future population and its expected level of water use. These two factors have been shifting over time. Population increases are estimated to be less than previously projected. Per-person water use has declined over the past 25 years as water conservation efforts increase.

The 2015 IRP Update reflects the latest and best estimates of these patterns. As detailed in this section, there are some important changes to note. Potential demands in the future appear to be lower than expected. Earlier projections about population growth have been updated with expectations of less growth, which translates into less new demand. Conversely, the supply picture is not as robust as estimated during the 2010 IRP Update. Groundwater supplies in the region may be less than what earlier projections predicted. This is largely due to the ongoing drought, as pumping levels have not been matched with either natural recharge or replenishment with imported supplies. Additional environmental restrictions are also leading to lower projections of SWP supplies, although Metropolitan is taking actions to stabilize these supplies.

The projection of both demands and supplies over the next 25 years is the basis for determining what levels of actions are necessary in the 2015 IRP Update adaptive management strategy. The following section provides detailed descriptions and forecasts of the water supplies and demands that are expected to be in place through 2040. It also shows that, with no new investment, these existing supplies and storage resources are insufficient to meet future demands. These findings reinforce the need to update the IRP periodically to determine whether supply/conservation actions are either on course or need adjusting to meet the reliability targets and that the targets themselves are correct.



The projection of both demands and supplies over the next 25 years is the basis for determining what levels of actions are necessary in the 2015 IRP Update adaptive management strategy.

Description of Water Conservation

Metropolitan and its member agencies have long been leaders in water conservation. Water conservation is encouraged through financial rebates and incentives for water-efficient fixtures and devices, and through plumbing codes and regulations that facilitate water savings. In addition, retail customer conservation and efficient water use is encouraged through tiered pricing: as consumers are shown the higher cost-of-service of increased water use in higher priced tiers, they tend to seek ways to become more efficient and reduce their use. Public outreach and education brings awareness for the need to adopt conservation measures in dry years. Water savings can be achieved through active, code-based and price-effect conservation. In Southern California, where there is a wide array of local and imported water supplies and an interconnected regional water infrastructure, water conservation serves the important regional function of reducing the demand for imported water supplies and thereby making regional water system capacity and storage available and accessible to meet the needs of users in the region.

ACTIVE CONSERVATION

Active conservation is water saved directly as a result of conservation programs by water agencies, including implementation of Best Management Practices by the California Urban Water Conservation Council. Active conservation is unlikely to occur without agency action.

METROPOLITAN'S CONSERVATION CREDITS PROGRAM

Metropolitan fosters active water conservation through its Conservation Credits Program (CCP). A regional program, the CCP provides financial incentives and rebates to residential and commercial customers for water-saving fixtures, devices retrofits and water audits. Since the program's inception in 1990, Metropolitan has provided $487 million in rebates and incentives.

SoCal Water$mart

By the end of fiscal year 2015/16, Metropolitan will have invested an additional $315 million, bringing the total cumulative spending on conservation to $802 million. Thanks to programs and rebates offered on over 80 types of water-efficient devices and fixtures, the CCP generated a cumulative 2.2 million acre-feet of water savings to date for the region. In addition, Metropolitan's member agencies at times administered their own conservation programs that are complementary to the CCP.

In the past 25 years, Metropolitan has developed numerous conservation programs targeting specific groups of water users under the CCP. For example, the former Save-Water-Save-A-Buck program successfully targeted industrial customers to improve water consumption efficiency in manufacturing processes. In recent years, Metropolitan consolidated the residential and commercial rebate programs into a singular regional program called SoCal Water$mart. SoCal Water$mart provides customers with easy access to rebates for water efficient products.

Launched in 2008, SoCal Water$mart provides rebates to residential customers for turf removal, high-efficiency clothes washers, high-efficiency toilets, multi-stream rotary sprinkler nozzles, smart irrigation controllers and residential water audits, among other items. Rebates for commercial customers include water-efficient plumbing fixtures, landscape equipment, food service equipment, HVAC equipment, medical and dental equipment, and turf removal.

The Turf Removal Program presented an opportunity to focus on outdoor conservation and to affect a cultural shift in outdoor landscape water uses.

Indoor conservation continues to play an important role in the region's overall goal of achieving water-use efficiency. Among the items popular with residents are high-efficiency clothes washers (HECW) which can save up to 10,000 gallons per washer per year over a conventional top loading clothes washer. HECWs with an integrated water factor of 3.7 or less are eligible to receive rebates. The integrated water factor is the measure of the amount of water used to wash a standard load of laundry. High-efficiency toilets (HETs) are also very popular among residents and businesses. Since 1990, Metropolitan and its member agencies across Southern California have provided financial incentives to residents and businesses to replace about 3.4 million high-water-consumption toilets (3.5 gallons or more per flush) with ultra-low-flush toilets and HETs. HETs use about 20 percent less water than its predecessor, the ultra-low-flush toilets (1.6 gallons per flush). Recent program changes on toilet rebates reflect the great success in the installation of efficient toilets. Revised rebates are provided for Premium HETs which use even less than HETs.

Metropolitan's Water Savings Incentive Program is a regional pay-for-performance program targeting large water users in the commercial, industrial, institutional, agricultural and large landscape sectors to improve efficiency. This program allows large-scale water users to customize their conservation projects and receive financial incentives for up to ten years of water savings for proven water-use efficiency improvement.

THE NATION'S LARGEST TURF REMOVAL PROGRAM

The unprecedented California drought increased consumer awareness of the serious water supply situation. Following Governor Brown's declaration of a drought emergency in 2014, Metropolitan's Board of Directors approved an expansion of the region's Turf Removal incentive program to meet consumer demands for new ways to save water. The Turf Removal Program presented an opportunity to focus on outdoor conservation and to affect a cultural shift in outdoor landscape water uses. The Turf Removal Program provides residential and commercial customers with financial incentives to replace their turf lawns with California Friendly® landscapes. Metropolitan doubled the existing rebate for Turf Removal to $2 per square foot of turf removed. This increase was on top of a previous increase from $0.30 per square foot to $1 per square foot. Coupled with additional member agency contributions, many Southland residents and commercial and industrial customers were able to remove and replace turf with an incentive of more than $3 per square foot. Following the step-up in the Turf Removal Program, an estimated 175 million square feet of lawn turf was removed. In total, $450 million was invested through the Turf Removal Program and the Conservation Credits Program over a two year period by Metropolitan. Including local and member agency programs, more than half a billion dollars were invested region wide, with the conservation program reaching an estimated 400,000 people. It is expected that the successes of the Turf Removal Program will result in a significant market transformation where consumers

will be aware and motivated to remove and replace turf with California Friendly® landscapes without a financial incentive. Metropolitan's Turf Removal Program and administrative process also served as a model for the rest of the state as part of the Governor's emergency drought responses, with the state calling for the removal of 50 million square feet of turf.

RESEARCH AND DEVELOPMENT

Metropolitan's Innovative Conservation Program (ICP) promotes studies of new water saving technologies through a competitive grant process. Since 2001, the ICP has issued 57 grants with the goal of fairly evaluating new conservation ideas. Metropolitan provided $2 million dollars through the ICP. The U.S. Bureau of Reclamation (USBR), Central Arizona Project and the Southern Nevada Water Authority also provided funding. Examples of projects funded through the ICP include soil amendment, water audit mobile apps, home graywater systems, soil moisture sensors and agricultural irrigation improvements. Metropolitan has also partnered with the Alliance for Water Efficiency to conduct water conservation research. Recent projects include a drought management case study from Australia, a water-neutral development ordinance, a study on commercial kitchen efficiency and a study on the rationale for landscape choices.

CODE-BASED CONSERVATION

Code-based conservation is water saved as a result of changes in water efficiency requirements for plumbing fixtures in plumbing codes. Also referred to as "passive conservation," this form of conservation would occur as a matter of course without additional financial incentives from water agencies.

For more than two decades, Metropolitan has supported plumbing and building code legislation consistent with its water conservation policy. For example, the Energy Act of 1992 required all toilets manufactured after 1994 to flush at 1.6 gallons or less thereby eliminating the manufacturing of new 3.5 gallons per flush toilets. Other recent noteworthy water conservation legislation includes Assembly Bill 715 (Laird 2007), Senate Bill 407 (Padilla 2009) and Assembly Bill 1881 (Laird 2006). AB 715 required toilets and urinals sold in California after January 1, 2014 to have a flush rate of 1.28 gallons or less per flush for toilets and 0.5 gallons or less per flush for urinals. The projected water savings attributed from this law is about 20 percent for each toilet sold and about 50 percent for each urinal compared to what the national standards required. SB 407 required the installation of water conserving plumbing fixtures for all building alterations or improvements to single-family residential real property made after January 1, 2014. The bill also required, on or before January 1, 2017, that all noncompliant plumbing fixtures in any single-family residential real property be replaced by the property owner with water-conserving plumbing fixtures.

For outdoor water use, AB 1881 (Laird 2006), required local agencies to adopt the state's updated Model Water Efficient Landscape Ordinance (MWELO) by January 2010 and required the Energy Commission to adopt performance standard irrigation equipment. On April 1, 2015, the Governor's Executive Order (EO B-29-15) further advanced the objectives of AB 1881. Among other things, the executive order directed the California Department of Water Resources (DWR) to update the state's MWELO through expedited regulation. The California Water Commission approved the revised ordinance on July 15, 2015. The revised MWELO increases water efficiency standards for new and retrofitted landscapes through more efficient irrigation systems, graywater usage, onsite stormwater capture and by limiting the portion of landscapes that can be covered with turf. It also requires reporting on the implementation and enforcement of local ordinances, with adoption and required reports due

by December 31, 2015. As currently written, MWELO does not include the type of enforcement at the local levels that will be required for all new home construction to be compliant.

PRICE-EFFECT CONSERVATION

With price-effect conservation, efficient water usage can be attained through behavioral usage reductions resulting from increases in the price of water. Retail agencies use tiered pricing and water budgets to promote efficient use of water.

Many economic studies have shown that consumers respond to changes in the price of water by reducing usage when faced with higher water rates. The overall cost of water supply and the water systems needed to deliver that water supply have steadily increased, leading to increases in the rates that are paid by the consumers. This trend is expected to continue as the future cost of water will include the higher cost of water supply acquisition, environmental mitigation and infrastructure maintenance and improvement. In addition to the rising cost of water, retail agencies are shifting towards using tiered pricing and water budgets that reflect the higher cost-of-service for providing increasing amounts of water. Under these marginal rate structures, consumers face the true (and higher) cost of incremental water supplies which in turn promotes more efficient use of water and higher water conservation savings.

WATER-USE EFFICIENCY STRATEGY

The Water Conservation Act of 2009 (Senate Bill X7-7) requires a statewide 20 percent reduction in urban per capita water use by 2020. Commonly known as "20x2020," this legislation requires urban retail water suppliers to develop urban water use targets to help meet the 20 percent reduction in per capita water use by 2020, with interim targets for 2015. Per capita reductions can be accomplished through any combination of increased water conservation, improved water-use efficiency and increased use of recycled water to offset potable demand. Retail water suppliers receive partial credit for past efforts in conservation and recycled water; therefore, not all agencies need to reduce per capita demand by an additional 20 percent in order to comply with this law.

Metropolitan, as a water wholesaler, is not covered by this law. However, Metropolitan provides support for Southern California retail agencies through program implementation such as the CCP for conservation and the Local Resources Program (LRP) for the development and use of recycled water. Metropolitan also provides technical assistance, support for legislation, code and standards updates and other financial incentives where needed to increase water-use efficiency.

"Let's All Take A Turn" emphasized the seriousness of the drought and shared the message that if everyone does a little more to save water, it adds up to make a substantial difference.

COMMUNICATION AND OUTREACH

Outreach and education increase the awareness of drought and water shortage with the public and encourage a conservation ethic that increases the adoption of water-saving devices and practices. Metropolitan conducts annual advertising, education and community outreach campaigns to urge residents and business owners to make permanent changes in their everyday uses of water. In the recent drought, Metropolitan in cooperation with member agencies conducted multi-lingual, multi-cultural water conservation advertising and outreach campaigns that turned the goal of saving water into measurable results throughout the region. In 2015, as Southern California entered its fourth year of drought, Metropolitan mounted a visually strong campaign that showcased knobs and faucets and used the tagline "Let's All Take A Turn" to emphasize the seriousness of the drought and share the message that if everyone does a little more to save water, it adds up to make a substantial difference. The research-based campaign included television, radio, digital and outdoor advertising as well as other customized materials and outreach events throughout the Southland. The entire campaign was produced in five languages: English, Spanish, Mandarin, Korean and Vietnamese. The media strategy was developed to effectively target diverse communities, age groups, homeowners and renters and the major languages spoken in the region. The campaign supplemented Metropolitan's other outreach activities and educational programs to inform and assist residents, businesses, public agency officials, community leaders and elected officials on the importance of water conservation.

In addition to advertising and outreach campaigns, Metropolitan continues to maintain a strong presence in community water resource education and conservation activities. Through its Community Partnering Program, Metropolitan co-sponsors water-related education and outreach events for member agencies, community groups and non-profit organizations. Projects include community events, conservation and garden projects, publications in multiple languages and educational materials dealing with watersheds, conservation and water recycling. Metropolitan also continues to update and expand a comprehensive K-12 water education curriculum that meets state standards for each grade level in the areas of science, math, language arts and social studies classroom materials.

