WATER TOMORROW

DWR-1345c

Integrated Water Resources Plan

2015 UPDATE

Technical Appendices

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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Appendix 1

Additional Background on Metropolitan

Appendix 1 – Additional Background on Metropolitan

FORMATION AND PURPOSE

The Metropolitan Water District of Southern California is a public agency organized in 1928 by a vote of the electorates of 11 cities located in Southern California. The agency was enabled by the Metropolitan Water District Act that was passed into law by the California Legislature. Metropolitan was formed "for the purpose of developing, storing, and distributing water" to the residents of Southern California.

Metropolitan imports and distributes water from the Colorado River through its Colorado River Aqueduct (CRA) and from the Sacramento-San Joaquin Bay Delta through the State Water Project (SWP). Metropolitan also develops other water resource and conservation projects throughout the state.

In 1992, Metropolitan adopted the following mission statement:
"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."

MEMBER AGENCIES

Metropolitan is currently composed of 26 member agencies, consisting of 14 cities, 11 municipal water districts, and one county water authority. Metropolitan is a water wholesaler with no retail customers, and it provides treated and untreated water directly to its member agencies. Fifteen member agencies provide retail service to customers, nine provide only wholesale service, and two provide a combination of both. Metropolitan's member agencies serve residents in 152 cities and 89 unincorporated communities. Throughout Metropolitan's service area, approximately 250 retail agencies supply water to the public.

Metropolitan's member agencies deliver a combination of local groundwater, local surface water, recycled water, and imported water purchased from Metropolitan. For some member agencies, Metropolitan supplies all the water used within that agency's service area, while others obtain varying amounts of water from Metropolitan to supplement local supplies. Metropolitan has historically provided between 45 and 60 percent of the municipal and industrial, and agricultural water used within its service area. The remaining water supply comes from local groundwater basins, local surface water, recycling, the city of Los Angeles' Aqueduct from the eastern Sierra Nevada, and the San Diego County Water Authority's water transfers from the Imperial Irrigation District delivered through an exchange of water supplies with Metropolitan. Member agencies also implement conservation programs that can be considered part of their supplies.

SERVICE AREA

Metropolitan's service area covers the Southern California coastal plain. It extends about 200 miles along the Pacific Ocean from the city of Oxnard on the north to the international boundary with Mexico on the south, and it reaches as far as 70 miles inland from the coast. The total area served is nearly 5,200 square miles and it includes portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. Although only 14 percent of the land area of the six Southern California counties is within Metropolitan's service area, about 86 percent of the populations of those counties reside within Metropolitan's boundaries.

BOARD OF DIRECTORS

Metropolitan's Board of Directors currently consists of 38 directors. Each member agency has at least one representative, with the agency's assessed valuation determining its additional representation and voting rights. Directors are appointed by the chief executive officer of the member agency with the consent of the governing body of the member agency or elected by a majority vote of the governing body of the member agency. The Board of Directors includes business, professional, and civic leaders and meetings are generally held on the second Tuesday of each month and are open to the public.

Throughout its history, the Board of Directors has delegated certain tasks to Metropolitan staff, which are codified in Metropolitan's Administrative Code. In addition, Metropolitan has developed policy principles to help achieve its stated mission. These policies can be found in a variety of documents including: specific policy statements, board-adopted policy principles, and letters submitted to the Board of Directors. Policy statements are also embedded in formal board meeting discussions and recorded in meeting minutes. The policies established by the Board of Directors are subject to all applicable laws and regulations.

OTHER PLANNING EFFORTS

The IRP is intended as a regional water resource planning document that identifies potential supplies to meet future demands. However, Metropolitan recognizes that reliable and comprehensive water planning goes beyond resource development. Metropolitan has developed programs and plans to address storage operations, shortages, emergency response for the Sacramento-San Joaquin Delta (Delta), regional disasters, energy management, long-term financial goals, water quality goals, and coordination with local agencies' own planning efforts.

Emergency Response

Metropolitan has a long history of emergency planning with several plans that describe how Metropolitan organizes and deploys resources to manage emergencies and ensure continuity of water system operations and critical business processes. Metropolitan's emergency response plans include: (1) Emergency Response Plan; (2) Emergency Response Organization; (3) Business Continuity Plan; and (4) IT Disaster Recovery Plan. These policies and resulting plans ensure that Metropolitan will have the business and organizational capability to continue to deliver water to its customers during an emergency.

Energy Management Initiatives

Metropolitan's Board of Directors established energy as a core initiative in 2007 and subsequently adopted revised Energy Policy Principles in 2008. In 2010, Metropolitan completed an Energy Management and Reliability Study which evaluated regulatory and costs risks and identified specific program and projects to meet the goals of energy reliability, cost containment, and greenhouse gas reductions.

Long Range Finance Plan

Metropolitan's Long Range Finance Plan is the planning document upon which Metropolitan and its member agencies base future capital and operating decisions. It includes a forecast of future costs and the revenues necessary to support operations and investments in infrastructure and resources while conforming to Metropolitan's financial policies. These financial policies, which address reserve levels, financial indicators, and capital funding strategies, ensure sound financial management and fiscal stability as Metropolitan implements this IRP Update.

Source Water Protection

Source water protection is the first barrier of a multiple barrier approach for ensuring the safety of drinking water. Metropolitan takes proactive steps to protect and improve the water quality of its source waters, and minimize threats of contamination entering drinking water sources. Sanitary Surveys are completed for the Colorado River and SWP watersheds every five years. These efforts allow Metropolitan to achieve reliable cost-effective compliance with current and emerging drinking water regulations, with the highest levels of consumer satisfaction.

Salinity Management

Salinity in water can affect household appliances and fixtures, agriculture, groundwater recharge, water recycling, and other uses. Salinity can also have a significant economic impact for Metropolitan's service area. Metropolitan's Salinity Management Policy aims to maintain salinity levels, measured as total dissolved solids or TDS, below 500 milligrams per liter in its treated water when feasible and practical. This is accomplished primarily through blending of lower-TDS SWP water with Colorado River water, and through extensive source control efforts with external partners.

Integrated Regional Water Management Plans

In 2002, SB 1672 created the Integrated Regional Water Management Plan Act (IRWM) to encourage local agencies to work cooperatively to manage local and imported water supplies to improve the water quality, quantity, and supply reliability. IRWM groups typically consist of public agencies with water or wastewater authorities, cities, counties, special districts and non-governmental organizations that address a broad range of issues. These issues include growing water demands; water supply reliability; water quality; stormwater management; open space and habitat; and project financing. There are currently seven IRWM groups within Metropolitan's service area, and all the member agencies participate in one or more IRWM groups. Metropolitan continues to participate in the Greater Los Angeles County Region IRWM Leadership Committee as its surface water management area representative. In addition, Metropolitan has been monitoring and providing technical assistance as requested to its member agencies that belong to various Regional Water Management Groups within the service area in the development of their IRWMPs. For example, on July 8, 2014, the Metropolitan' Board of Directors adopted a resolution approving the Greater Los Angeles County Region IRWM Plan.

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Integrated Water Resources Plan Update 2015

Appendix 2

2015 IRP Update Issue Paper Addendum

2015 IRP UPDATE ISSUE PAPER ADDENDUM

October 27, 2015

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1. Summary

The 2015 Integrated Water Resource Plan (IRP) Update Issue Paper Addendum builds on the information provided in the 2010 IRP Issue Papers, and was developed through a collaborative regional process to ultimately help inform future water resource discussions. Specifically, this paper identifies current and potential resource issues, opportunities, and actions in the areas of conservation, groundwater (including stormwater and other recharge), recycled water, seawater desalination, stormwater direct use, graywater, and resource interrelations.

The following table provides a summary of the 2015 IRP Update Issue Paper Addendum. More detailed information is provided in the subsequent sections of this report.

Table 1: Summary

Issues	Opportunities	Recommendations*
Conservation		
• Long-term commitment to conservation can be difficult to sustain during non-drought years • Institutional objectives and priorities may not be aligned to promote water conservation • Communicating to the retail level customers • Demand hardening makes further conservation increasingly difficult • Proposition 218 compliance regarding conserving water rate structures • Availability of water savings data	• Drought has created momentum • Technological advances are available to increase conservation • Consumer behavioral changes and market transformation have potential for future water savings	• Evaluate existing programs for areas of improvement • Explore new programs and devices • Expand partnerships with government agencies and utilities • Continue to assist with model ordinances • Explore ways to communicate water use to the end user • Provide targeted outreach and education, including to land-use planners • Study successes in retail water pricing • Explore research opportunities and technology development • Develop opportunities for information sharing and program integration • Explore strategies to help incentivize additional water conservation

Table 1: Summary (Continued)

Issues	Opportunities	Recommendations*
Groundwater (Including Stormwater and Other Recharge)		
• Region is experiencing historic low groundwater levels • Urbanization reduces groundwater recharge and increases flood risk • Climate change may alter precipitation patterns • Costs/Funding • Institutional challenges • Water quality • Operational & environmental Issues	• Adjudication amendments increase flexibility for groundwater management • Regulatory changes maximize recycled water recharge • New treatment and brine disposal technologies • Collaboration on multi-benefit projects	• Explore opportunities to address ongoing threats to sustainability • Explore innovative project and partnership development • Continue to provide an avenue for open regional discussion on stormwater
Recycled Water		
• Lengthy and variable permitting process • Negative public perception & conflicting messaging • Costs • Source control and effluent water quality needs • Operational issues • Conflicting institutional objectives	• Progress toward new regulatory process • Improving public perception • New funding opportunities • Partnerships • New technologies, research, & information sharing	• Explore opportunities to improve permitting process • Improve public education and awareness of water recycling • Explore various investment strategies such as incentives, ownership, and partnerships • Consider joint technical studies and projects
Seawater Desalination		
• New regulations affect future development • Costs • High energy use • Conflicting messaging	• Improve permitting process • Regional, state, and federal funding • Technology and innovation • Partnerships and collaboration with stakeholders • Communicating benefits	• Explore legislative, regulatory, and communications opportunities • Continue investment in new research, studies, and innovation • Investigate partnership opportunities for managing risk • Evaluate options for capacity building

Table 1: Summary (Continued)

Issues	Opportunities	Recommendations*
Stormwater Direct Use		
• Availability of supplies due to uncertain rainfall patterns • Operation and maintenance needs • Potential impacts to groundwater recharge and quality	• Rainwater capture is now available for non-potable uses without permitting requirements • Public awareness of water issues	• Evaluate a business case analysis and cost/benefit analysis for providing regional incentives • Continue to facilitate regional discussion on stormwater direct use • Encourage information sharing of challenges and lessons learned
Graywater		
• Permitting and regulations • Cost and economics • Drain-line carry • Potential health and environmental risks • Potential conflict with other resources	• Changes to plumbing and building codes • Removed authority to prohibit graywater use • Public awareness increased due to drought	• Continue to encourage research • Explore additional public education efforts
Resource Interrelations		
• Water quality • Regulatory challenges • Costs and limited funding • Lack of public support	• Collaboration on multi-benefit projects • Collaboration on grant funding • Technology, research, and information sharing • Heightened public awareness and regulatory reform during drought • Optimizing resource interactions	• Explore partnership opportunities for multi-benefit approaches • Explore research and technology development opportunities • Investigate integrated regulatory, outreach, and education efforts • Explore integrating resource, program, and planning opportunities • Explore funding strategies that improve economic feasibility of multi-benefit projects

* Recommendations (identified potential actions) do not obligate future policy or implementation for any agency, but instead aim to help advance the regional discussion on water resource issues.

2. Introduction

Local water resources and conservation play a critical and growing role in the region's water portfolio. For effective implementation, managers and policy-makers should be aware of the latest information on the development of these local resources and conservation efforts. This paper seeks to help inform future water resource discussions by identifying current and potential resource issues, opportunities, and actions in the following areas:

- Conservation
- Groundwater (including stormwater and other recharge)
- Recycled Water
- Seawater Desalination
- Stormwater Direct Use
- Graywater
- Resource Interrelations

The information provided in this paper does not obligate future policy or implementation for any agency, but instead aims to help advance the regional discussion on water resource issues.

OVERVIEW

The 2010 IRP included the development of six individual Issue Papers[1] based on each of the different resource areas, which summarized the findings of in-depth workgroup discussions, the status of local supplies and programs, and recommendations for future opportunities. The 2015 IRP Update Issue Paper Addendum builds on the previous Issue Papers, providing a discussion on the current challenges and opportunities of each resource, lessons learned since 2010, and updated recommendations.

Process

This Issue Paper Addendum is a product of an overall process of regional collaboration with input from the IRP Member Agency Technical Workgroup, the Water Use Efficiency Meetings, other resource experts, and stakeholders.