Description of Regional Water Resources

The region's water supply portfolio consists of local water supplies, imported water supplies, and the utilization of storage and transfers to provide water supply reliability to Southern California.

LOCAL WATER SUPPLIES

Local supplies are a significant and growing component to the region's diverse water portfolio. Local supplies can provide over half of the region's water in a given year, and it is important to maintain these supplies. Similar to water conservation, local supplies serve the important function of reducing demands for imported

water supplies and thereby making regional water system capacity and storage available and accessible to meet the needs of the region.

The following segment provides background information and discussion on the current state of local water supplies, including:

- Groundwater
- Recycled water
- Seawater desalination
- Los Angeles Aqueduct
- Local surface water
- Other identified resources

These resources are generally developed and managed by local water agencies within the Metropolitan service area. Appendix 2 (2015 IRP Update Issue Paper Addendum) includes additional discussions on groundwater, recycled water, seawater desalination, stormwater direct use and graywater.

GROUNDWATER

Groundwater is the production of water extracted from underground aquifers. Many people in Southern California depend on groundwater as a primary source of water supply. Effective use of local groundwater basins is a significant component of comprehensive water supply planning for Southern California. Groundwater basins within Metropolitan's service area provide an average of 1.4 million acre-feet per year.

Groundwater basins within Metropolitan's service area provide the potential for operational flexibility to manage water supplies in Southern California. Many local groundwater storage programs have been implemented over the years to maximize the use of in-region water supplies. The integration of groundwater and surface water has been part of the local water management in Metropolitan's service area since the 1950s. In addition, flood control agencies have captured local stormwater runoff for groundwater replenishment for more than 100 years, and operated seawater barrier projects in Los Angeles and Orange counties to prevent seawater intrusion into the coastal groundwater basins for more than 60 years. More recently, the expansion of recycled water recharge has improved groundwater sustainability in the region.

To further improve water supply reliability, groundwater recovery projects have been implemented to

recover otherwise unusable groundwater that has been degraded by minerals and other contaminants. These projects include the treatment of groundwater contaminated by various industrial operations and the desalination of brackish groundwater, which has a higher salinity than fresh water, but a lower salinity than seawater.

In the last 10 years, groundwater storage levels in the region have dropped more than 1 million acre-feet. Storage levels in key groundwater basins are nearing or have exceeded previous low levels reached in 1977. However, groundwater production has remained relatively constant despite a substantial decrease in groundwater recharge. Use of imported water for groundwater recharge has also declined in recent years, and has partially been replaced with greater recharge of recycled water. Expansion of recycled water recharge has buffered the region from more severe declines in groundwater supplies.

Groundwater sustainability – the long-term balance of production and recharge – is an integral part of ensuring long-term reliability in the region. The replenishment of the groundwater basins, both passively and actively,

To encourage recycled water development, Metropolitan established the Local Projects Program in 1982 to provide financial incentives to its member agencies for the development of recycled water projects.

is important to meeting that goal. Passive recharge is groundwater replenishment that occurs naturally and includes return flows,mountain recharge and infiltration of precipitation. Today, active (or artificial) groundwater recharge through spreading basins and injection wells supports on average of around 50 percent of the total groundwater production in region.

Threats to sustainability in the region include loss in groundwater production capacity due to ongoing drought, continued loss in recharge due to urbanization, future climate change and groundwater contamination and salt loading.

RECYCLED WATER

Recycled water is wastewater that has been treated so that it can be beneficially used for a variety of purposes ranging from landscape irrigation to groundwater recharge. Recycled water use categories include:

- Non-potable reuse for non-consumptive use such as agriculture and landscape irrigation and industrial uses
- Indirect potable reuse for groundwater recharge and surface water augmentation
- Direct potable reuse to serve purified water directly into a potable water supply distribution system

Recycled water plays an important role in maintaining regional water supply reliability. In 2014, non-potable

and indirect potable reuse projects in the Metropolitan service area collectively produced a total of 414,000 acre-feet. Regulations are currently under development for direct potable reuse and surface water augmentation.

To encourage recycled water development, Metropolitan established the Local Projects Program in 1982 to provide financial incentives to its member agencies for the development of recycled water projects. In 1991, Metropolitan established the Groundwater Recovery Program to provide financial assistance for the development of groundwater recovery projects. In 1995, these two programs evolved into the LRP. The success of the LRP is due to its adaptability to changing conditions. Periodically, Metropolitan and its member agencies review and update the LRP in response to water supply conditions. In October 2014, Metropolitan made significant enhancements to the LRP that consisted of: increasing the incentive amount; providing three incentive payment structures; incorporating seawater desalination as an eligible supply; including onsite retrofit costs; and providing reimbursable services to member agencies to expedite development of ready-to-proceed projects. Since 1982, Metropolitan has provided about $372 million for production of more than 2.2 million acre-feet of recycled water in the region to date. The LRP has incentivized an increased use of recycled water in the region by almost 200 percent.

Metropolitan continues to explore ways to help incentivize recycled water use. In order for a site to receive recycled water, it must be plumbed for recycled water use. On-site conversion costs (borne by customers) are generally high. In July 2014, Metropolitan established the On-site Retrofit Pilot Program to provide financial incentives to customers for the conversion of their potable industrial and irrigation systems to recycled water.

SEAWATER DESALINATION

Seawater desalination utilizes advanced technology to convert ocean water to potable water. The constant availability of ocean water is one of the key benefits of seawater desalination. Thus, Metropolitan and its member agencies have been considering seawater desalination as a potential new supply source since the 1960s. Up until the 1990s, seawater desalination was considered too expensive compared to other resource alternatives, especially imported water. However, advances in membrane technology, energy recovery and process design in the 1990s lowered desalination costs. In the early 2000s, several member agencies began pursuing local seawater desalination projects to diversify their resource portfolios and in 2001, Metropolitan created an incentive program to support these projects. Soon after, the Board of Directors approved Metropolitan's role as a regional facilitator for seawater desalination with the purpose of assisting the member agencies with state and regional development issues. In 2014, Metropolitan included seawater desalination projects in the LRP for the development of additional local supplies.

Most recently, the San Diego County Water Authority (SDCWA) completed construction of the 56,000 acre-foot capacity Carlsbad Desalination project, which is expected to be online by the end of 2015.

LOS ANGELES AQUEDUCT

The city of Los Angeles Department of Water and Power (LADWP), a Metropolitan member agency, imports water from the eastern Sierra Nevada through the LAA. The original LAA, completed in 1913, imported water from the Owens Valley. In 1940, the aqueduct was extended to the Mono Basin. A second aqueduct, which parallels the original, was completed in 1970 increasing the capacity to deliver water from the Mono Basin and the Owens Valley to the city of Los Angeles from 485 cubic feet per second to 775 cubic feet per second.

Over time, environmental considerations have required that LADWP reallocate approximately one-half of the LAA water supply to environmental mitigation and enhancement projects. Limiting water deliveries to the Los Angeles area from the LAA has directly led to increased dependence on imported water supply from Metropolitan.

LAA deliveries are made up of approximately 40 percent of the total runoff in the eastern Sierra Nevada in an average year. Annual LAA deliveries are dependent on snowfall in the eastern Sierra Nevada and are subject to significant hydrologic variability.

Hydrologic impact to LAA water supplies in the Mono Basin and Owens Valley is amplified by the requirements to release water for environmental restoration efforts in the eastern Sierra Nevada. Since 1989, when city water exports were significantly reduced to restore the Mono Basin's ecosystem, LAA deliveries from the Mono Basin and Owens Valley have ranged from a low of 36,000 acre-feet in 2015 to a high of 467,000 acre-feet in 1998. Average LAA deliveries since 1990 have been approximately 240,000 acre-feet, meeting about 40 percent of the LADWP's total water needs.

LOCAL SURFACE WATER

Local surface water resources consist of runoff captured in storage reservoirs and diversions from streams. Reservoirs hold the runoff for later direct use, and diversions from streams are delivered directly to local water systems. Within Metropolitan's service area, local water agencies currently own and operate 34 reservoirs. Although these reservoirs provide a storage capacity of 737,000 acre-feet, annual yield is dependent on rainfall, runoff and other operational considerations. The historic average yield of these local surface supplies, which come from reservoir releases and stream diversions, is about 104,000 acre-feet per year (based on the 2005-2014 average). The annual yield varies widely between wet and dry years, and most reservoirs that capture local surface runoff are operated with minimal carry-over storage. San Diego County has the greatest storage capacity for these types of reservoirs, with approximately 80 percent of the total local agency storage capacity in Metropolitan's service area.

OTHER IDENTIFIED RESOURCES

There are other local resources that have the potential for future development. Current development is on a smaller scale with studies and pilot projects underway.

On-Site Stormwater Capture and Use

Project examples of on-site stormwater use include: on-site cisterns and the collection of rainwater for use in cooling towers, truck washes, drip irrigation, toilet flushing, rain barrels and other non-potable uses such as restrooms, onsite irrigation and subregional/regional storage. Over the past few years, the movement to capture and use stormwater at homes and businesses in multi-beneficial ways has developed significantly.

Metropolitan currently offers a rebate of up to $75 per rain barrel. This rebate was expanded to encourage the use of large-capacity cisterns with a rebate of $300 per unit. Agencies such as LADWP offer an additional $25 per rain barrel. Other agencies offer rain barrel distribution events to encourage outdoor conservation. Rain barrels and cisterns can also increase public awareness of water issues leading to additional conservation activities and provide educational opportunities.

Graywater

Graywater includes wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines and laundry tubs. Graywater does not include wastewater from toilets, kitchen sinks, or dishwashers, or wastewater from diaper cleaning. Graywater is differentiated from blackwater (i.e., wastewater from toilets), treated recycled water and stormwater.

The effectiveness of graywater systems can vary based on recycled water programs that are in place. For example, communities in the Metropolitan service area with centralized recycling facilities may not be suitable for graywater promotion if no net new supplies would be created.

IMPORTED WATER SUPPLIES

The following section provides background information and discussion on the current state of imported water supplies from the Northern Sierra and the Colorado River Basin regions.

THE STATE WATER PROJECT

In 1960, voters statewide paved the way to construct

the SWP by approving the bonds for its construction, with Metropolitan to be the largest investor in the project. Metropolitan became the first of 29 agencies that contracts for a long-term water supply from the SWP, which consists of facilities to capture, store and transport water from the Feather River in Northern California. Metropolitan's contract is the largest of all of the State Water Contractors, with its 1,911,500 acre-foot contract amount comprising almost half of the total contract amount of 4,172,686 acre-feet. Each contractor is responsible for paying for its proportionate share of the physical facilities needed to deliver water supplies to its service area. Metropolitan's contract rights under the State Water Contract are described below.

SWP Contract Provisions

Table A Contract Amount: Metropolitan's basic contract amount is for 1,911,500 acre-feet. This represents the amount of water supply that would be available to Metropolitan in years where there is sufficient water supply for the SWP to deliver 100 percent of its total contract amounts. The amount of supply actually available on an annual basis is allocated to the State Water Contractors based on their proportionate Table A amounts. As a percentage of total contract amounts, annual SWP allocations have ranged from 5 percent to 100 percent of the Table A contract amounts. Metropolitan fully recognizes the range of deliveries and does not rely on a full Table A contract amount in its planning or operations.

Article 21 Interruptible Supplies: Metropolitan has a contract right to water supplies that are made available on an intermittent basis. Storm flows can occasionally make water supplies available that are in excess to the Table A allocation. State Water Contractors can take delivery of these supplies, with their rights being based on their proportional Table A contract amounts. Historically, Article 21 interruptible supplies have ranged from 0 to 240,000 acre-feet annually.

Turnback Pool: State Water Contractors have an option to return unused water supplies. These unused supplies are then made available through the Turnback Pool and

Photo by Florence Low, Courtesy of the CA Department of Water Resources

can be purchased by other contractors. Historically, Turnback Pool supplies have ranged from 0 to 282,000 acre feet annually. However, Turnback Pool supplies are not frequently available.

Other SWP Supplies and Agreements

In addition to the basic SWP contract provisions, Metropolitan has other contract rights that accrue to the overall value of the SWP. In addition to the contracted provisions, because each contractor is paying for physical facilities, they also have the right to use the facilities to move water supplies associated with agreements, water transfers and water exchanges. Metropolitan has also entered into agreements and exchanges that provide additional water supplies. These contract rights and agreements are detailed below:

Article 56 Carryover Storage: Metropolitan has the right to store its allocated Table A contract amount for delivery in the following year. Metropolitan can store between 100,000 and 200,000 acre-feet, depending on the final water supply allocation percentage.

SWP Terminal Storage: Metropolitan has contractual rights to store up to 65,000 acre-feet of water in

Lake Perris (East Branch terminal reservoir) and 153,940 acre-feet of water in Castaic Lake (West Branch terminal reservoir). This storage provides Metropolitan with additional options for managing SWP deliveries to maximize yield from the project. Any water used must be returned to the SWP within five years or it is deducted from allocated Table A amounts in the sixth year.