[1] The 2010 IRP Update Issue Papers can be found in the Technical Appendix: http://mwdh2o.com/PDF_About_Your_Water/2.1.2_IRP_Appendix.pdf

3. Conservation

OVERVIEW

Conservation is a major part of Metropolitan's regional resource strategy and was identified in the 2010 IRP as one of the core resources to meet projected levels of demand. Metropolitan and its member agencies support numerous water conservation programs in the region that involve incentives, research and development, and efforts to change consumer behavior.

California has experienced major drought conditions since the 2010 IRP. Immediately following Governor Jerry Brown's Emergency Drought Declaration in January 2014, Metropolitan took a series of actions to address drought conditions. In February 2014, Metropolitan declared a "Condition 2 – Water Supply Alert" to increase public awareness and urge local water agencies within the Metropolitan service area to adopt and enact water saving ordinances. In December 2014, recognizing the importance of indoor and outdoor conservation in managing the ongoing drought, Metropolitan's Board of Directors authorized an additional $40 million for conservation incentives to keep up with turf removal rebate demand, raising the two-year conservation budget to $100 million (fiscal years 2014/15 – 15/16). In addition, Metropolitan conducted an enhanced $5.5 million public outreach program including an extensive radio and television advertising campaign that greatly increased public awareness of the drought and encouraged increased conservation efforts.

The following winter of 2014/15 was the driest on record for the northern Sierra, where snowpack is extremely important for Metropolitan's imported water supplies. In 2015, California entered a fourth consecutive drought year and the seventh dry year out of the previous eight years. In March 2015, the Board authorized a second regional public outreach campaign asking the public to conserve even more. On April 1, 2015, Governor Brown issued an Executive Order (EO B-29-15) that, among other things, directed the State Water Resources Control Board (SWRCB) to implement mandatory water reductions in urban areas to reduce potable urban water usage by 25 percent statewide. On April 14, 2015, Metropolitan's Board voted to implement the Water Supply Allocation Plan, which places limits on the amount of water member agencies can purchase without facing a surcharge. On May 5, 2015, the SCWRCB adopted an emergency conservation regulation in accordance with the governor's directive. The provisions of the emergency regulation went into effect on May 18, 2015. As a result of this activity at the state and local level, Metropolitan experienced a 20-fold increase in application requests for water-saving devices rebates. In May 2015, Metropolitan's Board further increased the two-year conservation budget to an unprecedented $450 million, with $340 million committed to turf removal incentives.

The Governor's April 1, 2015 Executive Order also directed the California Department of Water Resources (DWR) to update the state's Model Water Efficient Landscape Ordinance through expedited regulation. The California Water Commission approved the revised ordinance on July 15, 2015. Under the rules of this newly adopted ordinance, new California yards and commercial landscaping installed after December 1, 2015, will use up to a third less water on average.[2]

Throughout the region, consumers have shown heightened interest in the use of Metropolitan's incentives to help move toward more efficient water use practices. While overall interest in incentives for water efficiency increased, the most significant increase occurred in Metropolitan's turf removal program. With water conservation activity reaching an all-time high in summer/fall 2015, the challenge will be to encourage and sustain water-saving behavior and to optimize the resources available to achieve the highest amount of water savings into the future.

CHALLENGES

Varying Commitment to Conservation

Resources committed toward water conservation efforts tend to vary significantly depending on the water supply situation. Unlike energy providers that maintain energy efficiency media campaigns on a continuous basis, conservation messaging from water utilities is often only highly-visible during periods of drought. A main challenge is coordination of consistent messaging across the region and maintaining long-term conservation efforts. Whereas energy providers are comprised of a relatively few public utilities and investor-owned utilities, water agencies are numerous and differ greatly in size, demographic profiles, and microclimates. In Metropolitan's service area for example, there are 26 member agencies that supply water to about 250 retail agencies that deal directly with customers.

Conflicting Institutional Objectives

Water retailers throughout California are working hard to comply with the mandatory use reduction targets set by the SWRCB. However, in some communities, the water retailer is a municipality with a wide range of responsibilities besides delivering water to local residents and businesses. In some cases, municipal goals and objectives may conflict with long-term water conservation. One example is landscaping. Although Assembly Bill 1 (Asm. Cheryl Brown), signed into law in July 2015, prevents cities and counties from imposing fines for brown lawns when the governor has declared a state of emergency due to drought conditions, they may revert to existing landscape standards once the drought ends and again

[2] California Department of Water Resources. July 15, 2015. "Water Commission Adopts Model Water Efficient Landscape Ordinance; Public Comment Helped Shape Revisions". Available at http://www.water.ca.gov/news/newsreleases/2015/071515b.pdf

require landscapes with higher water demand. Assembly Bill 1164 (Asm. Mike Gatto), signed into law on October 9, 2015, prohibits local governments from banning water-conscious landscaping at private residences while allowing cities and counties to set aesthetic and environmental standards.

Communicating Water Use to End Use Customers

Some water bills can be confusing and do not use user-friendly terms or billing units. This makes it difficult for customers to know how efficiently they use their water or how their use compares with their neighbors. Additionally, water utilities that lump costs into fixed charges rather than volumetric charges in order to ensure more steady revenue flows can inadvertently diminish the financial incentive for their consumers to reduce water usage. It also can be particularly difficult to engage commercial and property tenants and those who live in multi-family housing where there are disconnections between those who use water and those who pay the water bills.

Demand Hardening

Due to significant conservation investments over the past 25 years, the region is continually challenged with finding innovative and cost-effective ways to save more water. Obtaining additional conservation savings is becoming increasingly difficult and expensive as easier-to-achieve opportunities in the region are exhausted, particularly as residential indoor water-saving devices approach market saturation in some areas. Future long-term savings potential will be increasingly derived from customized commercial, industrial, and landscape programs and may ultimately result in lifestyle changes. However, the region is highly diverse and different communities have different levels of market saturation for indoor devices and program implementation. Areas with older housing may obtain more savings from indoor retrofits than areas with newer construction.

Compliance with Proposition 218 Requirements for Water Rate Structures

Proposition 218, enacted in 1996, imposes certain procedures, requirements, and voter approval mechanisms for local government assessments, fees, and charges. In April 2015, the Fourth District Court of Appeal issued a key Prop. 218-related decision in *Capistrano Taxpayers Association Inc. v. City of San Juan Capistrano*. The court ruled that tiered rate structures designed to encourage water conservation, where higher users pay progressively higher rates, violate Proposition 218 if they are not tied to costs of service. This decision may impact retail water suppliers attempting to use water rate structures as a measure to comply with the mandatory water use reduction requirements from the SWRCB.

Availability of Water Savings Data

A continuing challenge with any water conservation program is availability of reliable water savings data. Water savings estimates are instrumental for calculating incentive amounts and planning water demand reduction analyses. However, documented water savings studies have inherent component variables that could lead to different results under changed conditions. Because of the wide range of factors that can affect performance, water agencies must work in general savings terms or modify their savings estimates based on their observed results. In addition to the challenge to obtain representative data, the amount of water savings for many water efficient devices can vary greatly depending on user behavior, which is difficult to measure. For example, low-flow showerheads would seemingly generate consistent water savings, but residential end use studies have shown that shower usage times vary considerably and in some circumstances the average usage time increased to the point where no savings actually occurred. Other approaches such as turf removal are relatively new to Southern California and water savings data will need to be analyzed.

OPPORTUNITIES

Drought Has Created Momentum

The drought has heightened water awareness throughout the state and created new regulatory pathways to advance water conservation. For example, brown lawns and medians have spurred significant interest in creating alternative landscapes that require less water. This heightened awareness has led to unprecedented activity in Metropolitan's conservation incentive programs. The challenge in the future will be in maintaining this level of interest during wetter years or in the face of limited funding for incentives.

The Governor's April 2015 Executive Order called for revising the state's Model Water Efficient Landscaping Ordinance to increase 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 in turf. It also requires reporting on the implementation and enforcement of local ordinances, with required reports due by December 31, 2015. State law requires all land-use agencies to adopt a water-efficient landscape ordinance that is at least as efficient as the model ordinance prepared by DWR. DWR's model ordinance takes effect in those cities and counties that do not adopt their own. Land-use agencies also will be required to report on ordinance adoption and enforcement each year.

Technological Advances

Advances in technology also offer opportunities to increase conservation. These technological advances can vary from consumer smartphone applications to advanced meters that allow consumers to monitor their water use in real time. Technology allows water agencies to create conservation programs that better suit their customers based on customer use data. Additionally, on the consumer level, technological advances can simplify and encourage water conservation through smarter appliances that modify operations based on load and irrigation controllers that can be programmed through a smartphone.

Metropolitan frequently revises its list of devices eligible for rebates together with the member agencies through the Program Advisory Committee (PAC).

Behavioral Changes and Market Transformation

To meet the State's current mandate and future regional demands, conservation needs to put a greater focus on consumer behavior and how to encourage people to use water more efficiently. The primary methods used to affect behavioral change include advertising, media reporting, tiered water billing rates, water agency outreach, and social norm messaging programs. The current drought has received significant attention through the news media, water conservation advertising, and water agency outreach programs. In an effort to spur market transformation, Metropolitan created a turf removal program in 2008 with an incentive of 30 cents per square foot of turf removed. However, there was little interest in this program at that incentive level. Grants from the U.S. Bureau of Reclamation (USBR) and the California Department of Water Resources enabled Metropolitan to increase the incentive to $1 per square foot. As interest grew and member agencies began to contribute extra funding, popularity in this program soared. Metropolitan, in order to make this program equitable for all of its agencies, increased its incentive to $2 per square foot to match the top performing agencies. Shortly thereafter, demand for turf removal rebates increased beyond expectations and quickly consumed the available conservation budget. Rather than closing the program, Metropolitan decided to increase funding for the program to $340 million to encourage development of a new regional conservation mindset due to the high-visibility of turf removal. The underlying premise of a highly visible turf removal program is that additional water savings benefits will occur from neighbors removing their grass for a more sustainable landscape, investing in other water savings fixtures, or reexamining their own water use behavior. Sustainable landscapes can be both showcases for natural beauty and statements that people understand the need for addressing water scarcity in the region and that they are contributing to the solution.

LESSONS LEARNED

Mandatory Reporting Has a Powerful Effect on Conservation

In July 2014, the SWRCB adopted an emergency water conservation regulation which required mandatory monthly water use reports by urban water suppliers. In July 2015, the SWRCB assigned individual conservation targets for each retail urban water supplier. Urban water suppliers are expected to meet or exceed their individual conservation standard starting in June 2015 and continuing through February 2016. These water use reports have been highly effective at encouraging conservation. The format of these reports also suggests that reporting does not have to be complicated to be effective. Enforcement and compliance statistics indicate that water suppliers are following up on water waste reporting and issuing formal warnings and penalties against alleged violators. Waste reporting is an important tool for identifying leaks and overwatering that could go undetected for weeks resulting in millions of gallons of wasted water.[3] In addition, under the revised Model Water Efficient Landscape Ordinance adopted in July 2015, all local agencies are now required to report to DWR on the implementation and enforcement of their landscape ordinances by December 31, 2015, with additional annual reporting requirements.

Water Pricing Can Reduce Demand

Water pricing can reduce demand by providing an economic incentive for consumers to conserve water by altering their behavior. Many water suppliers have established rate structures to incentivize water conservation and have seen significant savings as a result. A recent study by researchers at the University of California, Riverside, School of Public Policy found that between July 2011 and April 2014, household usage was 10 to 15 percent lower under a tiered structure than it would have been under uniform rates.[4] However, the previously-noted court ruling for the city of San Juan Capistrano determined that the city's tiered water rate structure, designed to encourage conservation, violated the provisions of Proposition 218 and therefore was unconstitutional. This decision has discouraged water agencies that were contemplating adopting a tiered rate structure, and it forced agencies with conservation rate structures to go back and review their rates to ensure they are in compliance with Proposition 218.

Non-Price Measures are Also Effective

In recent years the energy utilities have incorporated non-price interventions using behavioral economics to successfully lead consumers to conserve more. A similar strategy is now taking place in the water industry, where customers are being exposed to a variety of social marketing tools to motivate and engage them to affect behavioral changes that lead to water savings. These social norms messaging programs seem to offer promising ways to affect and reduce resource use among consumers, especially when customers are shown their water use is out of alignment with their perceptions, and more importantly, similar households. In 2014, the California Water Foundation, East Bay Municipal Utility District, and WaterSmart Software announced results of an independent study on a yearlong social norms pilot project. The program utilized WaterSmart Software's Home Water Reports service to provide customers personalized reports on their water use and how they compared to their

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[3] State Water Resources Control Board. July 1, 2015. "State Reduces Water Use by Nearly 29 Percent in Advance of June Conservation Mandate". Available at http://www.waterboards.ca.gov/press_room/press_releases/2015/pr070115_may_conservation.pdf

[4] UC Riverside School of Public Policy, *Policy Matters*, Vol. 6, Issue 1, Fall 2014. Schwabe, Kurt, Barenklau, Ken, and Dinar, Ariel. "Coping with Water Scarcity: The Effectiveness of Allocation-Based Pricing and Conservation Rebate Programs in California's Urban Sector." Available at http://policymatters.ucr.edu/wp-content/uploads/2014/10/pmatters-vol6-1-water-incentives.pdf

neighbors. Findings showed that residential homeowners reduced their consumption by about 5 percent from the previous year.[5]

Legislation Can Help Change Marketplace and Prioritize Conservation

Recent years have shown conservation-related legislation can be highly effective when it involves changes to the marketplace rather than forcing changes upon residents and businesses. One example of productive legislation is AB 715, signed into law in 2007. AB 715 requires that all toilets and urinals sold in California after January 1, 2014 are to have a flush rate of 1.28 gallons per flush (gpf) for toilets and 0.5 gpf for urinals. The 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 require.

State legislation like AB 1881 (Water Conservation in Landscaping Act of 2006) and Senate Bill 407 (2009, Water Conservation: Plumbing Fixtures Replacement), were less effective than intended due to their complexity and lack of funding for training or enforcement for officials required to enforce the provisions of the law. Lessons learned from the outcome of these bills are now applied to improving the language on existing bills circulating through the legislature. The July 2015 update to the Model Water Efficient Landscape Ordinance further advances the objectives of AB 1881.

Recent legislation has prioritized and protected water efficient behavior against conflicting rules that penalize conservation. Examples include AB 2100, SB 992, and AB 1. AB 2100 was an urgency bill that went into effect immediately upon the governor's signature. For the period it was effective (July 21, 2014 through September 18, 2014), AB 2100 prohibited homeowner associations from imposing a fine or assessment against a unit or lot owner for reducing or eliminating watering of vegetation or lawns during any period for which the governor or a local agency has declared a state or local emergency due to drought. SB 992 went into immediate effect on September 18, 2014, superseding AB 2100 because it amended the same section of law, Civil Code Section 4735. SB 992 is nearly identical to AB 2100 except for two additional features on recycled water and pressure washing. For recycled water, it provided exception to the ban on fining or penalizing owners who fail to irrigate their landscaping if the association has access to recycled water for landscape irrigation. For pressure washing, SB 992 prohibits homeowner associations from requiring pressure washing exterior surfaces during a state or local drought emergency. As previously mentioned, AB 1 prevents cities and counties from imposing fines for brown lawns when the governor has declared a state of emergency due to drought conditions.

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[5] Mitchell, David L. and Chesnutt, Thomas, W. *Evaluation of East Bay Municipal Utility District's Pilot of WaterSmart Home Water Reports.* Prepared for California Water Foundation and East Bay Municipal Utility District. Available at http://californiawaterfoundation.org/uploads/1389391749-Watersmart_evaluation_report_FINAL_12-12-13(00238356).pdf

RECOMMENDATIONS

Programs

- Evaluate existing programs for effectiveness and areas of improvement
- Explore new programs and devices
- Expand partnerships with governments and utilities to increase funding and gain greater access to customers

Measures

- Continue to assist with model ordinances

Communication

- Explore ways to communicate water use to the end user, such as through user-friendly water bills, social media, and technology (smartphone apps, etc.)
- Provide targeted outreach and conservation education to city and regional planners who develop zoning and ordinances

Retail Water Pricing

- Study successes in retail water pricing structures that have effectively reduced water use and are in compliance with Proposition 218 requirements

Overall

- Explore research opportunities and technology development
- Develop opportunities for information sharing and program integration
- Explore strategies to help incentivize additional water conservation

4. Groundwater (Including Stormwater and Other Recharge)

OVERVIEW

Groundwater basins within Metropolitan's service area provide an average of 1.4 million acre-feet per year (MAFY) within the Metropolitan service area. Groundwater production is used to offset peak seasonal water demands on the imported water treatment and distribution systems. Further, surplus water supplies available during wet years are stored in groundwater basins for later use during dry, drought, or emergency periods. Metropolitan's 2005 Groundwater Assessment Study (referred herein as the Groundwater Report)[6] provides a description of the groundwater basins within the Metropolitan service area.

Active groundwater recharge in the service area started more than 100 years ago with the capture of stormwater. Basins began being recharged with imported water in the 1930s and with recycled water in the 1960s. Today, groundwater recharge through spreading basins and injection wells supports an average of about 50 percent of the total groundwater production in region. During the most recent drought, groundwater basin managers responded with a suite of actions to remove institutional barriers to increased stormwater capture or use of recycled water for groundwater recharge.[7]

CHALLENGES

The 2010 IRP Groundwater Issue Paper identified challenges for the potential use of available storage. These challenges include:

- Institutional issues for storage and recovery of stored water
- Funding needed for capital infrastructure and O&M costs
- Remediation of contaminated groundwater
- Lack of water to store

Additional challenges have been identified during workshop discussions for the 2015 IRP Update. These identified challenges are discussed below.

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[6] Groundwater Assessment Study. Available at http://www.mwdh2o.com/AboutYourWater/Sources%20Of%20Supply/Local-Supplies/Ground-Water-Sources

[7] Metropolitan Water District of Southern California. Board Report: Status of In-Regional Groundwater, February 2015. Available at http://edmsidm.mwdh2o.com/idmweb/cache/MWD%20EDMS/003735550-1.pdf

Potential Threats to Sustainable Groundwater Resources

Identification of the sustainable levels of groundwater production and strategies for maintenance of these levels is important to regional water supply reliability. As a result, this paper focuses more attention on groundwater sustainability and potential threats to reliability.

Groundwater Levels at Historical Lows

As basins experience a major decline in groundwater and storage, there is a potential risk for loss of groundwater production capacity in the region. The 2005 Groundwater Report estimated that there was approximately 3.8 million AF of usable space in groundwater basins (considered to be a healthy storage level) in 2005. Recent consecutive multiple dry years have significantly reduced recharge of the groundwater basins, and water levels throughout the region have reached historic lows. By December 2014, groundwater basin storage levels had declined by more than 1 million AF. For example, the key well elevation in the Main San Gabriel Basin as of June 2015 was 177.5 feet mean sea level (MSL), 22.5 feet below the established operating range and a historic low for the basin. Metropolitan estimates that within its service area, unused groundwater storage space increased to nearly 5 MAF in 2015. If this trend continues, the risk of being unable to sustain a reliable source of supply increases.

Urbanization Reduces Groundwater Recharge and Increases Flood Risk

Groundwater basins in the region were adjudicated many decades ago. For example, the adjudication of the Raymond Basin, in the Pasadena/San Marino/Foothill area, dates to 1943. Other adjudications date from the 1960s, 1970s, and 1980s. Data used to determine the basin safe yield predates these adjudications. Since then, urbanization has increased impervious coverage of basin areas and channelization of streambeds, impeding the outflow of stormwater and reducing infiltration that recharges groundwater aquifers.

Recent water use efficiency measures to reduce outdoor water use for landscape irrigation and to reduce leakage from water distribution pipelines may further reduce incidental recharge of groundwater aquifers. Development of sewer systems to replace septic systems has also reduced incidental recharge of groundwater. Several groundwater basin managers have revised basin safe yield quantities or initiated measures to sustainably use and preserve groundwater supplies. Simultaneously, water managers in these areas have identified projects to replace lost sources of recharge in order to maintain safe yields or to minimize reduction of the basin safe yield.

Climate Change May Alter Precipitation Patterns

Climate studies have suggested that climate change may alter historic precipitation patterns in Southern California. These studies indicate that total average precipitation over the long term may remain constant, but that the pattern of this precipitation may change to include longer periods of very dry weather with precipitation occurring less often and with greater intensity. Climate warming is predicted to reduce snow pack in local mountains which would also contribute to peak runoff and increasing challenges for capture and infiltration of stormwater. A warmer climate may also cause a longer growing season and increased evapotranspiration by vegetation. These changes in precipitation patterns may alter both passive and active stormwater recharge of groundwater basins.

Costs/Funding Issues

Groundwater

Funding for capital infrastructure continues to be a significant challenge. State propositions are a sporadic source of grant funds. Remediation of groundwater contamination presents a significant, on-going cost for operations and maintenance (O&M) that presents barriers to implementation.

Stormwater

Cost may also be a barrier for implementation of new stormwater projects. The more costly projects tend to be distributed projects located in areas where infiltration is poor. Less costly projects tended to be modifications to existing centralized facilities. It is also important to note that the range of costs does not consider the suitability for recharge for the project – a basin may not be suitable for recharge due to factors such as soils and geology or groundwater contamination. Although some potential stormwater projects may appear to have relatively low cost on a per AF basis, issues other than costs can impede their implementation, such as environmental issues associated with sediment removal and funding availability. Certain grant funding may only be available for upfront capital costs without covering ongoing operation and maintenance costs.

It also may be difficult to calculate the benefits versus costs. Not all areas within the Metropolitan service area are conducive to groundwater recharge, and the areas that do have a productive groundwater resource have varying basin characteristics. In addition, an increase in groundwater basin storage does not necessarily result in an equal increase in potential production yield. More than 90 percent of the groundwater resources within the Metropolitan service area are adjudicated or formally managed pursuant to statute or adopted groundwater management plans. Within adjudicated or formally managed basins, the legal rights to extract groundwater are often defined by the determined safe yield, which is calculated differently for each basin. Water right issues must be addressed on a site-by-site basis when stormwater is captured in the upper part of watersheds, since stormwater capture diverts runoff that would have otherwise flowed to downstream users. Stormwater capture may also complicate the accounting of groundwater pumping rights.

Recycled Water
Using recycled water for groundwater recharge is an important part of groundwater sustainability. For more than 50 years, recycled water has been recharged in spreading basins throughout the Metropolitan service area. In recent years, the trend has been toward more advanced levels of treatment to manage salt buildup, blend water requirements, and changing regulations. Advanced levels of treatment can dramatically increase the cost of replenishment supplies. Balancing cost versus treatment and blending requirements is an ongoing issue for increased use of recycled water for recharge.

Institutional Challenges

Unique Requirements for Each Basin
Each basin in the region has specific physical and institutional conditions that can complicate groundwater management. Physical conditions may include contaminant plumes, seawater intrusion, areas of high groundwater, or discharge of poor quality water. An approach to groundwater management that fails to address the unique nature of different groundwater basins will not be effective.

In recent years, storage policies in the Central, West Coast, and Main San Gabriel groundwater basins have been addressed with amendments to the existing adjudication agreements. The Central and West Coast basin judgments were amended in 2013 and 2014 to provide a new management structure for use of the storage space in the basins. The Main San Gabriel Basin judgment was amended to facilitate storage of water in advance of overproduction.

Broadening the Agencies' Mission
Multi-benefit approaches to groundwater storage projects may enable a new wave of projects. Single purpose may be too costly to provide cost-effective benefits. If a project can be modified to provide multiple benefits, two or more agencies may be able to collaborate and share costs. Stormwater capture may provide water supply, flood protection, and surface water quality management. Partnering agencies involved in such a project may need to revise policies or adjust operating procedures to realize these additional benefits.

Groundwater Quality

Remediation of Groundwater Contamination
Groundwater quality issues are a common concern throughout the region. Increased conjunctive use of surface and groundwater is hampered by groundwater quality problems. Increased storage of surface water may spread contaminant plumes or mix with existing contamination. Funding may not be available for capital facilities and for ongoing operation and maintenance of the treatment facilities. Further, some constituents present technical

feasibility challenges for their removal. Waste disposal can be a challenge if brine lines are not available or if capacity is limited. Regeneration or replacement of treatment media can also be costly and present hazardous waste disposal problems.

Recycled Water Recharge Regulatory Constraints

Recycled water has been used for groundwater recharge since the 1960s. However, expanded use of this resource has potential implications to groundwater quality. Recycled water, depending upon the level of treatment, can have a higher concentration of salts and nutrient loading. Regulatory constraints for recharge of recycled water include: treatment, blend water, retention time, and Basin Plan Objectives established by the applicable Regional Water Quality Control Board (RWQCB). These constraints are in place to help protect water quality, but may limit how much recycled water can feasibly be recharged into the groundwater basins. In addition, advanced levels of treatment may be required to meet the regulatory constraints.

Basin Salt Loading

Conjunctive use of surface and groundwater supplies may face hurdles when native groundwater is of better quality than imported or recycled recharge water. Constituents such as total dissolved solids (TDS), chloride, sulfate, and nitrate are common problems. Basin Plans adopted by RWQCBs are required to protect existing high quality waters from degradation. The Basin Plans also set out quantified water quality objectives for protection of existing or potential future beneficial uses of water. Increasing levels of recycled water or Colorado River water may contribute to basin salt loading.