Desert Water Agency/Coachella Valley Water District SWP Table A Exchange Agreement: Desert Water Agency and Coachella Valley Water District are State Water Contractors. They are located in the Coachella Valley, near Metropolitan's CRA. Instead of building physical facilities to deliver SWP water, Desert Water Agency/Coachella Valley Water District entered into an exchange agreement with Metropolitan to exchange SWP supplies for Colorado River supplies. Although this exchange is a net-zero in terms of water supply, the exchange agreement adds system flexibility, cost savings and water quality benefits for Metropolitan.

Desert Water Agency/Coachella Valley Water District Advance Delivery Agreement: Metropolitan can deliver Colorado River water to these two agencies in advance of the actual exchange of SWP Contract Table A allocations (see Exchange Agreement above). By delivering water in advance, Metropolitan can cover exchange obligations in advance of a given year and thus is able to receive Desert Water Agency/Coachella Valley Water District's available SWP supplies in a future year without having to deliver an equivalent amount of Colorado River water. This is essentially a storage program and allows for an increase in total water supplies for Metropolitan when needed.

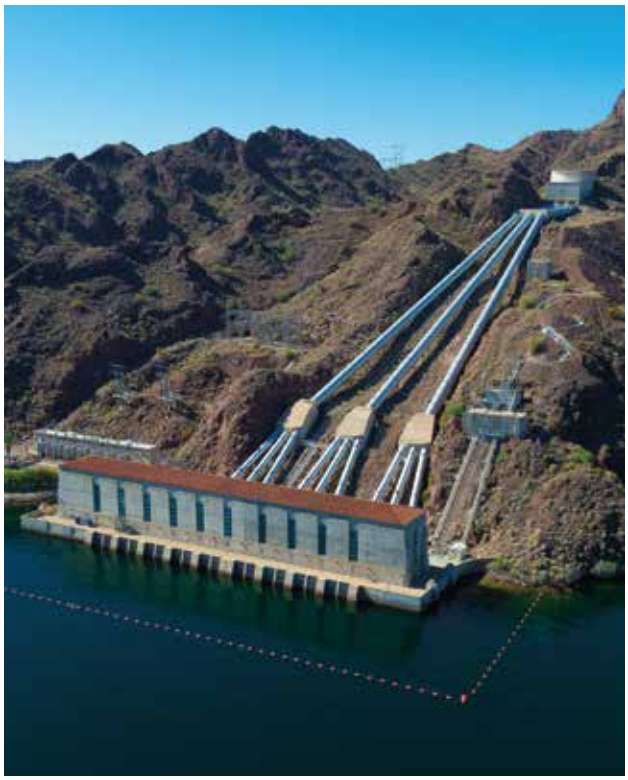
Desert Water Agency/Coachella Valley Water District SWP Table A Transfer: Metropolitan transferred 100,000 acre-feet of its SWP Table A amount (reducing Metropolitan's 2,011,500 acre-foot Table A contract amount to the current 1,911,500 acre-feet) to the Desert Water Agency/Coachella Valley Water District effective January 1, 2005. The Desert Water Agency/Coachella Valley Water District pays all SWP charges for this water, including capital costs associated with capacity in the SWP to transport this water to Lake Perris, as well as the associated variable costs. Water is delivered through the existing Desert Water Agency/Coachella Valley Water District exchange agreements. Metropolitan retains the option to recall and take delivery of the SWP transfer water (subject to the associated contract rights and provisions) in any year. The agreement reduces Metropolitan's SWP fixed costs in years when it has sufficient supplies while preserving an option for dry-year SWP supply.

Desert Water Agency/Coachella Valley Water District Other SWP Deliveries: Since 2008, Metropolitan takes delivery of non-SWP supplies acquired by the Desert Water Agency/Coachella Valley Water District. These deliveries have included water acquired from the Yuba Dry-year Water Purchase Program, the 2009 Drought Water Bank and Multi-Year Water Pool Demonstration Program.

Yuba Dry-Year Water Purchase Program: In December 2007, Metropolitan entered into an agreement with DWR for participation in the Yuba Dry-year Water Purchase Program. Under this program, water is made available for transfer. There are four components to this water purchase program, with differing transfer amounts and prices.

Factors that Could Impact SWP Supplies in the Future

The Sacramento-San Joaquin Delta is the hub of the SWP system. However, multiple stressors have impaired the ecological functions of the Delta. Various regulatory requirements are placed on the SWP's Delta operations to protect special-status species such as Delta smelt and spring- and winter-run Chinook salmon. The terms of biological opinions by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service have become increasingly restrictive over the years. SWP exports have decreased since 2005 as the federal biological opinions went into effect, restricting operations. Without a permanent fix in the Delta, standards that restrict flow and exports are expected to be the status quo. Pumping and exports would likely continue to decline through time as conditions for native species degrade.



THE COLORADO RIVER AQUEDUCT

Metropolitan built, owns and operates the 242 mile CRA. The CRA originates at Lake Havasu on the Colorado River and winds through a series of pump stations and reservoirs through the California desert to its terminal reservoir at Lake Mathews in Riverside County. The CRA has a full delivery capacity of about 1.2 million acre-feet.

The state of California holds a 4.4 million acre-foot normal apportionment to Colorado River water. Within the state's amount, Metropolitan has the Fourth Priority right to a normal apportionment of 550,000 acre-feet per year. Metropolitan also holds the Fifth Priority right for an additional 662,000 acre-feet per year, but this amount is outside of California's 4.4 million acre-feet per year normal apportionment and is only available when surpluses are declared or when unused supplies from other Colorado River users are available.

CRA Supply Development

Metropolitan has developed a number of supply and conservation programs to increase the amount of supply available from the CRA.

Imperial Irrigation District/Metropolitan Conservation Program: Since 1988, Metropolitan has funded water conservation programs within Imperial Irrigation District's (IID) service area. The conserved water from these programs is then transferred to Metropolitan. Conservation approaches range from distribution system improvements – such as the installation of non-leak irrigation gates – to water saving practices such as delivering water to farmers on a 12-hour rather than a 24-hour basis. Through this program, a total of 105,000 acre-feet per year of water is conserved.

Palo Verde Land Management & Crop Rotation Program: In 2005, Metropolitan entered into a 35-year program with the Palo Verde Irrigation District (PVID). Under the program, participating farmers in PVID are paid to reduce their water use by leaving up to 35 percent of their PVID acreage unirrigated. Between 33,000 and 133,000 acre-feet are made available to Metropolitan under this program.

Southern Nevada Water Authority Exchange: In 2004, Metropolitan and Southern Nevada Water Authority (SNWA) entered into an interstate storage and release program, in which Metropolitan stores otherwise unused SNWA supplies with an agreement to return the stored water in the future when needed by SNWA. As of 2015, Metropolitan had stored more than 400,000 acre-feet of water on behalf of SNWA, with a commitment to return 330,000 acre-feet at a later date.

Lower Colorado Water Supply Project: In March 2007, Metropolitan, the city of Needles and the USBR executed the Lower Colorado Water Supply Project contract. Under the contract, Metropolitan receives water that is unused by the project participants. Metropolitan receives 2,000 to 7,000 acre-feet per year from this project.

Intentionally Created Surplus Program: Under this program, Metropolitan may store conserved water in Lake Mead. Only water that has been conserved through extraordinary conservation measures, such as land fallowing, is eligible for storage in Lake Mead. These storage accounts are made up of water conserved by

fallowing in the Palo Verde Valley, projects implemented with IID in its service area, groundwater desalination, the Warren H. Brock Reservoir Project and the Yuma Desalting Plant pilot run.

Additional Non-Metropolitan CRA Supplies

In addition to Metropolitan's supply programs on the CRA, the SDCWA participates in two projects that also result in increased amounts of Colorado River water being delivered into the CRA to Southern California.

Imperial Irrigation District Transfer to San Diego County Water Authority: On April 29, 1998, SDCWA executed an agreement with IID to purchase conserved water. In order to deliver that water to SDCWA, Metropolitan and SDCWA entered into an exchange contract under which SDCWA makes the conserved water available to Metropolitan at Lake Havasu and Metropolitan delivers an equal amount of water to SDCWA. The transfer amount is scheduled to ramp up to 200,000 acre-feet by 2023. In 2015, 100,000 acre-feet were delivered.

All-American Canal and Coachella Canal Lining Projects: The state of California primarily funded, with support from Metropolitan and SDCWA, the lining of portions of the All-American and Coachella canals. The lining conserves approximately 96,000 acre-feet annually that were being lost through the formerly unlined canals. About 80,000 acre-feet of conserved water are delivered to the SDCWA via exchange with Metropolitan. The remaining 16,000 acre-feet are purchased by Metropolitan from the La Jolla, Pala, Pauma, Rincon and San Pasqual Bands of Mission Indians, the San Luis Rey River Indian Water Authority, the city of Escondido and the Vista Irrigation District, all of which will eventually receive the water directly upon completion of a water rights settlement.

Factors that Could Impact CRA Supplies in the Future

Other users along the Colorado River have rights that allow their water use to increase as their demands for water increase. Because Metropolitan holds the lowest priority Colorado River rights in California, any increase in these Present Perfected Rights will reduce supply available to Metropolitan. The Colorado River faces long-term challenges as demands on the river exceed available supply. In 2015, Lake Mead reached its lowest level in history since being filled, and the long-term outlook is for continued decline of the reservoir. These factors could reduce the amount of Colorado River water currently available to Metropolitan.

STORAGE AND TRANSFERS

Over the past two decades, Metropolitan has developed a large regional storage portfolio that includes both dry-year and emergency storage capacity. Storage is a key component of water management. Storage enables the capture of surplus amounts of water in normal and wet climate and hydrologic conditions when it is plentiful for supply and environmental uses. Stored water can then be used in dry years and in conditions where augmented water supplies are needed to meet demands. Storage generally takes two forms: surface reservoirs and groundwater basin storage. Since 1990, Metropolitan has invested billions of dollars to develop both forms of storage. In total, Metropolitan has developed dry-year storage with a capacity of more than 5.5 million acre-feet, a thirteen fold increase in storage capacity available to manage regional water supplies.

Some examples of storage resources that have been developed since 1990 include:

SURFACE WATER RESERVOIRS

- Diamond Valley Lake (810,000 acre-feet)
- SWP Article 56 Carryover Storage (up to 200,000 acre-feet)
- Flexible Storage in Castaic Lake and Lake Perris (219,000 acre-feet)
- Intentionally Created Surplus in Lake Mead (1.5 million acre-feet)

GROUNDWATER STORAGE

- Member Agency Conjunctive Use Programs (210,000 acre-feet)
- Semitropic Storage Program (350,000 acre-feet)
- Arvin-Edison Storage Program (350,000 acre-feet)
- San Bernardino Municipal Water District Storage Program (50,000 acre-feet)
- Kern Delta Water District Storage Program (250,000 acre-feet)
- Mojave Storage Program (390,000 acre-feet)

Table 3-1 shows the total storage capacity, aggregated put and take capacities (i.e., how much that can be "put" into storage, or taken out) and the projected 2015 end of year storage balance.

TABLE 3-1
Storage Program Capacities by Region and Estimated 2015 Ending Balances in Storage (Acre-Feet)

	PROGRAM STORAGE CAPACITY	MAXIMUM PUT CAPACITY	MAXIMUM TAKE CAPACITY	2015 ESTIMATED ENDING BALANCE[1]
Central Valley and SWP	1,630,000	540,000	560,000	460,000
Colorado River	2,390,000	650,000	600,000	290,000
In-Region	1,300,000	900,000	940,000	190,000
Subtotal Dry-Year Storage	5,320,000	2,090,000	2,100,000	940,000
Emergency Storage	647,000	647,000	0	647,000
Total Storage	5,967,000	2,737,000	2,100,000	1,587,000

[1]Based on the current trend as of September 2015; may vary depending on demands and hydrologic conditions for the remainder of the calendar year

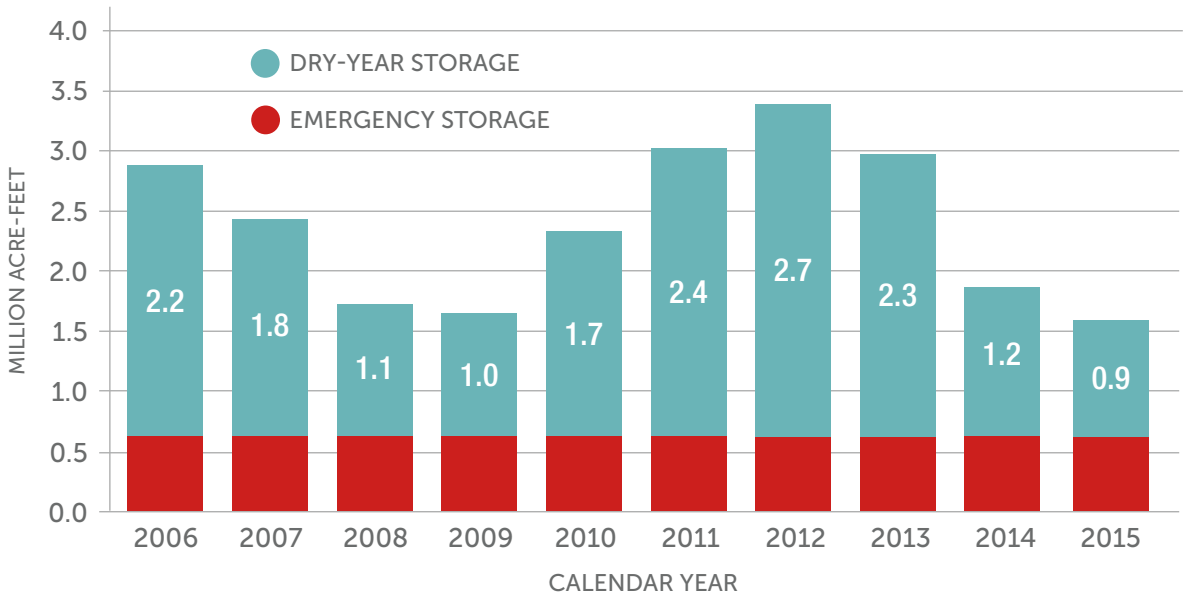
The withdrawal of water from Metropolitan's storage in dry years and the purchase of "transfer" water from willing sellers in these years, have played an integral role in maintaining Metropolitan's water supply reliability. Under the 2015 IRP Update, the role of storage and transfers will continue to be critically important for balancing water supplies and demands.