OPERATIONAL AND ENVIRONMENTAL ISSUES

Endangered Species

Endangered species associated with aquatic habitats affect the operations of stormwater reservoirs and stream courses for storage, conveyance, and recharge of stormwater, imported water, and recycled water. Water managers will need to develop approaches that provide a balance between water supply and ecological benefits as species decline and receive protection afforded by the state and/or federal endangered species acts, including the designation of critical habitat. Water flow velocity and duration may be affected as operational purposes are broadened to better accommodate ecological values. Establishment and maintenance of vegetation and suitable substrates may be objectives of these revised operations.

Operational

Groundwater recharge operations are complicated by differing objectives that apply to flood control and stormwater capture. In Southern California, many groundwater recharge facilities are located within or adjacent to flood control facilities. Stormwater recharge is reliant upon the capture and slow release of stormwater to downstream spreading facilities. Flood control reservoirs often have a primary purpose for flood control, which traditionally has involved moving large quantities rapidly downstream, before they rise and possible flood nearby areas. This approach tends to work against retaining stormwater for slow release for groundwater recharge. In some cases, a small water conservation pool is allowed to be held during the storm season with a somewhat larger pool allowed late in the season when flood risk is reduced.

Imported water is an important source of supply for supplemental recharge of groundwater basins. Treated drinking water may be recharged indirectly through the in-lieu method. In-lieu recharge of imported water is accomplished when additional imported water is used for municipal and industrial purposes in place of groundwater that was planned to be pumped and used. Treated imported water is also used for recharge through injection to the groundwater aquifer. This is most often done at seawater barriers. Imported water is increasingly being replaced by recycled water.

Challenges associated with spreading untreated imported water include access to recharge areas, water quality characteristics of the imported water as compared to the groundwater, and the potential for quagga mussels to be transmitted via untreated Colorado River water. The presence and spawning of quagga mussels in the Colorado River and downstream facilities, if unchecked, would adversely affect the capacity and operation of Metropolitan's conveyance, storage, and distribution systems, as well as any further downstream facility that might receive such water. Access to recharge areas requires that the imported water spreading deliveries be scheduled for times when spreading grounds are not being used for recharge of stormwater or recycled water. Additionally, imported water spreading deliveries need to be scheduled around maintenance of stormwater channels used for conveyance and maintenance of spreading grounds.

Specific requirements for groundwater recharge may impact which water sources can be used in a specific basin. The TDS, chloride, and sulfate concentrations in imported water used for spreading is of concern to groundwater basin managers trying to comply with RWQCB Basin Plan water quality objectives. In many basins, water from the State Water Project is preferred for groundwater recharge due to lower TDS levels. Further, in recent years, the potential for presence of quagga mussels in untreated Colorado River water places substantial requirements for desiccation (drying) of conveyance and spreading areas to kill quagga mussels and avoid further spread of this invasive species. These requirements greatly limit where and when Colorado River water may be used for groundwater recharge.

Sediment Removal

Stormwater reservoirs lose storage capacity as sediments in runoff settle out and accumulate. Sediment must be removed if capacity is to be maintained for flood control and stormwater capture for recharge. Sediment production greatly increases in years following forest fires, and significant challenges restrict agencies' ability to remove large amounts of sediment from the reservoirs. Challenges include addressing impacts to riparian habitat and species and impacts to nearby neighborhoods from truck traffic, noise, and dust. Finding suitable sediment disposal locations must also be accomplished. Removal of sediment for maintenance of reservoir capacity can be very expensive due to the large quantity of material that must be moved. Spreading basins are also affected by fine sediments and algae growths that clog the spreading facilities. Removal is necessary in order to maintain percolation rates.

OPPORTUNITIES

Adjudication Amendments Increased Flexibility for Groundwater Management

Recent amendments to groundwater basin adjudications have increased the potential to store water supplies in advance of dry years. This advanced storage will ease the impact on basin water levels when dry years reduce availability of storm and imported water supplies for groundwater recharge. By formally recognizing storage in these basins, the adjudication amendments will encourage better conjunctive management of imported, recycled, and stormwater supplies.

Regulatory Changes Maximize Recycled Water Recharge

In June 2014, the Division of Drinking Water (DDW) modified the regulations regarding the use of recycled water for groundwater recharge. Changes such as modifications of the blend water period from 60 months to 120 months may provide opportunities for enhanced recycled water recharge – increasing the time period allows agencies to better take advantage of hydrologic conditions. Additionally, the percentage of water required to dilute the recycled water has been decreased, increasing the maximum recycled water contribution. Many seawater barriers are moving toward 100 percent use of highly treated recycled water and no longer be required to use non-recycled water for blending over time. These measures allow recycled water recharge to continue during dry periods, and for groundwater managers to maximize the use of recycled water.

New Technologies for Treatment and Disposal

Several agencies are researching alternative treatment technologies through Metropolitan's Foundational Actions Funding (FAF) Program[8]. For example, new treatment and brine

[8] Information on Metropolitan's FAF Program can be found at: http://mwdh2o.com/AboutYourWater/Planning/Funding-Programs/Innovative-Supplies-Funding/Pages/default.aspx

disposal technologies may provide additional opportunities for groundwater recovery and recycled water recharge.

Multi-Benefit Approaches

Multi-benefit approaches may provide opportunities to increase stormwater capture for water supply. Additionally, with the recent changes in the Central, West Coast, and Main San Gabriel Basins, partnerships for utilization of available supplies and groundwater storage space create additional opportunities.

LESSONS LEARNED

Groundwater Production Maintained During Dry Years

Dry years have shown that groundwater basins are able to continue groundwater production with historically low water levels. While significant overdrafting of groundwater is not to be encouraged, it is reassuring that basins can be successfully drawn down in response to extreme extended drought conditions. To avoid long-term subsidence, overdraft, or other impacts, the basins will need to be recharged as soon as the drought ends.

Dry years have also demonstrated the ingenuity of local water managers. When imported water supplies are limited, system operational changes have helped to ensure that all areas continue to have access to drinking water supplies. Metropolitan was able to radically re-operate its system to address a severe shortage of State Water Project supplies. Other agencies implemented interconnections between systems, repaired wells or lowered well bowls and installed treatment to allow recovery and use of contaminated groundwater. Additional recycled water projects have come online to meet certain water supply demands (landscape irrigation, industrial applications, and groundwater recharge), freeing up potable water for other purposes. The U.S. Army Corps of Engineers allowed temporary deviations from its flood control operations manuals to allow increased capture and recharge of stormwater.

Groundwater management planning within a watershed context is more effective than individual projects planned outside this context. Pilot and demonstration projects provide valuable data, allowing technical, operational, and institutional problems to be identified and addressed prior to major capital infrastructure commitments.

Cost is a Significant Factor in the Development of Stormwater Projects

Many agencies are faced with limited available funding to help with capital and O&M costs for the development of stormwater projects. These agencies often seek outside Federal and State funding through grants and loans. Often, such grants and loans only fun the upfront capital portion of the total costs and the agency and/or the property owner is responsible for funding the ongoing O&M. With an increasing population, the region must further manage increased water demands as well as increased stormwater runoff and related stormwater quality issues, which may eventually require facility upgrades to increase capacity and treatment.

Distributed stormwater capture projects are typically more expensive than centralized projects. However, distributed projects may produce addition benefits and bring additional partners to the table. For example, green streets can bring together agencies responsible for street repairs, water supply, and flood control together with property owners to develop projects that benefit all the stakeholders.

Land acquisition is an important part of the success of any recharge project. Often, the effective recharge areas are already used for other projects or have become urbanized, making it difficult to develop new recharge projects. Modification of existing recharge areas, such as deepening spreading basins or developing ongoing sediment removal programs may be the primary way to increase recharge.

Public Outreach is Critical for Stormwater Projects

It is important to begin outreach early to increase public support and education. The Elmer Street Neighborhood Retrofit is an example of a successful stormwater project because of ongoing public outreach and education of homeowners, through the coordinated efforts of the City of Los Angeles and the Los Angeles County Department of Public Works, which designed the project, and the Council for Watershed Health, which administered the project.

Expected Groundwater Yield in the Region Reduced in the Long-Term

The recent drought and subsequent historical low groundwater levels have highlighted groundwater sustainability issues in the region. Despite groundwater levels dropping, groundwater production in the region has been relatively stable for the past several years. The loss of recharge while maintaining production has resulted in a loss in storage of more than 1 million acre-feet. In the past, groundwater basin producers and managers had an optimistic view of future conditions and expected to be able to maintain higher levels of production. However, in many basins, pumpers are not using their full adjudicated rights because of groundwater quality issues, inability to perform well maintenance, distribution system issues, or management actions that reduce allowable pumping. In consideration of these conditions, the current outlook of expected future groundwater production in the region is lower than previously anticipated.

RECOMMENDATIONS

Explore Opportunities to Address Ongoing Threats to Sustainability

- Evaluate performance of existing storage programs
- Review storage and transfer strategies
- Explore options to facilitate more effective utilization of groundwater and increased recharge
- Study long-term impacts of drought on groundwater management
- Evaluate the potential of improvements in storm forecasting to increase stormwater capture in reservoirs without adverse effects to flood protection

Explore Innovative Project and Partnership Development

- Continue to explore opportunities for partnerships between water and wastewater agencies
- Look for opportunities to develop multi-benefit approaches with different agencies
- Evaluate funding opportunities (e.g., Metropolitan's Local Resources Program) to assist projects that increase groundwater recharge or improve groundwater quality
- Evaluate a business case analysis and an accurate cost/benefit analysis for providing regional incentives/rebates based on the study of various stormwater pilot projects. It is important that the business case analysis include calculations of regional benefit and dry-year yield

Continue to provide an avenue for open regional discussion on stormwater

- Encourage information sharing of lessons learned to improve future water supply augmentation efforts, including:
    - Technological improvements
    - Water quality data
    - Information gained from the study of pilot projects
    - Examples of governance
    - Regulatory processes
    - Operations and maintenance
- Seek opportunities to seek partnerships, joint funding, or other multi-benefit projects

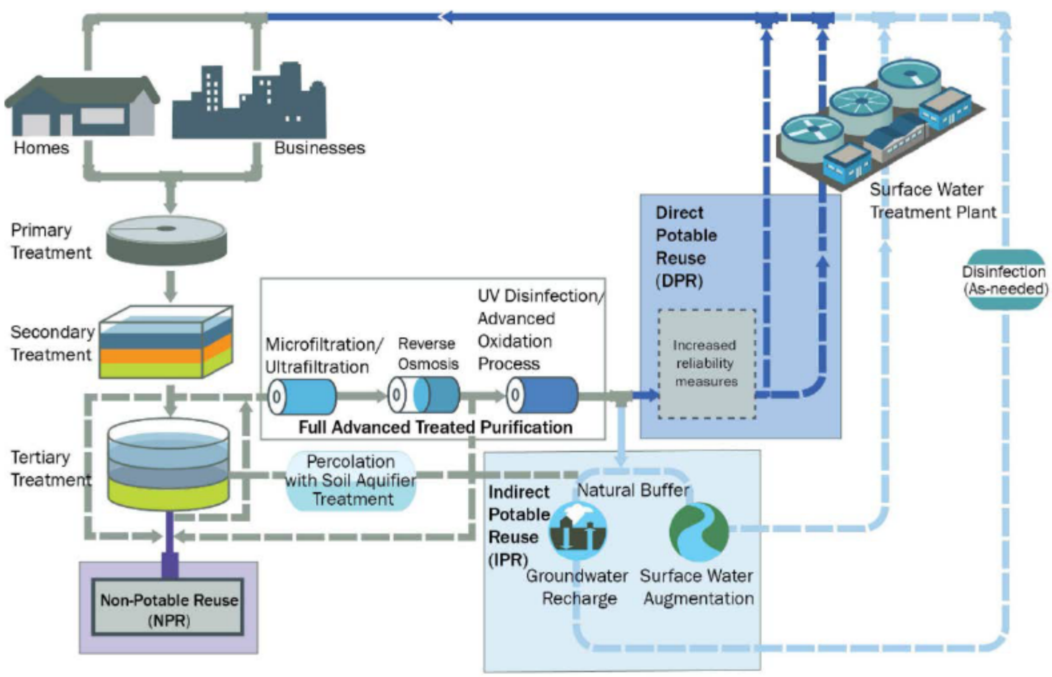
5. Recycled Water

OVERVIEW

Recycled water use categories include non-potable reuse, indirect potable reuse for groundwater recharge and surface water augmentation, and direct potable reuse. **Figure 5-1** shows a general schematic of treatment processes for non-potable reuse, indirect potable reuse, and direct potable reuse.

The 2010 IRP Update identified challenges and opportunities to the development of recycled water projects. Some of those challenges have since been addressed as agencies move forward to facilitate increased use of recycled water. This section will cover additional challenges, opportunities, lessons learned, and recommendations to enhance the development of recycled water.

Figure 5-1: General Schematic of Recycled Water Use



Non-potable reuse. NPR includes any application of recycled water not involving drinking water for human consumption. NPR water originates from homes and businesses as municipal wastewater and undergoes tertiary treatment at a reclamation facility to meet specific water quality standards (i.e., Title 22 of the California Code of Requirements).

Indirect potable reuse. IPR is the application of multiple levels of treatment to purify water for groundwater recharge or surface water augmentation.

Direct potable reuse. DPR is the planned introduction of full advanced treated purified water directly into a public water system's treated or raw water supply. DPR may include increased reliability measures in lieu of a natural buffer and will be better defined through ongoing research.

Source: California Urban Water Agencies

CHALLENGES

Challenges to enhanced recycled water development include permitting, public acceptance, cost, water quality, operational, and institutional barriers.

Lengthy and Variable Permitting Process

The SWRCB established the Recycled Water Policy (Policy). This Policy requires the SWRCB and the nine RWQCBs to encourage the use of recycled water, consistent with state and federal water quality laws. The Policy provides additional directions to the RWQCBs on appropriate criteria to be used in regulating recycled water projects. The DDW of SWRCB and the nine RWQCBs are responsible for setting the rules and permitting for recycled water projects. The timeline and roadmap for getting a permit is challenging and inconsistently implemented in different regions of the state. Limited history and technical information (e.g., on direct potable reuse) to inform regulations and limited staffing at DDW and other agencies has challenged the ability to propose, revise, and adopt new regulations in a timely manner. Agencies planning and designing direct potable reuse and indirect potable reuse projects face delays because of regulatory uncertainty. In addition, many project proponents hoping for grant or loan funding have identified lengthy CEQA review as a challenge.

Indirect potable reuse projects face regulatory constraints such as treatment, blend water, retention time, and Basin Plan Objectives, which may limit how much recycled water can feasibly be recharged into the groundwater basins. For example, the Basin Plan Objective for TDS of a particular basin may be lower than the quality of the tertiary water effluent available, resulting in the need for more blend water or advanced levels of treatment. These treatment requirements impact the economic feasibility of a project.

Public Perception/Conflicting Messaging

Conflicting messaging confuses the public about the safety of recycled water. There is not a clear understanding by the public of the difference between non-potable reuse, indirect potable reuse and direct potable reuse uses. The public is most familiar with non-potable reuse as they see recycled water in use at parks, golf courses, schools, and other large landscapes. However, public perception and acceptance of drinking recycled water (indirect potable reuse and direct potable reuse) is a much bigger challenge. Signage for non-potable reuse projects at parks, schools, and golf courses that read, "Using recycled water; do not drink" can adversely affect the public's acceptance of direct potable reuse and indirect potable reuse. In addition, negative labelling such as "toilet to tap" also affects public perception. Although public acceptance of recycled drinking water has improved, effective education and public outreach is still needed. There is a need for new messaging to reduce the confusion.

Cost

Cost, including up-front capital and ongoing operation and maintenance, remains a barrier to recycled water development. Most low-cost projects have been built. The price tag for expanding the recycled water distribution systems remains a barrier to full implementation of non-potable reuse projects – these projects require pipelines connecting the treatment plants and the individual users. Some agencies may also be considering indirect potable reuse and direct potable reuse projects to reduce the need to have extensive recycled water distribution systems because of the cost. Some non-potable reuse and indirect potable reuse projects and all direct potable reuse projects require advanced treatment facilities, which are comparatively expensive. Advanced treatment may also require additional brine concentrate disposal facilities (e.g., a brine line) and extensive infrastructure for injection wells/spreading facilities, or for delivery of the product water to a spreading ground, surface reservoir, or water treatment plant for potable uses. End users play a very important role for recycled water advancement. Site conversion costs (borne by the customer) and additional conveyance infrastructure for new customers can also be a barrier to reaching full non-potable reuse project capacity. Some agencies may be challenged with cash flow issues or cannot secure the funding needed to implement projects.

In addition, with the increasing prospect of statewide regulations for indirect potable reuse and direct potable reuse, some agencies pursuing indirect potable reuse are hesitant to extend their existing distribution system for non-potable reuse projects for fear of stranded facilities. Similarly, some agencies pursuing direct potable reuse may delay their planned indirect potable reuse project to prevent stranded distribution facilities[9].

Source Control and Effluent Water Quality Needs

Source water quality and flow control is essential to help safeguard the water recycling treatment process and the end use of the water by placing controls on the type, timing, and amount of wastewater that comes into the plant, a good source control program limits treatment plant disruptions and ensures treatment processes are capable of handling spikes in volume, industrial influent, and high salinity influent. When it comes to the treatment process, recycled water policy requires that the effluent meets certain water quality standards. Salt and nutrient management plans protect groundwater beneficial uses and prevent excess degradation, which may limit expanded indirect potable reuse applications if the agency does not have funds for advanced treatment to remove salts to meet the Basin Plan Objectives. In some cases, existing source control plans may need to be updated to deal with constituents of emerging concern and with more stringent needs of the users.

[9] Indirect potable reuse projects usually require injection wells or a distribution system to a surface reservoir or recharge basin, and may also require improvements to a surface reservoir, recharge basin, or treatment facility.

Water use efficiency helps conserve water, but also incidentally reduces wastewater volume resulting in an increase in the concentration of wastewater. As a result, additional treatment is needed, which increases operation and maintenance costs of the system. Source water quality is especially important for implementing indirect potable reuse and direct potable reuse projects to protect potable water systems.

Operational Issues

While each agency is different, it is important to recognize the possible operational issues that may occur with the use of recycled water, including:

- Reduction in wastewater flows due to ongoing conservation and drought
- Lack of seasonal storage to address diurnal and seasonal demands; construction of storage facilities may be needed for flow equalization
- Brine disposal needs
- Environmental flow or stream discharge requirements may limit the ability to deliver recycled water during high demand periods
- Regulatory issues such as blend requirements and water quality objectives may impact the effectiveness of indirect potable reuse
- Lack of regional GIS data to optimize recycled water deliveries
- Need for multiple barriers to ensure recycled water quality and for monitoring techniques that provide feedback in real-time to respond to plant disruptions, especially with direct potable reuse projects
- Need for additional operator training and certification

Conflicting Institutional Objectives

Institutional coordination among drinking water, wastewater, and groundwater management agencies may be challenging and the agencies may face barriers due to the difficulty in aligning varying institutional objectives. The main objective of a wastewater agency is to collect, treat, and safely dispose of wastewater based on a set of established standards. This may conflict with the objectives of a groundwater agency that is legally tasked to protect the quality of groundwater. At the same time, water agencies developing recycled water projects are usually seeking a consistent, higher quality treated wastewater for a successful recycling program – though the wastewater agency may not be treating the wastewater to such higher quality for its normal disposal, and the groundwater agency may still be concerned about the quality of the return flows of this recycled water to the groundwater basin.

OPPORTUNITIES

Progress Towards New Regulatory Process

The state of California has made some progress in developing permit standards that provide opportunities to expand recycled water use.

Non-potable reuse: The SWRCB developed a general permit for non-potable uses of recycled water in June 2014 that provides an opportunity for new projects to come online sooner with more standardized monitoring requirements. Further, revisions are being considered to attract additional users and further streamline recycled water projects.

Indirect and direct potable reuse: The SWRCB is facing a December 2016 deadline under SB 918 to develop regulations for surface water augmentation and to investigate and report to the legislature the feasibility of direct potable reuse.

New Funding Opportunities

On January 17, 2014, as part of the governor's emergency drought declaration, the SWRCB, through the Clean Water State Revolving Fund, will provide up to $800 million in low interest loans for water recycling projects that offset or augment state water supplies and can be completed within three years. Projects must apply for the funding through the SWRCB by December 2, 2015. As of December 17, 2015, over 60 projects had applied requesting more than $1.7 billion in funding.

Proposition 1 (Assembly Bill 1471, Rendon) authorized $7.545 billion in general obligation bonds for water projects with $725 million for water recycling and desalination projects. Another $625 million will be administered through SWRCB's Water Recycling Funding Program for water recycling and $100 million through DWR for desalination.

In 2014, Metropolitan increased the financial incentives under its Local Resources Program (LRP) for agencies to develop recycled water. Metropolitan also established the On-site Retrofit Pilot Program to provide rebates to customers that convert their irrigation and industrial system from potable water to recycled water. In addition, Metropolitan established the Reimbursable Services Program to provide technical and construction assistance to its member agencies for local project development. Metropolitan advances funds and is reimbursed by the agency.

Improving Public Perception

The drought has heightened water awareness in the region and has provided momentum for water conservation and reuse. The public is more willing to accept alternative supplies such as recycled water. Public outreach and education have also helped improve the public's perception of recycled water. Public sharing of information, open door stakeholder meetings, and focus groups have been very effective at distributing information and addressing public concerns. Case studies and demonstration projects are used to educate and improve public perception on recycled water.

Ample opportunities exist for cooperation among agencies to address the issue of conflicting and confusing messaging by branding or the use of alternative terminologies. A regional workgroup could explore and encourage outreach partnerships among agencies.

New Technologies, Research, and Information Sharing

New technologies, research, and information sharing greatly enhance the development of recycled water. Programs such as Metropolitan's FAF Program focus on technical studies and pilot projects that reduce barriers to future local production. Projects under this program include optimizing new treatment techniques for recycled water, exploring new monitoring methodologies, and testing innovative brine concentration technology. In addition to the technical portions of this program, the FAF Program supports collaboration between agencies and regional sharing of information.

Research is especially critical in advancing new water supply options, such as direct potable reuse. WateReuse in partnership with other agencies (including Metropolitan) is leading the California Direct Potable Reuse Initiative[10] to advance direct potable reuse as a water supply option in California and address regulatory, utility, and community concerns. The Foundation's report *Direct Potable Reuse: A Path Forward*[11] provides an overview of direct potable reuse and identifies research needs.

Regional studies can also examine the needs of multi-jurisdictional areas and foster communication among agencies to promote the use of recycled water. For example, sharing regional information such as GIS data can identify areas of recycled water surpluses and needs.

In addition, a clearing house could be developed to collect and disseminate information on research and technology developments and studies

Partnerships

Drinking water, wastewater, and groundwater management agencies share some common objectives, including access to source water, cost minimization, and protection of the environment. Many agencies are successfully cooperating and developing recycled water projects. These partnerships can allow sanitation districts to reduce the cost of disposing treated wastewater to the ocean, reduce impacts to the marine environment, and provide a source of reclaimed water to water agencies for recycling. At the same time, groundwater basin management agencies could be the recipients of final recycled water, helping maintain or increase groundwater levels.

[10] https://www.watereuse.org/foundation/research/direct potable reuse-Initiative
[11] https://www.watereuse.org/product/direct-potable-reuse-path-forward

LESSONS LEARNED

There have been many success stories on recycled water development. Focusing on public outreach and education has improved public perception. Partnerships and joint efforts among water and wastewater agencies proved to be an effective way to remove barriers and make progress. Numerous studies and research funded by federal, state, and local agencies are benefitting local and regional effort.

Public Outreach Is Important

Public outreach and education have helped improve the public's perception of recycled water. When the public is informed and takes part in the decision making process, they will likely be more accepting of a project.

Water shortages raise awareness for alternate ways to conserve. As a result, the public is more willing to accept alternative supplies such as recycled water, support the more expensive projects, and tolerate rate increases. Some residential property owners are interested in using recycled water for watering plants to help with the drought. For example, residents have access to recycled water from "residential recycled water fill stations" in the Irvine Ranch Water District. Developing similar programs throughout Southern California would help increase recycled water use and conservation of potable supplies.

Additional Funding Needed

LRP incentives and onsite retrofit program funding have increased use of recycled water in the region by almost 200 percent. However, incentives alone may not be enough to spur project development - capital funding is also necessary because the LRP only provides funding after a project begins operation. As an example, even though Metropolitan recently increased its LRP incentive rates, there are only a few applications for new projects because agencies lack capital funding to construct the project in the first place. Although available construction funding for recycled water projects has recently increased under the recently passed Proposition 1, projects generally still require a 50 percent local match. One source of funding is typically not enough to fund a recycled water project.

Funding is also needed for studies, pilot projects, and research. Metropolitan's FAF Program provided funding for studies and pilot projects to help advance the development of local supplies.