Figure 3-1 shows the actual end of year balances in Metropolitan storage from 2006 through 2014, and the estimated balance for the end of 2015 based on current trends. In addition, Metropolitan maintains roughly 650,000 acre-feet of emergency storage in all years. Figure 3-1 further illustrates how storage has been used to successfully manage annual differences between supplies and demands. At the end of 2006, Metropolitan's dry-year storage

reserves reached 2.2 million acre-feet. From 2007 through the end of 2009, Metropolitan withdrew 1.2 million acre-feet from its storage reserves to help mitigate shortfalls between supplies and demands. These shortfalls were due in large part to low SWP deliveries, new fisheries restrictions and a sequence of dry hydrologic conditions. From the end of 2009 through the end of 2012, improved hydrologic conditions on the SWP, combined with low demands, allowed Metropolitan to return 1.7 million acre-feet to its storage reserves. Due to unprecedented dry conditions throughout California in 2013 and 2014, Metropolitan again called on storage reserves to manage reduced water supplies. In 2013 and 2014, Metropolitan withdrew a combined 1.5 million acre-feet from its dry-year reserves. At the time that the 2015 IRP Update was being developed, Metropolitan planned on drawing an additional 260,000 acre-feet from storage reserves in 2015. Metropolitan's dry-year storage reserves were projected to end the year at around 940,000 acre-feet.

FIGURE 3-1

Ending Storage Balances 2006-2015[1]



[1]2015 projection based on the current trend as of September 2015; may vary depending on demands and hydrologic conditions for the remainder of the calendar year

Water transfers are an integral part of the water management strategy for Metropolitan. Water transfers are generally described as temporary or limited-term voluntary transactions of water supplies between willing parties. There are a number of programs that are considered to be water transfers. Some of these programs, particularly those with a longer term, are described in previous sections on the SWP and CRA. Metropolitan also regularly explores opportunities for shorter-term water transfers that provide water supply benefits in dry years. In the drought of the late 1980s and early 1990s, Metropolitan participated in dry-year transfers and water bank programs to help manage through that period. However, in the most recent drought period, these types of transfers were not as readily available. As a result, Metropolitan did not pursue large amounts of water transfer supplies in 2014 or 2015 primarily due to very limited transfer water availability, high water transfer costs, and potential high water losses that would result from conveying the transfer supplies through the Delta.

The limited availability of dry-year transfers in 2014 and 2015 is an important lesson learned for the 2015 IRP Update. The value of water transfers for water supply reliability in the 2015 IRP Update will come from a comprehensive water transfer approach. This approach seeks to procure water transfers in normal and wet years and integrate these water transfers with the regional storage portfolio to maximize their dry-year value. The regional storage portfolio is also a key to facilitating unbalanced water exchanges in the future. In an unbalanced exchange, a participant will commit to deliver a quantity of water in a given year in exchange for receiving a greater or lesser proportion of that quantity in a future year. This type of water transfer agreement extends the use of Metropolitan's storage to manage other water user's surplus supplies in exchange for additional water deliveries.

Appendix 3 and Appendix 4 provide additional information on Metropolitan's storage and transfer programs.

Forecasting the Regional Need: Demands and Water Conservation

Retail water demand forecasting is essential for planning total water requirements in Metropolitan's service area. Retail water demand can be met through a combination of conservation, local supplies, and imported supplies. As a wholesale water supplier, Metropolitan's long-term plans focus on the future demands for Metropolitan's imported supplies. In order to project the need for resources and system capacity, Metropolitan begins with a long-term projection of retail water demands. Total retail demands include:

- **Retail Municipal and Industrial (M&I):** Retail M&I demands represent the full spectrum of urban water use within the region including residential, commercial, industrial and institutional water uses. To forecast retail M&I demands, Metropolitan uses econometric models that have been adapted for conditions in Southern California. The econometric models are statistical models that can capture and explain the impacts of long-term socioeconomic trends on retail M&I demands. The econometric models incorporate projections of demographic and economic variables from regional transportation planning agencies to produce forecasts of water demand.

- **Retail Agricultural Demand:** Retail agricultural demands consist of water use for irrigating crops. Metropolitan's member agencies provide projections of agricultural water use based on many factors, including farm acreage, crop types, historical water use and land use conversion.

- **Seawater Barrier Demand:** Seawater barrier demands represent the amount of water needed to hold back seawater intrusion into the coastal groundwater basins. Groundwater management agencies determine the barrier requirements based on groundwater levels, injection wells and regulatory permits.

- **Replenishment Demand:** Replenishment demands represent the amount of water member agencies plan to use to replenish their groundwater basins in order to maintain sustainable basin health and production. Replenishment demands reflect updated estimates which include water needed to recover basins from current drought conditions.

RETAIL M&I DEMAND FORECAST

In forecasting retail M&I water demand, Metropolitan employs an econometric model (the Metropolitan Water District - Econometric Demand Model or MWD-EDM). MWD-EDM utilizes multiple regression, which is generally favored by academics and practitioners for long-term water demand analysis. It uses demand relationships based on actual observed behavior to consider the effect of anticipated changes in demand factors on long-term demand.

The MWD-EDM is comprised of three separate regression models:

- Single-Family Residential (SFR) Model
- Multifamily Residential (MFR) Model
- Commercial, Industrial and Institutional (CII) Model

The SFR and MFR models forecast average monthly household consumption before conservation while the CII model forecasts average monthly consumption per employee. Each of the models estimates water demand before conservation. More information on the regression models can be found in Appendix 7.

DEMOGRAPHICS

Metropolitan's retail demand modeling is driven by key demographics such as projected population, households, employment and median household income. These projections are produced by regional transportation planning agencies as part of their long-term regional growth plans. The forecasts that were previously used in Metropolitan's 2010 IRP Update represented the most recent forecast of retail demands based on then-current growth projections. Since then, data from the 2010 Census showed that the earlier growth projections had overestimated growth trends. In addition, the economic recession that began in 2007 had widespread and persistent impacts that prompted government agencies to revise growth projections. The 2015 IRP Update uses the revised growth forecasts that incorporate effects from the 2010 Census recalibration and the economic recession.

Metropolitan uses demographic growth projections produced by two regional transportation planning agencies, the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG). Together they represent more than 200 cities in Southern California and produce long-term transportation and housing plans for sustainable communities. Among other responsibilities, SCAG and SANDAG also prepare projections of population, households, income and employment for their regions. Both planning agencies update their regional growth forecasts approximately every four years, at different times. SCAG is the regional planning agency for six counties: Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura. SANDAG is the regional planning agency for San Diego County. Metropolitan uses the forecast for every county except Imperial, which is outside of Metropolitan's service area. Significantly, SCAG and SANDAG official growth projections are backed by environmental reports. These regional growth forecasts provide the core assumptions underlying Metropolitan's retail demand forecasting model.

Recent Demographic Forecasts

In April 2012, SCAG released the *2012-2035 Regional Transportation Plan/Sustainable Communities Strategy* growth forecast (RTP-12). The RTP-12 incorporated updated data and assumptions that reflected the 2007-2009 economic recession, the 2010 Census count and 2011 employment data from the California Employment Development Department for the Imperial, Los Angeles, Orange, Riverside, San Bernardino and Ventura counties.

In October 2013, SANDAG released the Series 13: 2050 Regional Growth Forecast, a comprehensive projection of the regional demographic, economic and housing trends expected over the next four decades for the San Diego region. Metropolitan uses the forecast for the San Diego County Water Authority's service area in the retail demand forecast.

In March 2011, the U.S. Census Bureau released the decennial 2010 population count for the counties served by Metropolitan, which was much lower than existing estimates. SCAG and SANDAG lowered their growth projections to account for the decennial census count as well as changed economic conditions due to the Great Recession. Their current growth forecasts reflect these adjustments. The following table provides the forecast of population, households, and employment.

TABLE 3-2
Forecast of Primary Demographic Drivers

	2016	2020	2025	2030	2035	2040
Population	18,928,000	19,354,000	20,019,000	20,637,000	21,206,000	21,791,000
Households	6,154,000	6,413,000	6,653,000	6,872,000	7,095,000	7,323,000
Employment	8,276,000	8,538,000	8,875,000	9,166,000	9,356,000	9,628,000

Effects of the Great Recession on SCAG's and SANDAG's Forecasts

The Great Recession of 2007-09 severely impacted the region's economic growth. Economic growth is a major factor in population growth through migration. Job availability attracts people to the region. Conversely, a scarcity of employment leads to out-migration as people leave in search of work. Between 2007 and 2010, the region lost approximately 750,000 jobs. The state and the region experienced disproportionately high job losses compared with the nation. Because patterns of migration are influenced by job availability, Southern California saw net out-bound domestic migration. Other major factors that affect population growth are fertility and mortality. The acute economic uncertainties also affected people's decision to start a family. Consequently, delayed family formation and reduced birth rates contributed to slower population growth than was anticipated before the recession. However, mortality rates are projected to be lower as well, and the proportion of older people (age 65+) significantly increases. As a result, the net growth in population in the post-recession era is projected to be lower than previously projected in the 2010 IRP Update. Appendix 6 provides a detailed comparison of the demographic projections used in Metropolitan's 2010 and 2015 IRP Updates.

Total demand in Table 3-3 represents the amount of water need in Metropolitan's service area for consumption and for maintaining production of local groundwater and surface reservoirs.

TABLE 3-3
Forecast of Retail Demands by Type (Acre-Feet)

DEMAND	2016	2020	2025	2030	2035	2040
Retail M&I[1]	3,344,000	3,669,000	3,732,000	3,801,000	3,870,000	3,925,000
Retail Agricultural	110,000	130,000	167,000	163,000	161,000	160,000
Seawater Barrier	72,000	72,000	72,000	72,000	72,000	72,000
Replenishment	326,000	292,000	295,000	297,000	297,000	297,000
Total Demand	3,852,000	4,163,000	4,266,000	4,333,000	4,400,000	4,453,000

[1]Retail M&I demand post-conservation.

CONSERVATION SAVINGS MODEL

Unlike traditional water supplies, which can be directly measured, conservation reduces water demand in ways that can only be quantified indirectly. Demand is reduced through changes in consumer behavior and savings from water-efficient fixtures, such as toilets and showerheads. There are numerous approaches for estimating and projecting conservation savings, and many are utility-specific to meet the unique needs of different water agencies. Metropolitan has developed a Conservation Savings Model (Conservation Model) to estimate savings from the extensive existing conservation programs funded by Metropolitan, as well as those produced by plumbing codes. Metropolitan also incorporates the savings due to the impacts of price on consumers in its demand forecasts. The retail demand estimates shown in Table 3-3 already reflect the reductions achieved from these conservation savings projections.

Conservation savings are commonly estimated from a base-year water-use profile. Beginning with the 1996 IRP, Metropolitan identified 1980 as the base year for estimating conservation because it marked the effective date of a new plumbing code in California requiring toilets in new construction to be rated at 3.5 gallons per flush or less. Between 1980 and 1990, Metropolitan's service area saved an estimated 250,000 acre-feet per year as the result of this 1980 plumbing code and unrelated water rate increases. Within Metropolitan's planning framework, these savings are referred to as "pre-1990 savings." Pre-1990 savings were estimated for the 1996 IRP. Metropolitan's conservation accounting combines pre-1990 savings with estimates of more recently achieved savings.

The Conservation Model also estimates water savings from the new state landscape ordinance known as MWELO. Water savings from MWELO are estimated with two primary constraints. First, the MWELO ordinance applies only to new home construction and existing households and businesses when permits are required for large landscape retrofits. This comprises only a small proportion of the region's total households and businesses. Second, the current MWELO does not have a uniformly effective enforcement mechanism, leading to questions on whether all parts of Metropolitan's service area would comply with the new standards. The Conservation Model accounts for this by

discounting the percentage of new homes that would comply. In addition, for this analysis MWELO is assumed not to affect existing homes and businesses; therefore savings associated with MWELO compliance are not calculated for existing stock.

The Conservation Model accounts for the following sources of conservation savings:

- **Active Conservation:** Water saved directly as a result of conservation programs by water agencies, including implementation of Best Management Practices established by the California Urban Water Conservation Council. Active conservation is unlikely to occur without agency action.
- **Code-Based Conservation:** Water saved as a result of changes in water efficiency requirements for plumbing fixtures in plumbing codes. Sometimes referred to as "passive conservation," this form of conservation would occur as a matter for course without any additional financial incentives from water agencies. Water savings from MWELO, discounted to include 50 percent of new home construction, is included in the estimates of code-based conservation.
- **Price-effect Conservation:** Water saved by retail customers attributable to the effect of changes in the real (inflation-adjusted) price of water. Because water has a positive price elasticity of demand, increases in water price will decrease the quantity demanded.

The following table represents the conservation savings estimates by source. More detailed discussion of the Conservation Savings Model can be found in Appendix 9.

TABLE 3-4
Conservation Savings Estimates by Source (Acre-Feet)

CONSERVATION	2016	2020	2025	2030	2035	2040
Active[1]	230,000	210,000	196,000	184,000	166,000	159,000
Code-Based	341,000	381,000	423,000	462,000	497,000	532,000
Price-Effect[2]	205,000	215,000	258,000	304,000	350,000	398,000
Pre-1990	250,000	250,000	250,000	250,000	250,000	250,000
Total Conservation Savings	1,026,000	1,056,000	1,127,000	1,200,000	1,263,000	1,339,000

[1]Active conservation savings achieved through Metropolitan's Conservation Credits Program and from member agency-funded programs installed up to fiscal year 2015/16.

[2]Price-effect savings include water use savings as a result of reduced demands.

LOCAL SUPPLY PROJECTIONS

Local supplies represent water produced by Metropolitan's member agencies to meet their total demands. Local supplies are a key component in determining how much Metropolitan supply is needed. Projections of local supplies use information from multiple several sources, including Urban Water Management Plans submitted to the state by the member agencies, Metropolitan's annual local production surveys and interaction between Metropolitan and member agency staff. The following provides a brief overview of the local supplies included.

- **Groundwater and Surface Water:** Groundwater production consists of extractions from local groundwater basins. Surface water comes from stream diversions and rainwater captured in reservoirs.
- **The Los Angeles Aqueduct:** A major source of imported water is conveyed from the Owens Valley via the LAA by LADWP. Although LADWP imports water from outside of Metropolitan's service area, Metropolitan classifies water provided by the LAA as a local resource because it is developed and controlled by a local agency.
- **Seawater Desalination:** Highly treated seawater suitable for municipal and industrial potable use.
- **Groundwater Recovery and Recycled Water:** Developed and operated by local water agencies, groundwater recovery projects treat contaminated groundwater to meet potable use standards and recycled water projects treat wastewater for municipal and industrial use.
- **Non-Metropolitan Imports:** Water supplies imported by member agencies from sources outside of the Metropolitan service area.

In order to forecast the quantities of local supplies its member agencies are more certain to produce, Metropolitan only includes projects that are currently producing water or are under construction. Projects in these categories of development provide a higher level of certainty, and are more likely to produce as forecasted. The following table shows the average-year forecast of local supplies.

TABLE 3-5

Projections of Existing and Under Construction Local Supplies by Project Type (Acre-Feet)

LOCAL SUPPLY	2016	2020	2025	2030	2035	2040
Groundwater Production	1,277,000	1,290,000	1,288,000	1,288,000	1,288,000	1,289,000
Surface Production	105,000	110,000	110,000	110,000	110,000	110,000
Los Angeles Aqueduct	243,000	261,000	264,000	264,000	266,000	268,000
Seawater Desalination[1]	51,000	51,000	51,000	51,000	51,000	51,000
Groundwater Recovery[1]	125,000	143,000	157,000	163,000	165,000	167,000
Recycling[1]	387,000	436,000	466,000	486,000	499,000	509,000
Recycling - M&I	219,000	243,000	267,000	285,000	298,000	308,000
Recycling - Replenishment	111,000	126,000	129,000	131,000	131,000	131,000
Recycling - Seawater Barrier	56,000	67,000	70,000	70,000	70,000	70,000
Other Non-Metropolitan Imports	13,000	13,000	13,000	13,000	13,000	13,000
Total Local Supplies	2,199,000	2,304,000	2,348,000	2,374,000	2,392,000	2,406,000

[1]Projections only include projects that are currently producing water, or are under construction.

Appendix 5 contains a complete inventory of local projects provided by the member agencies. This inventory also includes projects within the service area that are in development categories which are not included in the forecast: full design and appropriated funding, advanced planning, feasibility, and conceptual. This inventory includes potential future projects that could be developed toward meeting regional IRP targets.

DETERMINING DEMANDS ON METROPOLITAN

Imported water from Metropolitan serves as an additional source of supply to its 26 member agencies. For many member agencies, their primary source of water is produced locally from groundwater basins, surface reservoirs, the LAA, recycled water projects, groundwater recovery projects and seawater desalination projects. When local supplies are not enough to meet retail demands, member agencies purchase imported water from Metropolitan to meet their remaining needs. However, a number of agencies rely heavily on Metropolitan due to their limited local supplies.

In determining demands for imported water, Metropolitan developed its Sales Model to calculate the difference between total forecasted retail demands and local supply projections. The balance is the demand on Metropolitan's imported water supply. The Sales Model calculates the difference between forecasted demands and projected local supplies after factoring in climate impacts. It employs a modeling method using historical hydrologic conditions from 1922 to 2012 to simulate the expected demands on Metropolitan supplies based on hydrologic conditions. Each hydrologic condition results in one possible outcome for the forecast year in the planning horizon. Each forecast year has 91 possible outcomes, one for each historical hydrology year. This method of modeling produces a distribution of outcomes ranging from the driest to the wettest years within this historical period.

The Sales Model forecasts three types of demands on Metropolitan:

- **Consumptive Use:** Metropolitan's non-interruptible supplies that are used to meet retail M&I demand
- **Seawater Barrier:** Water needed to hold back seawater intrusion into the coastal groundwater basins
- **Replenishment:** Water for groundwater or reservoir replenishment, when available, to meet replenishment demands

The following table provides the forecast of average-year demands on Metropolitan. For additional information on Metropolitan's Sales Model, see Appendix 8.

TABLE 3-6
Forecast of Demands on Metropolitan by Type (Acre-Feet)

DEMAND ON METROPOLITAN	2016	2020	2025	2030	2035	2040
Consumptive Use	1,423,000	1,689,000	1,750,000	1,791,000	1,840,000	1,879,000
Seawater Barrier	16,000	5,000	2,000	2,000	2,000	2,000
Replenishment	214,000	166,000	166,000	166,000	166,000	166,000
Total Demand on Metropolitan	1,653,000	1,859,000	1,918,000	1,959,000	2,008,000	2,048,000

Imported Supply Forecasts

Imported supplies serve not only as supplies for Metropolitan's member agencies, but also as the primary source of water delivered to storage. Storage reserves are essential to ensuring reliability for the region, and for guarding against risk and uncertainty. Imported supplies are the key to building and maintaining storage reserves. The following describes the forecasts of supplies available from the SWP and CRA with no new investments.

STATE WATER PROJECT SUPPLY FORECAST

A description of Metropolitan's SWP supply programs and agreements can be found earlier in this report. Expected deliveries from the SWP will vary in a given year and through time due to weather/climate and hydrology, regulatory/operating guidelines and restrictions, land use in the watershed and the physical system and facilities.

WEATHER/CLIMATE AND HYDROLOGY

The SWP forecast is significantly affected by weather/climate and hydrology. In a given year, variations in temperature, rainfall and snowpack greatly affect the amount of water available from the SWP. These weather-based factors directly affect the amount of water that accumulates and runs off from the SWP watersheds. Closely related to weather-based impacts is the corresponding hydrology. Many factors, such as land cover and development within the watershed or antecedent soil conditions, affect how weather-based factors translate into hydrologic factors like runoff and river flow. Over time, the underlying climate can also change both the estimates of weather-based factors and hydrology. The forecasts of SWP supplies used in the 2015 IRP Update analyses include a full range of 91 different weather and hydrologic impacts taken from a sequential historical sample from 1922-2012. In addition, a change in the weather and hydrology due to projected climate change are also included in the forecasts from 2020 through 2040.

REGULATORY/OPERATING GUIDELINES AND RESTRICTIONS

The SWP forecast is significantly affected by regulatory and operating conditions and restrictions that govern SWP operations. In a given year, these conditions and restrictions dictate how much water can be pumped and exported. The SWP forecasts include the expected deliveries under the regulatory and operating conditions that are expected to be in place in given years in the forecast period.

PHYSICAL SYSTEM AND FACILITIES

The physical system and facilities that comprise the SWP are key factors in determining how much water can be delivered. Changes in the physical system and facilities would change the amount of water that the SWP can store, pump and export given a particular weather/climate, hydrology and regulatory and operating conditions. The SWP forecasts include the expected deliveries under projected changes in the physical system and facilities. These projected changes will vary by scenario.

Under a "Do Nothing" or no new investment forecast for the SWP, there are notable changes that will occur through time. The most notable is the decline in SWP supplies due to climate change and the likelihood of more restrictive regulatory and operating conditions. Average SWP deliveries in 2016, given underlying climate and regulatory and operating conditions, were estimated to be 1.2 million acre-feet. Without significant actions and investments to protect these supplies against new regulations and flow restrictions from biological opinions, a sharp and permanent decline in pumping and exports could occur. These declines are projected to become more severe in 2020, consistent with the scheduled timetable for the review of Biological Opinions for key fisheries in the Delta. More restrictive regulations and operating conditions, combined with the impacts of projected climate change, could reduce average year SWP deliveries to 837,000 acre-feet.

The following table summarizes the minimum, average and maximum expected Table A and Article 21 supplies available to Metropolitan over the forecast period. The forecasts of SWP supplies used in this analysis include a full range of 91 different climate impacts from 1922-2012. Additional information on the specific SWP modeling studies and assumptions used in this analysis can be found in Appendix 10.

TABLE 3-7

Summary of State Water Project Supplies Available to Metropolitan Without Additional Investments (Acre-Feet)

SWP	2016	2020	2025	2030	2035	2040
Minimum	210,000	154,000	154,000	154,000	154,000	154,000
Average	1,202,000	837,000	837,000	837,000	837,000	837,000
Maximum	2,022,000	1,695,000	1,695,000	1,695,000	1,695,000	1,695,000

COLORADO RIVER AQUEDUCT SUPPLY FORECAST

In addition to its Fourth and Fifth Priority entitlements from the CRA, Metropolitan has access to a number of other supply and conservation programs; these programs are described earlier in this report. Programs such as the IID/Metropolitan Conservation Program provide supplies in all years, regardless of hydrology, and are considered base supply programs. Other programs such as the PVID program and Intentionally Created Surplus provide flexibility in different year types. These flexible programs work in conjunction with the base supply programs to manage water into storage in wet years, and provide additional supply in dry years. The following table shows the forecast of base CRA supply programs over the forecast period. Some of these supplies are expected to change over time, and these changes are reflected in the table. The flexible supplies are not shown in the table. Additional information on the specific CRA modeling studies and assumptions used in this analysis can be found in Appendix 10.

TABLE 3-8

Forecast of Colorado River Aqueduct Base Supplies and Adjustments (Acre-Feet)

CRA	2016	2020	2025	2030	2035	2040
Basic Apportionment	550,000	550,000	550,000	550,000	550,000	550,000
Present Perfected Rights	-2,000	-2,000	-2,000	-2,000	-2,000	-2,000
SNWA Return Obligations	0	0	0	0	-5,000	-10,000
IID-MWD Conservation Program	85,000	85,000	85,000	85,000	85,000	85,000
Palo Verde Program Minimum	30,000	30,000	30,000	30,000	30,000	30,000
IID-SDCWA Transfer and Exchange	100,000	193,000	200,000	200,000	200,000	200,000
Canal Lining Projects SDCWA	80,000	80,000	80,000	80,000	80,000	80,000
Canal Lining Projects	16,000	16,000	16,000	16,000	16,000	16,000
Lower Colorado Water Supply Project	8,000	8,000	7,000	6,000	5,000	4,000
Total Base Supply Programs	867,000	960,000	966,000	965,000	959,000	953,000

Remaining Need: The Regional Water Balance

The first step in determining the remaining need is to evaluate the balance of existing levels of supplies against future projections of demands. Constructing a "Do Nothing" water balance provides a picture of what future reliability would look like with no additional actions or investments in water supply or demand management. The "Do Nothing" analysis determines whether additional developments that help to balance supplies and demands are needed to ensure reliability into the future. This look at the regional water balance incorporates all of the forecasts of demands and supplies described previously in this report.