Partnerships Can Be Successful

History shows us that partnerships among agencies helps advance use of recycled water and provide tangible benefits to each participating agency. A good example of partnerships working well is the agreement between Orange County Water District (OCWD) and the Orange County Sanitation District. This partnership began in the 1970s, when OCWD built the Water Factory 21 to produce recycled water to mitigate seawater intrusion in the Orange

County Groundwater Basin. Twenty years later, the two agencies decided to jointly build the Groundwater Replenishment System (GWRS) recycled water project. GWRS is the largest planned indirect potable reuse facility in the world with a current capacity of 100,000 AFY and future expansion to 130,000 AFY.

Other examples of cooperation between agencies to further recycled water use include partnerships between the city of Los Angeles and West Basin Municipal Water District (West Basin Water Recycling Program), the city of Los Angeles and the city of Burbank (North Hollywood Water Recycling Project), city of Long Beach and the Water Replenishment District (Alamitos Barrier Water Recycling Project), the Sanitation Districts of Los Angeles County and Central Basin Municipal Water District (Century and Rio Hondo Water Recycling Project).

Water Industry Organizations and Regional Collaboration Help Advance Recycled Water

Recent advancements to recycled water development are due, in large part, to cooperation and collaboration among water and sanitation districts as well as other water industry organizations. Historically, the WateReuse Association was one of the main advocates for recycled water development in the state. Their activities initially focused on permitting issues, public outreach/education, conferences for information sharing, and research related to recycled water. As recycled water became a core resource for water and wastewater agencies, they started to ramp up their activities to help advance recycled water and utilized partnerships with academia along with other trade organizations such as the Association of California Water Agencies, California Urban Water Agencies, WateReuse Association, and California Associations of Sanitation Agencies. Professional organizations such as American Water Works Association and Water Environment Federation are another vehicle to promote recycled water through research, technical seminars, and operator training and certification. These organizations have proven to be effective in promoting regional collaboration on research and leveraging resources.

RECOMMENDATIONS

The 2010 Issue Paper included a set of recommendations, many of which are still valid today. The following include additional recommendations for consideration.

Explore Opportunities to Improve Permitting Process

- Streamline and simplify water recycling regulations with uniform administration consistent with operations, public health, and the environment
- Support legislation and regulation that expands the types of recycled water uses consistent with the protection of public health and help achieve the state's recycled water goal (an additional 1 million acre-feet by 2020)

- Convene a forum to discuss projects, permitting, and treatment technologies

Improve Public Education and Awareness of Water Recycling

- Pursue unified, consistent messaging
- Consider expanding residential fill stations to further advance public acceptance of recycle water

Explore Various Investment Strategies, Such As Incentives, Ownership, and Partnerships

- Promote collaboration among stakeholders and agencies to facilitate implementation of recycled water projects in California
- Promote development of new financing to increase water recycling, advance research in science and technology, assess health effects, develop additional regional planning, and study innovative technologies
- Explore a business case for further development of recycled water partnerships or ownership
- Consider additional end user programs to replace potable water systems with recycled water
- Collaborate on pursuing grant funding

Consider Joint Technical Studies and Projects

- Explore a collaborative regional effort to develop a regional GIS data set
- Explore integration approaches
- Investigate programs for the development of new technologies, such as comprehensive real-time monitoring devices and techniques that improve water quality and ensure public health, and maintain public confidence
- Study opportunities to protect or improve the quality of wastewater source supplies
- Explore development of a regional study to help identify opportunities for seasonal storage

6. Seawater Desalination

OVERVIEW

Metropolitan's 2010 IRP Update included an issue paper that provided a broad overview of seawater desalination's benefits and barriers to development. The purpose of this addendum is to highlight changed conditions since 2010 and describe key factors shaping the development of seawater desalination within Metropolitan's service area.

Metropolitan and its member agencies have been considering seawater desalination as a potential new supply source since the 1960s. The 2010 IRP Update included seawater desalination as one of the resources that could be developed to meet a core local supply goal of 102,000 AFY by 2025. Several member agencies have made significant progress in developing seawater desalination projects since the 2010 IRP. The following table provides a summary for projects in Metropolitan's service area.

Table 6-1
Summary of Existing and Proposed Seawater Desalination Projects within Metropolitan's Service Area

Status	Agency	Location	Capacity (AF)
Existing	San Diego County Water Authority	Carlsbad	56,000
Permitting	Orange County Water District/MWDOC	Huntington Beach	56,000
Planning	West Basin MWD	TBD	20,000 – 60,000
Planning	South Coast Water District / MWDOC	Doheny Beach	5,000 – 16,000
Planning	San Diego County Water Authority	Camp Pendleton	56,000 – 168,000
Planning	Calleguas MWD	TBD	20,000 – 80,000
On-hold	Long Beach (City of)	TBD	10,000
Total			**223,000 – 446,000**

The constant availability of ocean water is one of the key benefits of seawater desalination. Seawater desalination can provide critical supply reliability during droughts, and increase Southern California's resilience against the possibility of longer and more intense dry periods resulting from climate change.

With the exception of certain types of subsurface intakes, seawater desalination projects do not impact upstream or downstream water supplies. As a result, seawater desalination supplies are not constrained by California's complex system of water rights and are not subject to statutory court ordered or drought-related curtailments.

Seawater desalination produces high quality potable supplies that after post-treatment and stabilization can be integrated into existing drinking water systems and delivered directly to consumers. For example, in the Middle East and the Caribbean, seawater desalination is the principal water supply for many urban areas. Also, water managers in Israel have found that high quality seawater desalination supplies benefit its expansive water recycling program for agriculture by improving the quality of the source wastewater.

Seawater desalination's unique properties – independence from hydrological variability and California's water rights system – make it a valuable resource that can help increase the reliability of Southern California's supply mix

CHALLENGES

Although water agencies in Southern California have included seawater desalination in their resource portfolios since the 2000s, they have also encountered several interrelated barriers to development along the way. Changes since the 2010 IRP include the environmental context, new state regulations, updated cost estimates, and a growing awareness of the water-energy nexus.

Protecting California's Marine Environment

California's iconic marine and coastal environments are essential, unrivaled resources. Over 73 percent of Californians live in coastal-adjacent counties. Economically, ocean and coastal activities support 472,000 jobs and contribute 39.1 billion to the state's gross domestic product.[12] Coastal-adjacent tourism and recreation alone account for $17 billion in commercial activity.

Seawater desalination is poised to contribute to this coastal economy, but must do so in the context of numerous challenges facing the Southern California's fragile marine environment. These threats include: [13]

- Marine debris and pollution
- Overfishing
- Endangered species
- Invasive species
- Sea level rise
- Ocean acidification
- Habitat loss

The Ocean Protection Council, which develops state policy recommendations regarding marine resources, considers seawater desalination an emerging issue along with marine

[12] Coastal and Ocean Economic Summaries of the Coastal States; National Ocean Economics Program, 2014
[13] http://ocean.nationalgeographic.com/ocean/protect/

renewable energy and offshore aquaculture.[14] Understanding the environmental challenges facing the marine environment is an important consideration as water agencies add seawater desalination to water supply portfolios.

New Regulations Affect Future Development

In the past five years, state agencies have implemented new regulations that will affect the future development of seawater desalination. This includes amendments to the SWRCB's Ocean Plan and Once Through Cooling regulations, as well as the establishment of Marine Life Protected Areas (MLPAs) in Southern California.

Ocean Plan Regulations

In May 2015, after more than five years of development, the SWRCB updated California's Ocean Plan with regulations targeting seawater desalination projects. The new regulations include unprecedented requirements for intakes, outfalls, brine discharges and environmental mitigation provisions. The regulations give RWQCBs broad powers to determine project design elements of potential projects and to request unlimited studies. The new regulations will increase the costs of permitting, construction, operation, and mitigation for most projects, and could affect the ability to develop regional-scale projects.

Once Through Cooling Regulations

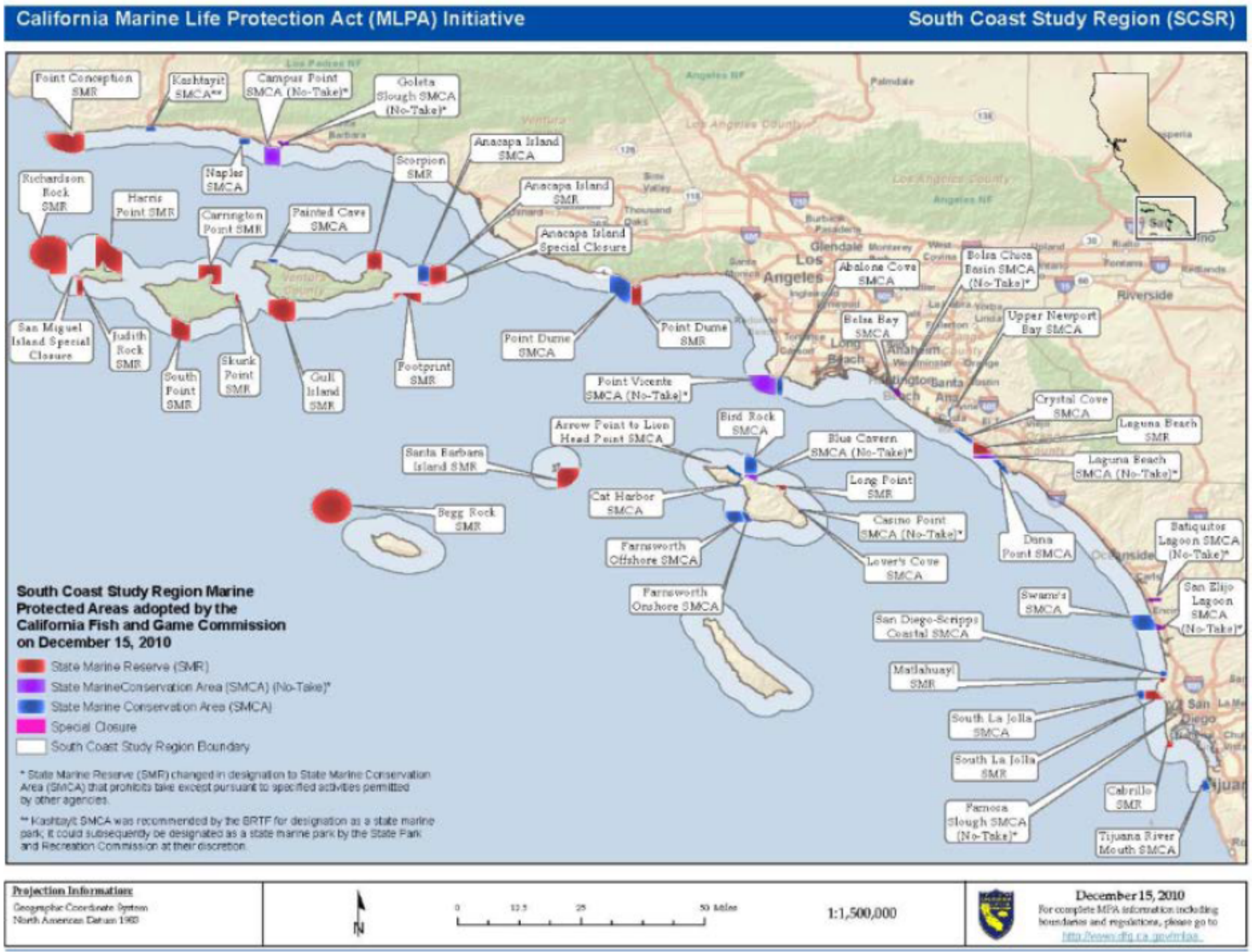
Prior to the revised Ocean Plan regulations, in 2010 the SWRCB adopted regulations requiring coastal power plants to phase out the use of once-through-cooling over the next 15 years. Once-through-cooling is the use of seawater to cool power plant generators in a single-pass system. In response, owners of coastal power plants are decommissioning generators that rely on once through cooling, and in many cases repowering using alternative technologies such as air-cooled systems. The phase-out of once-through-cooling diminishes the environmental and operational benefits of co-locating seawater desalination projects with power plants. However, coastal power plants will remain attractive sites for development due to the presence of coastal-dependent industrial zoned land, electrical infrastructure, and the potential to repurpose existing intake and outfall infrastructure. Projects affected in Metropolitan's service area include the Carlsbad, Huntington Beach, and West Basin projects.

[14] http://www.opc.ca.gov/webmaster/ftp/pdf/2012-strategic-plan/OPC_042412_final_opt.pdf

Marine Life Protected Areas

In 2011, the then California Department of Fish and Game created a system of 50 MLPAs covering approximately 15 percent of Southern California's coastline.[15] MLPAs are defined zones along the Channel Island and mainland coast where certain types of commercial and recreational activities are restricted (see **Figure 6-1**). The MLPA network includes areas near planned seawater desalination projects, and there is a cluster of MLPAs located near the planned desalination project at Doheny Beach.