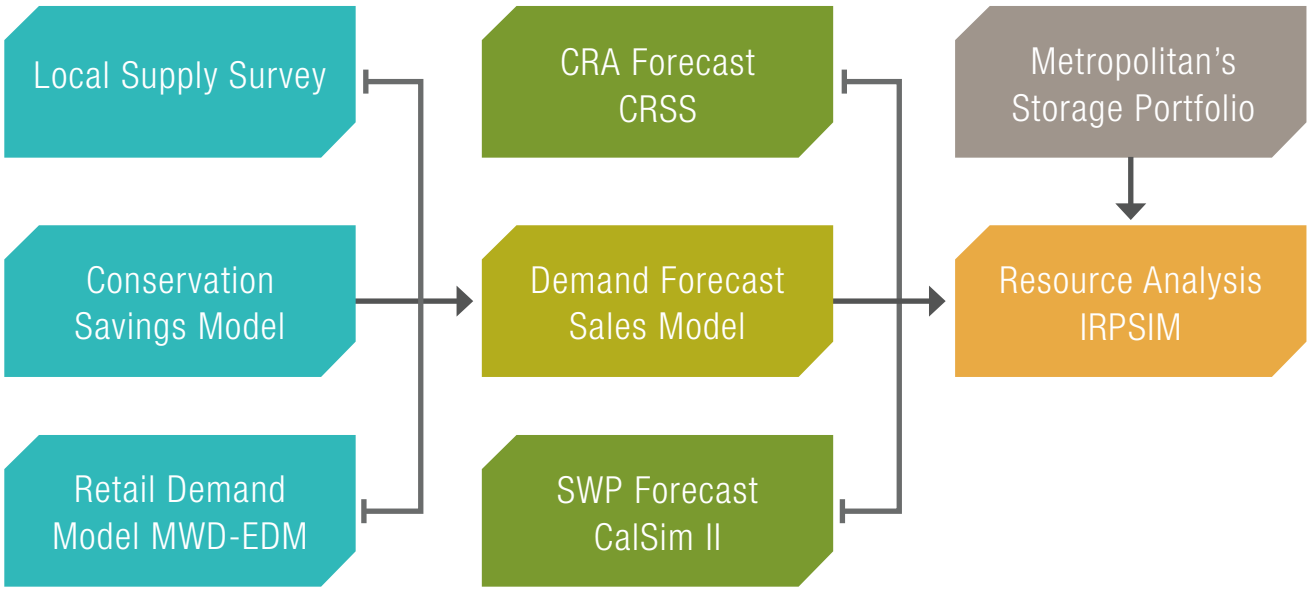
MODELING RELIABILITY

In order to evaluate reliability under future scenarios of water supplies and demands, Metropolitan uses a sophisticated water resources modeling platform called the Integrated Resources Planning Simulation Model (IRPSIM). IRPSIM is designed to integrate projections of demands, conservation, imported supplies and storage out to 2040, and to simulate outcomes and water balances under a set of varying hydrologic and weather/climate conditions. IRPSIM uses a sample of 91 years of historical hydrology and weather/climate from 1922 to 2012 as a test of reliability. This methodology generates 91 different outcomes for each forecast year, and thus allows Metropolitan to evaluate the probabilities of surpluses and shortages over the forecast horizon.

The IRPSIM methodology of sequential hydrology analysis is also very effective in capturing the operation of storage resources over time. Metropolitan's entire regional storage portfolio is included in the IRPSIM modeling framework, with individual programs operated based on defined parameters for put, take, and total storage capacity as described in Appendix 11. The regional storage portfolio is used in the IRPSIM model to manage the year-to-year differences between supplies and demands across the forecast horizon. Storage resources are drawn down and refilled over time to balance these differences; storage use in one year then informs the starting storage balance in the next year.

The following figure illustrates the relationships between IRPSIM and the various planning models used by Metropolitan. These planning models generate the forecasts of supplies, demands and conservation described in this report, which serve as inputs to IRPSIM. Appendix 11 contains a detailed description of the IRPSIM model and methodology.

FIGURE 3-2
Diagram of Metropolitan Planning Models and Forecasts



METRICS FOR MEASURING RELIABILITY: SHORTAGES AND SUPPLY ALLOCATIONS

The regional goal of the 2015 IRP Update is to provide a high level of water supply reliability. IRPSIM provides the water resource simulation modeling outputs that allow Metropolitan to measure whether or not a potential resource mix is likely to be reliable. In order to evaluate the results of a water balance analysis, one or more defined metrics are needed to measure against modeling outputs. A metric is a measurable figure that the outputs from the model can be compared to in order to make an evaluation. In the case of the IRP modeling, a metric will help determine if individual water balance outcomes are reliable or not. The quantity of water supply shortages is a traditional metric of reliability. Shortages within an IRPSIM simulation show when the region is either out of water, or unable to deliver available water supplies due to constraints such as conveyance capacities. Water shortages represent an inability to provide water to the retail-level customer, which is considered to be a severe situation and a definite measure of unreliability. In fact, a true water shortage is a situation that the region has not faced up to this point.

A second metric for reliability is a determination on whether the region would be required to impose shortage restrictions. More commonly known as allocation or mandatory rationing, this situation occurs when water resources, particularly storage resources, reach a point of depletion where limitations are imposed in an attempt to stretch remaining resources to be prepared for future shortage conditions. Instead of using water shortages as the only metric for reliability, Metropolitan also evaluates low levels of storage as a metric for measuring reliability. Low storage levels are a primary driver for the implementation of Metropolitan's WSAP and is reflective of how the region reacted during droughts in the last two decades. From the retail consumer's point of view, imposed restrictions are similar to actual water shortages in terms of having an unreliable water supply. In the droughts of the early 1990s, 2009-2010 and 2015, Metropolitan implemented supply allocations to its member agencies in an effort to extend low storage reserves even though the region was not out of water. Actions in the last two implementations of Metropolitan's WSAP show that when regional dry-year storage levels approach 1.0 million acre-feet (an indicator of low storage), supply allocations will be considered.

WATER BALANCE RESULTS: THE "DO NOTHING" CASE

IRPSIM was used to analyze future reliability and storage outcomes for the "Do Nothing" water balance. The results of the IRPSIM analysis include probabilistic outcomes of demands, conservation, local supplies, shortages, and storage balances.

Figure 3-3 shows the reliability, or shortage, results of the "Do Nothing" water balance analysis in the year 2020. The blue area shows 91 outcomes of supplies versus demands in 2020, before any storage actions are taken. The 91 outcomes are ranked in order, from the largest shortage on the left of just over 850,000 acre-feet, to the largest surplus on the right of almost 1.4 million acre-feet. These results also show that before any storage actions are taken, Metropolitan would expect to have shortage conditions (below the 0 axis) 46 percent of the time and surplus conditions (above the 0 axis) 54 percent of the time.

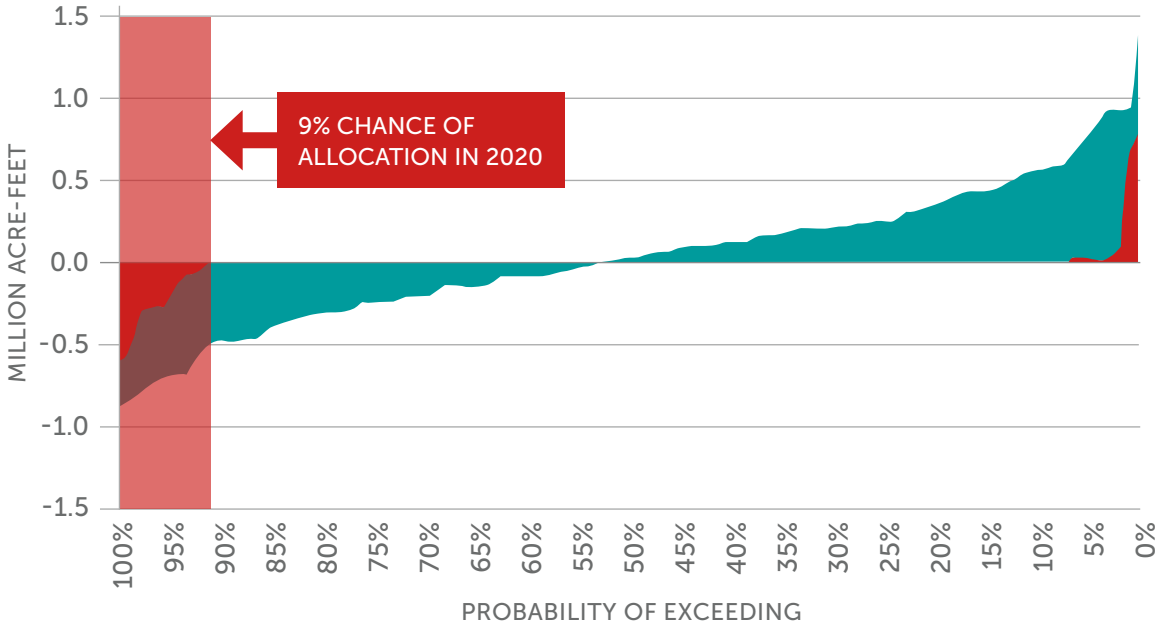
The solid red area shown in Figure 3-3, illustrates the remaining surpluses and shortages after Metropolitan's storage portfolio is used to help manage differences between supplies and demands. On the surplus supply side, the results show that approximately 8 percent of the time, there would be surplus water supplies that could not be managed using available storage; with

a maximum surplus remaining of almost 800,000 acre-feet. On the shortage side, 9 percent of the time, the results show remaining water shortages beyond what can be managed through withdrawals from available storage reserves; with a maximum shortage of around 600,000 acre-feet. The remaining 84 percent of the time,the differences between supplies and demands can be managed completely using storage with no shortages to the region and no surplus water that could not be stored.

Although Figure 3-3 only shows reliability results for 2020, IRPSIM generates this same information for every year in the forecast period from 2016 to 2040. The following figure summarizes the results for the "Do Nothing" case over time, showing the probability of shortages in five year increments before and after storage actions. These results are based upon the detailed information shown in Figure 3-3; the red shaded area showing a 9 percent chance of shortage corresponds to the 2020 results in Figure 3-4. These results show that the probability of shortages increases dramatically over time under the "Do Nothing" case, reaching nearly a 60 percent chance of shortages by 2040.

FIGURE 3-3

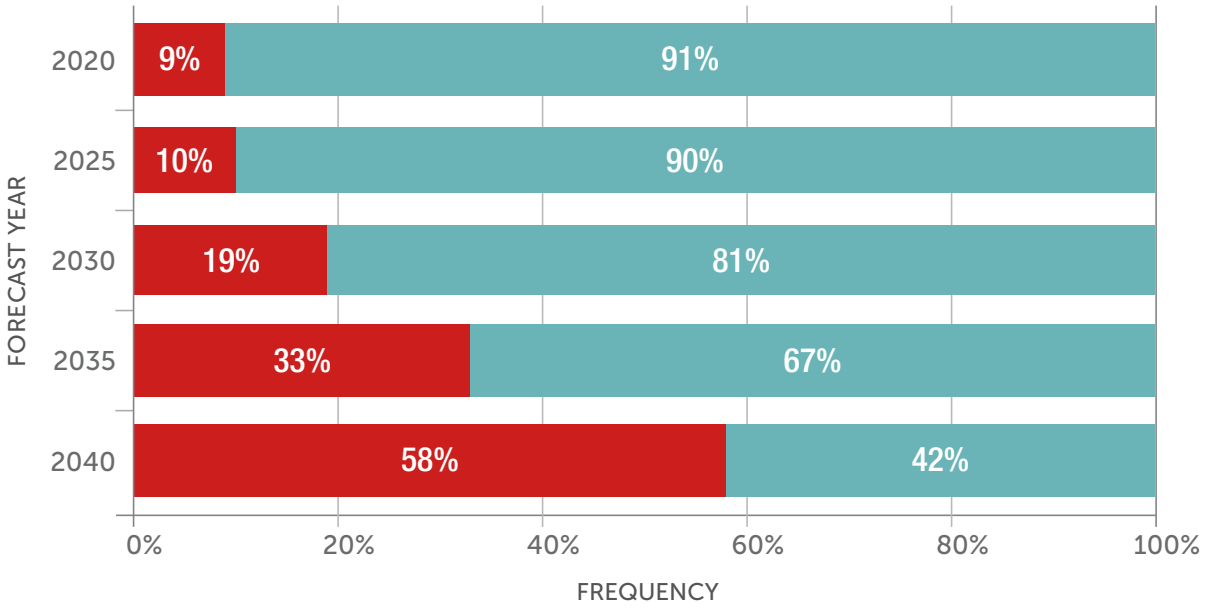
2020 Water Balance Under the "Do Nothing" Case[1]



[1]IRPSIM results represent 91 modeled outcomes based on weather/climate and hydrology from 1922-2012. This is intended to be an indicator of reliability.

FIGURE 3-4

Summary of Shortage Probabilities Under the "Do Nothing" Case[1]

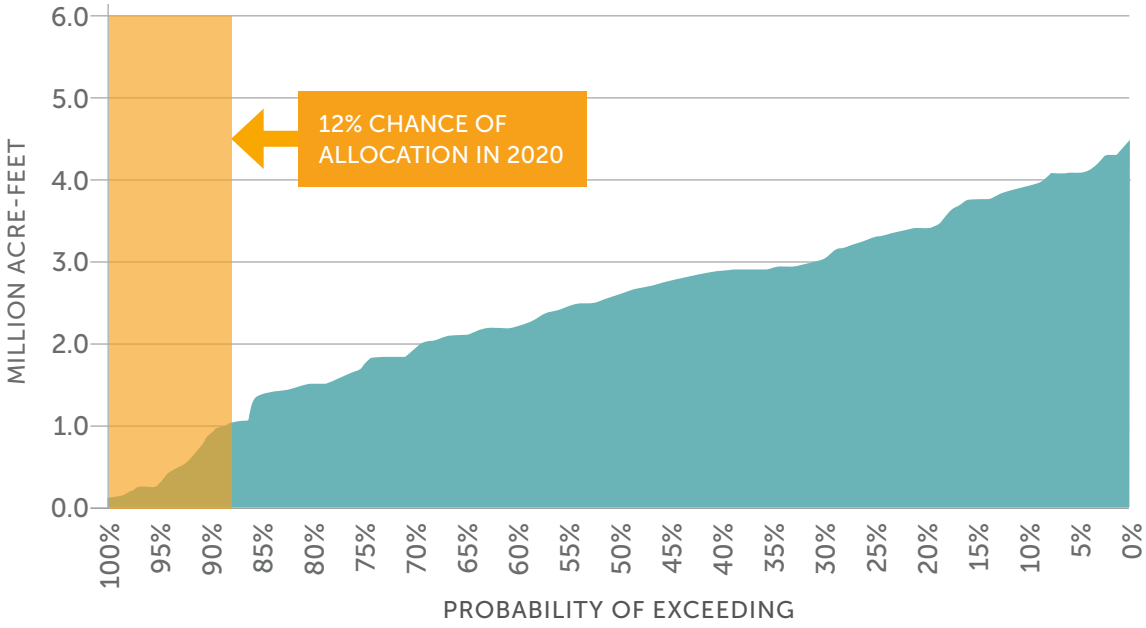


[1]IRPSIM results represent 91 modeled outcomes based on weather/climate and hydrology from 1922-2012. This is intended to be an indicator of reliability.

In addition to producing the reliability results described in the previous figures, the IRPSIM model provides simulation data that evaluates the corresponding impacts to storage reserves. Storage levels are critical because low storage levels have led to consideration of water supply allocation in the past and thus are an indicator of low reliability. Figure 3-5 shows the range of potential dry-year storage balances for the year 2020. Again, these results show 91 different outcomes of water in storage, ranked from lowest to highest. The balances of ending dry-year storage range from

FIGURE 3-5

2020 Probability of Dry-Year Storage Ending Below 1 Million Acre-Feet Under the "Do Nothing" Case[1]



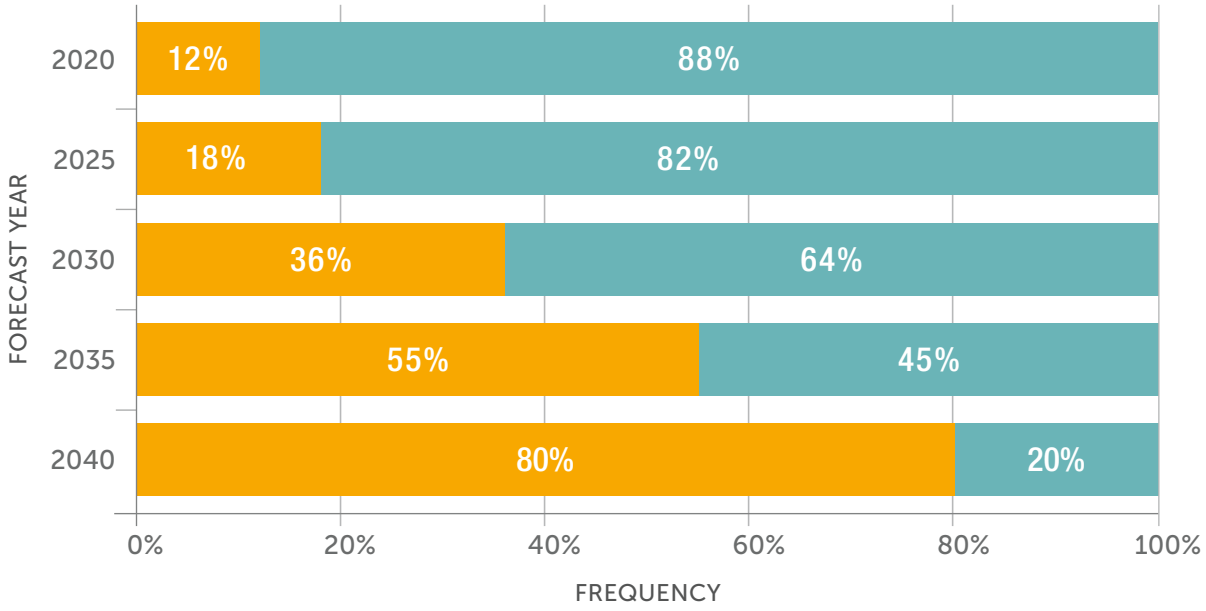
[1]IRPSIM results represent 91 modeled outcomes based on weather/climate and hydrology from 1922-2012. This is intended to be an indicator of reliability.

about 75,000 acre-feet up to almost 4.5 million acre-feet. When evaluated against the metric of low storage, which is defined as regional dry-year storage levels below 1.0 million acre-feet, the results show that 12 percent of the time storage would be below the low storage metric. This equates to the region facing a 12 percent chance of implementing Metropolitan's WSAP in 2020.

In a similar fashion to the reliability results shown above, Figure 3-6 summarizes the probabilities of implementing supply allocations in 5 year increments. The shaded orange area in Figure 3-6 corresponds to the 12 percent chance of allocation shown below for the year 2020. These results show that the probability of supply allocation increases dramatically over time under the "Do Nothing" case, reaching an 80 percent likelihood in 2040.

FIGURE 3-6

Summary of Allocation Probabilities Under the "Do Nothing" Case[1]



[1]IRPSIM results represent 91 modeled outcomes based on weather/climate and hydrology from 1922-2012. This is intended to be an indicator of reliability.

WATER BALANCE CONCLUSIONS: NEED TO TAKE ACTION

The "Do Nothing" water balance clearly illustrates how if Southern California stopped adapting and relied only upon on its existing supply assets and current achievements in conservation, shortages and implementation of Metropolitan's WSAP would likely occur in an unacceptable level of frequency in the years ahead. This finding is a reminder that working to maintain a reliable water system is never done. In this case, "doing nothing" and making no further investments in water supply and demand management would impose a huge cost on all Southern Californians. The same shortage conditions facing the region in the early 1990s, in 2009-2010, and this year, with imposed fines and penalties for exceeding water use limits, would occur a large percentage of the time. That potential threat of unreliability is too great to ignore; in order to achieve levels of high reliability, significant water supply and conservation investments will be needed.

6.

Findings and Conclusions

Metropolitan's tradition of providing reliable supplies to a growing, dynamic region will be put to the test with the challenges that undoubtedly lie ahead. Yet Metropolitan's ability to make key investments at the right time, and to adapt to ever-changing circumstances, provide confidence that a reliable water portfolio will continue to be maintained as events unfold.

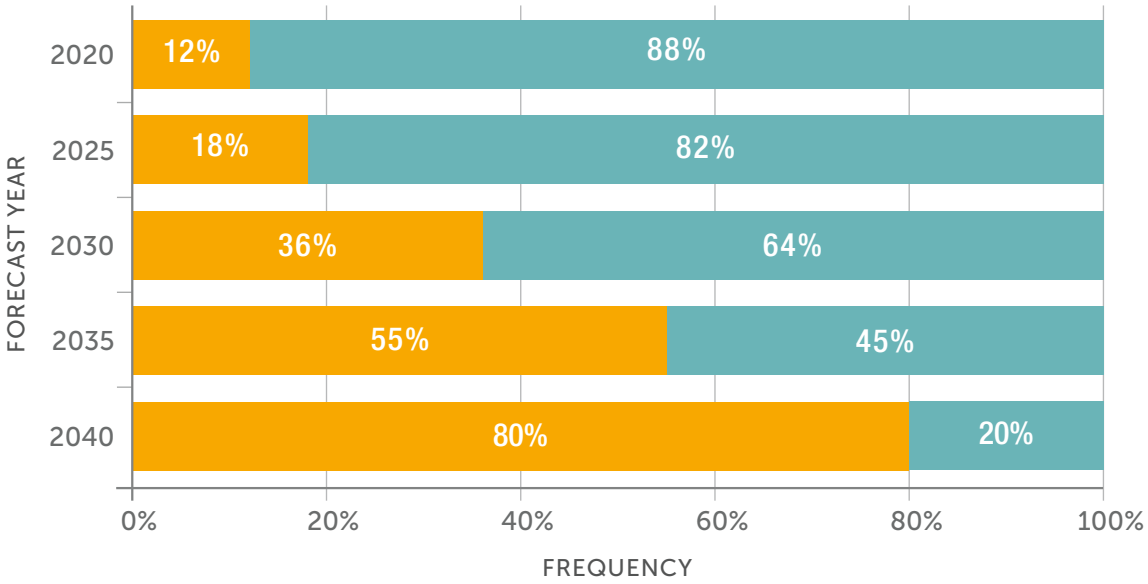
Several findings and conclusions have emerged as particularly important in this 2015 IRP Update process.

Action is Needed

Without the investments in conservation, local supplies and the California WaterFix targeted in the 2015 IRP Update, shortages and implementation of Metropolitan's WSAP would likely occur in an unacceptable level of frequency in the years ahead. Modeling results show that under a "Do Nothing" case, the probability of supply allocation increases dramatically over time, reaching an 80 percent likelihood in 2040. Doing nothing is not an option.

FIGURE 6-1

Summary of Allocation Probabilities Under the "Do Nothing" Case[1]



[1]IRPSIM results represent 91 modeled outcomes based on weather/climate and hydrology from 1922-2012. This is intended to be an indicator of reliability.

Photo by Paul Hames, Courtesy of the CA Department of Water Resources

The past IRPs have prepared the region to manage challenges today, and the 2015 IRP Update provides an adaptive strategy for overcoming the challenges of tomorrow.

MAINTAIN COLORADO RIVER SUPPLIES

The plan to stabilize deliveries at 900,000 acre-feet in a typical year will require more than 900,000 acre-feet of planned actions. A portion of the base allocation is at risk from some senior water right-holders using more than their historic use. Some programs and partnerships may not deliver initial estimates. A robust set of actions and partnerships on the river will be necessary to meet both average-year projections as well as plans for a full aqueduct in dry years. Shortage is undeniably a larger risk compared to the 2010 IRP Update. The potential for shortage speaks to the need for a portfolio approach to stabilizing this vital imported supply.

STABILIZE STATE WATER PROJECT SUPPLIES

Since the 1990s, deteriorating environmental conditions have steadily decreased the availability and reliability of supplies. While water supply restrictions have not resulted in stabilizing the population of a single threatened fish species, incrementally greater restrictions are likely with incrementally worsening conditions – unless decisive actions are taken. State and federal agencies are advancing such actions through the tandem California WaterFix and EcoRestore efforts. Yet even if final plans are reached and Metropolitan joins other public water agencies to invest in system modernization, California must rely on the existing water delivery system until an improved one is built. Until then, earthquakes and floods will represent additional risk for the SWP. Long-term yields likely will not be precisely identified until numerous regulatory processes are completed. The value of a collaborative approach with state and federal agencies to resolve questions about proper SWP operations cannot be understated. The roles of better science and inter-agency collaboration will shape the future Delta and profoundly determine whether the coequal goals of Delta restoration and statewide water supply reliability are advanced.

DEVELOP AND PROTECT LOCAL SUPPLIES AND WATER CONSERVATION

The 2010 IRP Update was the first to explicitly state how new demands from population growth in Southern California will be met by increasing in-region supplies and lowering per-capita regional demands. The 2015 IRP Update embraces and advances this regional self-sufficiency ethic by increasing the targets for additional local supplies and conservation. Any historic local supply cannot be taken for granted as reliably maintaining historic production levels. Groundwater basin managers collectively are estimating decreased yields due to a reliance on these basins during the current drought

ACHIEVE ADDITIONAL CONSERVATION SAVINGS

Pursue further water conservation savings of 485,000 acre-feet annually by 2040 through increased emphasis on outdoor water-use efficiency using incentives, outreach/education and other programs.

DEVELOP ADDITIONAL LOCAL WATER SUPPLIES

Develop 230,000 acre-feet of additional local supplies produced by existing and future projects. The region would reach a target of 2.4 million acre-feet by 2040, a key to providing water supply reliability into the future.

MAINTAIN COLORADO RIVER AQUEDUCT SUPPLIES

Develop programs to ensure that a minimum of 900,000 acre-feet is available when needed, with access to 1.2 million acre-feet in dry years.

cycle. More frequent droughts would reduce projected yields of the Owens River system for LADWP. Actual local supply production could be lower in the future than what is assumed in the 2015 IRP Update. Yet the region is fortunate to have a robust portfolio of potential local supply opportunities. Increasing the target for local supply and water conservation development sends a powerful signal that work to maintain a reliable system is never done. As for water conservation, the region showed its remarkable potential for ratcheting down demand by exceeding Metropolitan's WSAP reduction targets during the 2015 drought. Making these conservation gains permanent, particularly outdoors, will require a continued conversion of residential and business landscapes, stronger conservation ordinances and perhaps additional incentives as well.