Figure 6-1: Marine Protected Areas in Southern California



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15 http://www.dfg.ca.gov/marine/mpa/scmpas_list.asp

Most construction and operational activities associated with seawater desalination are prohibited in MLPAs with the exception of certain types of subsurface intakes. Additionally, the SWRCB's Ocean Plan regulations require locating screened seawater intakes as far away from MPLAs as feasible. MLPAs could benefit desalination projects as potential opportunities to mitigate marine life impacts.

Costs

The 2010 IRP identified planning, capital, and operating costs as implementation barriers for seawater desalination projects and cost continues to be a limitation to development. Capital costs and unit costs can vary significantly based on site and project-specific factors. These include design capacity, utilization factor, land availability, intake/outfall infrastructure. Other factors affecting cost include the types of processes needed to meet water quality goals as well as the length of pipeline and pumping requirements for integrating desalinated seawater into the distribution system. As a result, cross-comparisons between projects can be misleading.

Energy Use

Despite continued advancements in energy efficiency and process design since 2000, seawater desalination remains more energy intensive than most alternative new supplies. The reverse osmosis (RO) process uses the majority of energy in most plants, but product water and seawater intake pumping requirements can also affect overall energy use. Electric power can range from 28 percent to 50 percent of a project's total unit costs.[16]

Conflicting Messaging

Public education and acceptance is key factor in the successful implementation of seawater desalination projects. Currently, there are conflicting messages on seawater desalination. The conveyance of a uniform public message and further stakeholder education is needed.

OPPORTUNITIES

There are several opportunities for accelerating the development of seawater desalination in Southern California, including improved approaches to permitting, funding, technology, collaboration, and communication of benefits.

Streamlined Permitting Process

Although permitting is a challenge, several actions since the 2010 IRP have improved the permitting process. For example, CalDesal, a consortium of water utilities and other stakeholders with an interest in desalination and salinity control, promoted legislation in 2011 to streamline the permitting process for seawater desalination. The legislation ultimately led

[16] WateReuse; Seawater Desalination Power Consumption White Paper; 2011

to a coordination agreement among the Coastal Commission, State Lands Commission, SWRCB, Regional Water Quality Control Boards and other state agencies with related permitting authority. These agencies will collaborate with each other and the project developer early in the permitting process to avoid redundancy and provide clarity on the permitting requirements. The process, which is facilitated by the Ocean Protection Council and known as the Seawater Desalination State Interagency Working Group, represents an opportunity to reduce both the cost and time required to obtain permits, while ensuring appropriate review by the state agencies.[17]

Additional opportunities for improving the permitting process include the Governor's 2014 Water Action Plan and a Memorandum of Understanding (MOU) between the SWRCB and the Coastal Commission regarding implementation of the Ocean Plan regulations. The governor's plan calls for streamlining permitting for local projects, including seawater desalination.[18] The MOU between SWRCB and other state agencies will clarify implementation of the Ocean Plan regulations when there are overlapping permitting authorities between agencies. The MOU should help provide consistent application of the Ocean Plan regulations and avoid conflicting requirements placed on seawater desalination projects.

Funding Opportunities

Since the 2010 IRP, opportunities have increased for regional, state, and federal funding. This includes funding for projects as well as for research and development.

Regional Funding

Metropolitan has provided regional project funding for seawater desalination since 2001. Metropolitan programs include:

- Seawater Desalination Program (SDP): The SDP provides up to $250 per AF on a sliding scale for a term of 25 years or until 2040, whichever comes first. Projects with signed SDP agreements include: city of Long Beach, Municipal Water District of Orange County, and West Basin Municipal Water District.
- 2014 Update Local Resources Program (LRP): Under the LRP, seawater desalination projects are eligible for an incentive of $340 per AF for up to 25 years.
- Foundational Actions Funding Program (FAF): Metropolitan also supports applied seawater desalination research and development by member agencies. The current round of Program funding includes: a study related to slant well subsurface intakes and an evaluation of corrosion resistance of various materials for use in wedge-wire screens.

[17] http://www.opc.ca.gov/desal/
[18] http://resources.ca.gov/docs/california_water_action_plan/Final_California_Water_Action_Plan.pdf

State and Federal Funding

State funding opportunities for seawater desalination and other local supplies have increased since 2010. This includes funding under Proposition 1 as well as funding made available to respond to California's ongoing drought. A summary of state funding is provided below:

- Water Bond: The $7.5 billion Water Bond included $725 million for recycling and other advanced treatment projects such as desalination. DWR expects to issue a $49 million round of funding for desalination in 2016[19]
- Proposition 50: DWR also awarded $8.75 million in grants out of Proposition 50 for brackish and seawater desalination projects ranging from research to project construction, including two projects in the Metropolitan service area: SDCWA: received $2.6 million for a system integration study for the Carlsbad Project and received $1.0 million for intake pilot testing for the Camp Pendleton Project[20]
- The California Energy Commission: Request for proposals for up to $3 million for renewably-powered desalination projects as part of a $30 million solicitation that includes a focus on new agricultural and urban conservation technology.

Federal funding for seawater desalination has come primarily through the USBR's Desalination and Water Purification Research Program:

- USBR: In 2015, USBR funded $350,000 in seawater desalination research projects21 in Metropolitan's service area, including: $150,000 for West Basin's subsurface intake study and $200,000 for SDCWA's pilot study for Camp Pendleton
- USBR: USBR supports research and provides funding for pilot testing new technologies as well as the Brackish Groundwater National Desalination Research Facility in New Mexico.[22]

Technological Advances

Southern California is one of the birthplaces of RO technology, and remains a leading center for innovation. Membrane manufacturers, chemical suppliers, and desalination design firms comprise a strong desalination technology industrial cluster in the region.

Innovation in the seawater desalination industry is accelerating on a number of fronts. Research into energy efficiency has the potential to further reduce the energy requirements for seawater desalination. However, the new Ocean Plan regulations have created an urgent need for additional research into intakes, outfalls, marine life entrainment, and salinity impacts.

19 http://www.water.ca.gov/desalination/2016Cycle4.cfm
20 http://www.water.ca.gov/desalination/2014Cycle3.cfm
21 http://www.usbr.gov/research/AWT/DWPR/2015_DWPR.html
22 http://www.usbr.gov/research/AWT/BGNDRF/

Examples of promising energy-related technologies include forward osmosis, biomimetic membranes, graphene-based membranes, and desalination on a micro-chip. These technologies, as well as many others, are in the research phase of development. Innovative process designs can also reduce RO energy consumption, and renewably-powered desalination is also an area of active research.

Partnerships Can Help Manage Risk

For large, capital intensive water projects, managing project risks is important for successful implementation. Risks associated with seawater desalination projects include development, operational, and demand risks. Innovative partnerships have the potential to address these risks for water agencies and other project developers. The Carlsbad project is an example of how a partnership with a private developer can help mitigate risk for public agencies. The Water Purchase Agreement between the SDCWA and Poseidon Water, the project developer, explicitly defines how different risks are allocated to each party. The risk allocation affects the cost of the water but assigns risks to the party best able to manage them.[23]

Partnerships can also be used to manage demand risk. Demand risk refers to a situation where a water project is underutilized or stranded due to a lack of demand for project water. Many different types of water projects are subject to demand risk, including recycled water projects,[24] pipelines, fresh water treatment plants, and other types of water supply infrastructure.

Partnership approaches to seawater desalination can mitigate these risks by coordinating the use of project water to maximize efficiencies. The approach was originally considered by the City of Santa Cruz – Soquel Creek Water District project. The City of Santa Cruz needed water additional supplies to address reliability during dry years. The Soquel Creek Water District needed additional water supplies to recharge its coastal groundwater basin which was at risk for seawater intrusion. The partnership agreement would have allowed Santa Cruz to take project water in dry years and in summer months to manage peak demands, while Soquel Creek took project supplies in normal to wet years and in the winter.[25] While the project is no longer under development, this approach could be applied to manage demand risks, either locally or with regional partners. Project phasing can also help manage demand risk.

[23] San Diego County Water Authority; Special Board Report, September 20th, 2012; http://www.sdcwa.org/sites/default/files/files/board/2012_presentations/2012_09_20_presentations.pdf
[24] http://awa.asn.au/uploadedfiles/Water_Recycling_Fact_Sheet.pdf
[25] http://www.scwd2desal.org/index.php

Communication of Benefits

Another opportunity centers on improving the communication of the benefits of seawater desalination. Seawater desalination can diversify local and regional resource portfolios while providing supply benefits uniquely suited for managing short-term and long-term uncertainties. Often the desalination's unique benefits are overwhelmed by negative information put forth by groups opposed to desalination projects. The member agencies pursuing desalination project in Metropolitan's service area have featured extensive public outreach as part of their develop process. However, more outreach is needed to counteract persistent negative messaging occurring at both the state and local levels.

LESSONS LEARNED

Case Studies

Experienced gained in developing seawater desalination projects in California and overseas can provide guidance for addressing many of the implementation challenges discussed above. **Table 6-2** provides project summaries that highlight lessons learned from various projects in California and overseas.

System Integration Study

Distribution system integration is an important but sometimes over looked element of seawater desalination design and operations. How desalinated supplies are integrated with existing potable water distribution systems can affect existing distribution system and project operations, and can be a determining factor for avoiding stranding water supply infrastructure. In 2011, Metropolitan completed a survey of international integration practices and associated lessons learned for ten large projects. **Table 6-3** summarizes the key study findings regarding operations and water quality.

Table 6-2
Summary of Seawater Desalination Case Studies

Case Study	Lessons Learned
Carlsbad	• Large desalination plants are possible in California • Cost estimates change over time • Benefits of public-private partnerships • Complexity of California's permitting process
Santa Cruz-Soquel Creek	• Partnerships can help manage demand risks • Community opposition can derail carefully planned projects
Australia[26]	• Turned to seawater desalination during historic drought • Four plants on the east coast were put on standby mode when the drought ended • Two plants on the west coast are running at 100% capacity where the drought has not ended • Renewable energy can offset GHG emissions but can increase cost • Streamlined permitting process with a single master permit covering all regulatory agencies • Seawater desalination can be an important emergency supply during floods
Spain[27]	• Constructed 26 small and large scale plants as part of State sponsored "AGUA" program along Mediterranean coast[28] • Avoided cost and environmental impacts of expensive large-scale conveyance project • Agricultural customers reluctant to purchase higher priced supplies, leading to low utilization factors • Implemented innovative subsurface intakes at several facilities
Israel	• Rapidly developed five large projects representing 580,000 AFY in response to long-term crisis[29] • Low salinity of the product water benefits Israel's extensive recycling program for agricultural use

[26] "A tale of two cities: Desalination and Drought in Perth and Melbourne" NCEDA, 2013
[27] http://www.nytimes.com/2013/10/10/business/energy-environment/spains-desalination-ambitions-unravel.html?_r=0
[28] Presentation by J. Zorilla to the Multi-States Salinity Coalition, February, 2011.
[29] Source: Water Desalination Report, June 2013.

Table 6-3
Summary of Lessons Learned - Seawater Desalination System Integration

Topic	Reported Strategies
Inter-tie Location	• Upstream intertie: operational flexibility, blending potential, larger demands • Nearby intertie: shorter conveyance pipelines, less pumping
Reported Blending Practices	• Projects reported blending in reservoirs, storage tanks, and pipelines • Blending varied based on availability of alternative supplies
Operations	• Base-loaded where seawater desalination is a high percentage of supply
Corrosion • System integrity • Lead and copper • Aesthetics	• Blending • Meet corrosion indices • Post-treatment conditioning to match existing supplies
Bromide • Disinfection by-products • Chloramine residual decay	• Blending • Two-pass RO process • Modify chloramine residual formation process
Boron • Potential impacts to landscapes and agriculture	• Blending • Two-pass RO process
Other	• Modeling can help ensure successful integration • Consider end users when developing quality goals • Engage public in all stages of development • Integration costs are site specific and can be a major component of the project

RECOMMENDATIONS

Regional actions may be able to address some of the current barriers to development. These include research and studies, regulation and legislation, and technical capacity building. The following summarizes high-level recommendations for moving forward:

- Consider investing in new research and studies
    - Subsurface and screened intakes
    - Entrainment and brine discharge impacts
    - Siting and integration studies
    - Mitigation approaches
    - Renewable energy and energy efficiency
- Explore legislative, regulatory, and communications opportunities
    - Continue support for CalDesal, the Southern California Salinity Coalition, the Multi-States Salinity Coalition, and related stakeholder groups
    - Consider new public outreach and messaging efforts
    - Educate decision makers and key stakeholders
    - Support permit coordination among state agencies
- Evaluate options for capacity building
    - Promote technical training on seawater desalination technologies and planning
    - Leverage knowledge base and support capabilities of the local desalination industrial sector
    - Preserve coastal sites for future project development
    - Explore opportunities to minimize demand risks and stranded investments

7. Stormwater Direct Use

Direct use of stormwater/urban runoff (stormwater) was not directly identified as a water supply component in the 2010 IRP Update. Over the past few years, the movement to capture and use stormwater in multi-beneficial ways has developed significantly.