MAXIMIZE THE EFFECTIVENESS OF STORAGE AND TRANSFERS

Rebuilding Metropolitan's supply of water reserves is an imperative when the drought is finally over. So is carefully managing the remaining reserves in the meantime. Metropolitan's vast network of groundwater banks and reservoirs is only as impressive as Metropolitan's ability to replenish it. The role of the water market, and transfers, is undergoing much rethinking statewide, and Metropolitan is no exception. The water transfer market in the current drought period has proven to be both small and expensive. The dry-year water transfer market likely cannot be relied upon to provide a dry-year solution for future droughts. However, water transfers in average and above-average hydrologic years may prove to be both plentiful and affordable. Thanks to Metropolitan's investments in storage and distribution system conveyance (for example, the Inland Feeder system that fills Diamond Valley Lake), Metropolitan has the infrastructure capability for purchasing, moving and storing water in years that are not severely dry. A comprehensive water transfer approach that takes advantage of water when it is available will help to stabilize and build storage reserves; increasing the ability for Metropolitan to meet demands in dry years. Water transfers can also augment core water supplies in the near term to strengthen water supply reliability while longer term projects are being constructed. While Metropolitan has the capability to move and store this water once it is conveyed through the Delta, the statewide delivery system remains constricted because of the ongoing problems in the Delta. The future water market is inextricably tied to the future of the Delta.

STABILIZE STATE WATER PROJECT SUPPLIES

Manage SWP supplies in compliance with regulatory restrictions in the near-term for an average of 980,000 acre-feet of SWP supplies. Pursue a successful outcome in the California WaterFix and California EcoRestore efforts for long-term average supplies of about 1.2 million acre-feet.

MAXIMIZE THE EFFECTIVENESS OF STORAGE AND TRANSFER

Develop a comprehensive strategy to pursue transfers and exchanges to hedge against shorter-term water demands and supplies imbalances until long-term solutions are in place.

Continue With the Adaptive Management Approach

Although we cannot know for certain what is in store in the future, Metropolitan has an adaptable plan that increases future reliability. Reliability targets are only as good as the assumptions and information at the time they are developed. Identifying and implementing additional resources that expand the ability to meet future changes and challenges helps to manage the risk associated with those changes and challenges. But just as important as the reliability targets, is clearing the way to adapt based on changing circumstances. By updating the IRP, the region is able to incorporate changed conditions into its plans. Also, by advancing a new generation of local supplies through the 2015 IRP Update's Future Supply Actions, Metropolitan can continue to set a solid foundation of alternatives that can be implemented in the face of change. This change may be greater or lesser than what we may anticipate. But it is a certainty. Simply put, no matter what the adversity that the region may face, the 2015 IRP Update is a response and a way to adapt.

THE 2015 IRP UPDATE TARGETS

In order to meet the goal of providing water supply reliability, there are significant reliability targets identified, as summarized in Table 6-1. Table 6-1 begins with retail demands before conservation; this is the estimated amount of water the region would need on average if no investments in conservation were made. The following line shows the total conservation savings targeted under the 2015 IRP Update. Total targeted conservation savings are projected to increase by 485,000 acre-feet from 2016 to 2040; this increase goes a long way towards reducing retail demands, as well as offsetting future growth in demands. Retail demands after conservation are projected to increase by 429,000 acre-feet over the forecast period, compared to an increase of 914,000 acre-feet without conservation. The bottom half of Table 6-1 shows the total amount of imported and local supplies targeted under the 2015 IRP Update. The total supply reliability target increases by 238,000 acre-feet from 2016 to 2040, with 227,000 acre-feet coming from local supplies, and the remainder from imported supplies. Although the combined CRA and SWP supply targets seem relatively fixed, there is significant effort needed to stabilize and preserve these supplies. For example, when looking at the net change from 2016 to 2040 SWP deliveries only increase by 11,000 acre-feet. This hides the projected declines in SWP supplies projected to begin in 2020. The projected increase in SWP supplies from 2020 to 2040 is actually 229,000 acre-feet. Overall, the total conservation target and the total supply reliability target result in a combined 723,000 acre-foot increase by 2040. This number would be closer to 940,000 acre-feet if the 229,000 acre-feet of net change in SWP supplies were considered. To achieve these levels of development and overall reliability, it is critical to maintain CRA supplies, stabilize SWP supplies and engage in policy discussions that result in a strategy for the development and maintenance of local supplies and conservation.

TABLE 6-1

2015 IRP Update Total Level of Average-Year Supply Reliability Targets (Acre-Feet)

	2016	2020	2025	2030	2035	2040
Retail Demands before Conservation	4,878,000	5,219,000	5,393,000	5,533,000	5,663,000	5,792,000
Total Conservation Target	1,034,000	1,096,000	1,197,000	1,310,000	1,403,000	1,519,000
Retail Demands after Conservation	3,844,000	4,123,000	4,196,000	4,223,000	4,260,000	4,273,000
Minimum CRA Diversion Target	900,000	900,000	900,000	900,000	900,000	900,000
Average Year SWP Target	1,202,000	984,000	984,000	1,213,000	1,213,000	1,213,000
Total Local Supply Target	2,199,000	2,307,000	2,356,000	2,386,000	2,408,000	2,426,000
Total Supply Reliability Target	4,301,000	4,191,000	4,240,000	4,499,000	4,521,000	4,539,000

ADDITIONAL SUPPLIES TO ADDRESS RISKS AND UNCERTAINTIES

The 2015 IRP Update reliability targets are based on a wide range of potential future conditions. Beyond that range, the 2015 IRP Update process identified additional foreseeable challenges and risk scenarios. To address these risks, an additional 200,000 acre-feet of water conservation and local supplies would be needed. This additional supply goal should be considered when examining implementation polices and approaches.

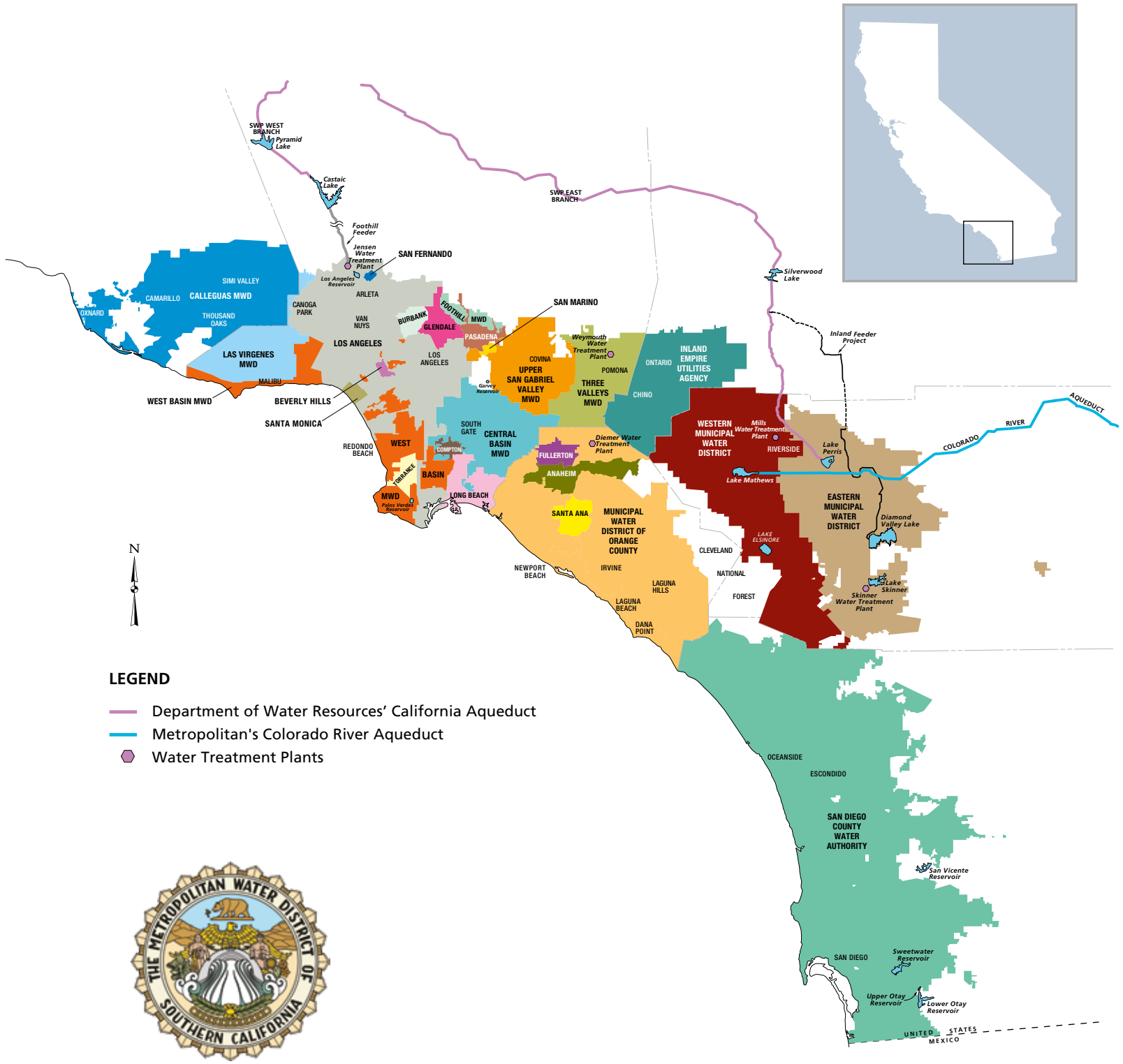
Summary

Southern California finds itself at a moment in its water history unlike any other, given the unprecedented drought conditions and the barrage of challenges facing existing supplies. The past IRPs have prepared the region to manage these challenges today, and the 2015 IRP Update provides an adaptive strategy for overcoming the challenges of tomorrow. This strategy for continued water supply reliability includes a diversified portfolio of actions that calls for stabilizing and maintaining imported supplies; meeting future growth through increased water conservation and the development of new – and protection of existing – local supplies; pursuing a comprehensive transfers and exchanges strategy; building storage in wet and normal years to manage risks and drought; and preparing for uncertainty with Future Supply Actions.

Southern California has grown by 5 million people over the past generation with the same supply of imported water. Through the vision advanced in the 2015 IRP Update, Southern California can repeat this achievement in the coming generation.

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Agency Map



LEGEND

- Department of Water Resources' California Aqueduct
- Metropolitan's Colorado River Aqueduct
- Water Treatment Plants

MEMBER AGENCIES

MEMBER CITIES

City of Anaheim

City of Beverly Hills

City of Burbank

City of Compton

City of Fullerton

City of Glendale

City of Long Beach

City of Los Angeles

City of Pasadena

City of San Fernando

City of San Marino

City of Santa Ana

City of Santa Monica

City of Torrance

MEMBER WATER AGENCIES

Calleguas Municipal Water District

Central Basin Municipal Water District

Eastern Municipal Water District

Foothill Municipal Water District

Inland Empire Utilities Agency

Las Virgenes Municipal Water District

Municipal Water District of Orange County

San Diego County Water Authority

Three Valleys Municipal Water District

Upper San Gabriel Valley Municipal Water District

West Basin Municipal Water District

Western Municipal Water District of Riverside County

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Pictured on page XII: F.E. Weymouth Water Treatment Plant, La Verne, CA (MWD Image Collection)

Pictured on page 1.1: Whitsett Intake Pumping Plant on the Colorado River, Circa 1938 (MWD Image Collection)

Pictured on page 1.3: Diamond Valley Lake, Hemet, CA (MWD Image Collection)

Pictured on page 1.7: Drought Tolerant Garden, Long Beach, CA (MWD Image Collection)

Pictured on page 1.10: Solar panels at Robert A. Skinner Water Treatment Plant, Riverside County, CA (MWD Image Collection)

Pictured on page 2.1: Metropolitan's Union Station Headquarters Boardroom, Los Angeles, CA (MWD Image Collection)

Pictured on page 3.1: Drought Tolerant Garden, Long Beach, CA (MWD Image Collection)

Pictured on page 3.3: Drought Tolerant Plant (MWD Image Collection)

Pictured on page 3.7: "Take Your Turn" water conservation signage at Randy's Donuts, Inglewood, CA (Sal Vazquez)

Pictured on page 3.8: Recycled water project at Eastern Municipal Water District, Riverside County, CA (MWD Image Collection)

Pictured on page 3.11: Sandhill Crane, Acampo, CA, courtesy of the CA Department of Water Resources (Florence Low)

Pictured on page 3.13: Whitsett Intake Pumping Plant on the Colorado River (MWD Image Collection)

Pictured on page 4.1: Orange County Sanitation District Wastewater Treatment, Orange County, CA (MWD Image Collection)

Pictured on page 5.1: Metropolitan's Union Station Headquarters, Los Angeles, CA (Matthew Hacker)

Pictured on page 6.1: Suisun Marsh, Suisun City, CA, courtesy of the CA Department of Water Resources (Paul Hames)

WATER TOMORROW

Integrated Water Resources Plan

To view an online version of this report, the Executive Summary,
and the Technical Apendices visit www.mwdh2o.com

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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