OVERVIEW

Although the majority of the future stormwater capture projects are infiltration projects rather than direct use projects, direct use Best Management Practices (BMPs), such as cisterns, rain barrels, or public restroom projects are increasingly promoted, especially with smaller-sized parcels and in areas where infiltration is not a feasible option. These types of BMPs commonly are used to supplement irrigation or meet non-potable demands. As such, the effect of direct use BMP projects on the water supply portfolio differs from that of large infiltration projects. Instead of increasing the groundwater production yield (supply), direct use projects reduce potable demands. This benefit can be viewed in a similar manner to water conservation.

CHALLENGES

The following section includes a discussion of the major challenges of implementing direct use stormwater projects, including availability of supplies, operation and maintenance costs, and grant funding.

Rainfall Patterns

Rainfall is hard to predict and a lack of rainfall can limit the applicability of direct use. In addition, during heavy rains, the collection systems may not be able to hold all the available water. During the rainy season, when there is limited need for irrigation water, stored water can become stagnant. In addition, due to the seasonal nature of rainfall in Southern California, there is limited impact to summer peaking. Most of the demand reduction is in the winter and is largely dependent on fill-release cycles and the intensity of rain events.

Operation and Maintenance

Direct use systems require regular maintenance as they may be prone to stagnant water and algae growth, and attract rodents, mosquitoes, insects and lizards. They can become breeding grounds for many animals if they are not properly maintained. Proper vector control and ongoing maintenance is important for these projects.

Many agencies are faced with limited available funding to help with O&M costs. Grants often only fund the up-front capital portion of the total costs of a rainwater harvesting system and the agency and/or the homeowner is responsible for the ongoing O&M.

Groundwater Impacts

The following section addresses groundwater impacts which potentially include reduced recharge and water quality issues.

Reduction In Recharge

In some areas, direct stormwater capture may reduce groundwater recharge. Water that would normally be diverted to downstream recharge area is captured for irrigation and largely consumed.

Water Quality

Urbanization also generally degrades the water quality of stormwater. Water that is captured and used for irrigation may impact soil quality (and ultimately groundwater quality). For example, when stormwater drips from roofs, the roof material itself may have dangerous chemicals and debris that can be harmful. It is generally good practice to bypass the containment system during the first rainfall.

OPPORTUNITIES

Since the 2010 IRP Update, Governor Brown signed the "Rainwater Capture Act of 2012" (AB 1750) prior to enactment of the Act, the SWRCB required all potential appropriators obtain a permit to appropriate water from any source, including water falling in the form of precipitation. Since enactment, the use of rainwater is not subject to the California Water Code's SWRCB permit requirement. AB 1750 exempts the capture and use of rainwater from rooftops from the SWRCB's permitting authority over appropriations of water. AB 1750 also allows residential users and other agencies to capture and use stormwater.

Non-Potable Use

Project examples include: onsite cisterns and the collection of rainwater for use in cooling towers, truck washes, drip irrigation, toilet flushing, and other non-potable uses such as:

- Restrooms
- Onsite irrigation
- Subregional/regional storage

Metropolitan currently offers a rebate of up to $75 per rain barrel and $300 for large-capacity cisterns. Agencies such as the Los Angeles Department of Water and Power offer an additional $25 per rain barrel. Other agencies offer rain barrel distribution events to encourage outdoor conservation.

Public Outreach

Stormwater direct use projects can increase public awareness of water issues. In addition they can provide educational opportunities by public participation in the stormwater projects.

LESSONS LEARNED

The following section outlines lessons learned since the 2010 IRP regarding stormwater direct use.

Additional Operation and Maintenance Required

As noted above, rainwater harvesting systems require regular maintenance. The responsibility for maintenance often falls to the homeowner so it is important to provide proper training to homeowners in the operation of the facilities. For municipal projects, maintenance is provided by the project proponent but this is often difficult to maintain beyond initial construction due to lack of available funding.

Projects Take More Time

It is more challenging for an agency to build a direct use stormwater project because it is a new concept for Southern California. Initial findings from recent projects are that they take additional time for permitting and overall construction.

Additional information can also be found in a recently published report by the National Academies of Science, Engineering, and Medicine entitled *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits.*[30]

RECOMMENDATIONS

- Evaluate a business case analysis and an accurate cost/benefit analysis for providing regional incentives/rebates based on the study of various pilot projects. It is important that the business case analysis include calculations of regional benefit and dry-year yield
- Continue to provide an avenue for open regional discussion on the direct use of stormwater
- Encourage information sharing of challenges and lessons learned to improve future water supply augmentation efforts, including:
    - Technological improvements
    - Water quality data
    - Information gained from the study of pilot projects
    - Examples of governance
    - Regulatory processes
    - Operations and maintenance

[30] National Academies of Sciences, Engineering, and Medicine. December 2015. Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits. Available at http://www.nap.edu/catalog/21866/using-graywater-and-stormwater-to-enhance-local-water-supplies-an

8. Graywater

OVERVIEW

Graywater was identified as a potential resource in the 2010 IRP Update. At the time, the 2010 IRP Update Graywater Technical Workgroup Issue Paper recommended that Metropolitan should not take an active role in providing financial incentives for installing graywater systems because of high costs, lack of data, and uncertainty in the regulatory environment.[31] The purpose of this issue paper is to discuss changes and remaining issues since the 2010 IRP Update.

Graywater Defined

Graywater can be considered a byproduct from washing. It 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.

Graywater in California

At the time of the 2010 IRP Update, California had some of the most restrictive standards in the country which were documented in the 2010 IRP Graywater Technical Workgroup Issue Paper. Since 2009, California has significantly reduced institutional barriers. Revised regulations have made graywater more accessible for residents. Currently, there is no longer a requirement for costly 9-inch subsurface irrigation systems, and basic clothes washer systems ("laundry-to-landscape") no longer require a permit. On a practical level, legal graywater use in California is still largely limited to outdoor reuse because indoor reuse requires disinfection and treatment to tertiary recycled water standards.[32]

CHALLENGES

Permitting and Regulations

Graywater systems other than basic laundry-to-landscape systems involve permitting processes with local jurisdictions that can be confusing, time-consuming, and costly. By their nature, graywater systems are distributed projects and are usually customized retrofits. Because of barriers involved with permitting, many graywater users install graywater systems

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[31] Metropolitan Water District of Southern California, 2010 IRP Update Technical Appendix, A.8 Graywater Technical Workgroup Issue Paper. Available at http://www.mwdh2o.com/PDF_About_Your_Water/2.1.2_IRP_Appendix.pdf

[32] 2013 California Plumbing Code, Chapter 16, 1601.7.2. Available at http://www.iapmo.org/2013%20California%20Plumbing%20Code/Chapter%2016.pdf

without obtaining permits or inspections. This makes it difficult to track graywater usage and obtain systematic data.

While current technologies around the world support a range of sources and uses, not all are legal in California. There are few packaged systems that meet California requirements, are easy to install, and easy to maintain.

Costs

Graywater users may not be aware of long-term commitment in terms of time and monetary costs needed to maintain their systems prior to installation. Graywater systems need regular maintenance, and monetary benefits alone may not justify costs to the owners.

Potential Health Impacts

Improper use or storage can potentially lead to pathogens or vectors. Because of this, human contact and storage are still prohibited. However, there have been no reported cases of illness related to graywater systems.

Potential Soil Impacts

Compared with potable water, graywater typically has higher concentrations of dissolved salts and other constituents which, if too high, can be detrimental for irrigated soils and plants. Without regular rainfall or soil flushing, salts can accumulate in the soil. With excessive rain, additional minerals and nutrients can runoff into natural waterways and increase risk of algal blooms. In particular, water that has been softened tends to have high sodium content. Therefore, it is advisable for graywater users to take precautions such as switching to potassium-based water softeners and using environmentally-friendly detergents.

Drain-Line Impacts

A concern related to the proper operation of plumbing fixtures is drain line carry (i.e., what a toilet is able to flush down the drain line). High-efficiency retrofits for toilets, urinals and showerheads already reduce the amount of water that is going down the drain. Graywater diversions could have the unintended consequence of further reducing the volume of wastewater, causing insufficient volume to carry waste down the drain line under certain conditions with older plumbing systems.

Potential Conflict with Other Resources

Groundwater

Graywater used for irrigation can potentially add unwanted salts or other contaminants to groundwater. When a construction permit is required, the permit may require identification of the groundwater level and soil absorption qualities. Graywater systems are not allowed where percolation tests show the absorption capacity of the soil to be insufficient to accommodate the maximum discharge. Graywater disposal fields are not allowed to be within three feet vertical of the highest known seasonal groundwater level.[33]

Sewer Systems
Large-scale implementation of graywater could create low-flow conditions in sewers. When graywater is diverted before it reaches the drain line, it no longer is being blended with blackwater that is discharged into a sewer. This reduced flow has consequences to the biological and chemical composition of the sewerage and places additional stress on sewage treatment mechanisms that must handle increasing concentrations of chemicals, pathogens, and nutrients. Moreover, less water in the sewer line means that there is less flow to push along solids. This may lead to more blockages in sewer pipes, especially in coastal communities that tend to have gentler slopes with less gravity flow.

Recycled Water
Graywater diversions, especially to outdoor applications, may reduce the wastewater available for treatment plants to reclaim as recycled water. Recycled water is a significant source of local water supply in the region and a major component of Metropolitan's IRP.

Conservation
Graywater volume decreases as water-use efficiency increases. Graywater may have unintended effects on overall water use. For example, a consumer who uses graywater may decide to delay replacement of an old clothes washing machine with a more efficient model and has less incentive to change existing landscaping to more water-saving alternatives. As buildings and homes become more water efficient, the potential to save water through graywater systems will be reduced, making graywater systems less cost effective.

OPPORTUNITIES

Policy

California Plumbing Code since 2009
California's graywater code is found in Chapter 16 of the 2013 California Plumbing Code. In 2009, the California Plumbing Code introduced three-tier permitting standards that include basic laundry-to-landscape systems that no long require permits or inspections as long as the installer follows the guidelines in the code. Other types of systems require a permit from the local jurisdiction. Under the current code, graywater systems must:[34]

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[33] 2013 California Plumbing Code, Chapter 16, 1
http://www.iapmo.org/2013%20California%20Plumbing%20Code/Chapter%2016.pdf
[34] Greywater Action website. "California Greywater Regulations." Available at http://greywateraction.org/?p=11128 Accessed July 6, 2015.

- have a way to direct flow back to the sewer/septic system, with a clearly-labeled valve
- send the water to irrigate landscape
- keep the water on the same property where it is produced and follow set-backs listed in the code
- have a maintenance manual
- discharge graywater under a two-inch cover of mulch, plastic shield, or stones

Graywater systems must not:

- contain diaper water
- contain hazardous chemicals
- have pooling graywater or runoff
- make graywater accessible to people or pets (such as in an open tub)
- include a pump (except the clothes washing machine's internal pump)
- connect to the potable water supply
- affect other parts of the building, such as the electrical or structural components

Graywater No Longer Prohibited by Local Governments

AB 849, passed in 2011, removed the authority of a city, county, or local agency to prohibit the use of graywater. Local jurisdictions may only adopt standards that are more restrictive than state requirements, and such ordinances must indicate local conditions that necessitate the more restrictive requirements.

Governor's Executive Order B-29-15

On April 1, 2015, Governor Brown issued Executive Order B-29-15. Among other provisions, it directed enforcement of statewide mandatory urban water reduction by 25 percent compared with 2013 use, and it directed the California Energy Commission, jointly with the DWR and the State Water Resources Control Board, to implement a Water Energy Technology program to deploy innovative water management technologies.

Revised Model Water Efficient Landscape Ordinance

Executive Order B-29-15 also directed DWR to revise the state's existing model landscape ordinance through expedited regulation. The California Water Commissioned adopted a revised Model Water Efficient Landscape Ordinance on July 15, 2015. To encourage graywater use, the model ordinance allows landscapes under 2,500 square feet that are irrigated only with graywater or captured rainwater to meet a simple irrigation checklist and not be subject to the entire ordinance.

Administrative

Consolidation of Authority

SB 518 requires that the California Building Standards Commission, as part of its triennial review, adopt building standards for graywater in nonresidential occupancies, and it also terminated DWR's authority on standards for nonresidential graywater. This consolidates authority for graywater standards under the CBSC.

Streamlining Permit Processes

Some local jurisdictions are streamlining their permit processes. For example, in 2012, the City of Los Angeles revised its permitting application for simple graywater systems to improve the customer experience, providing a straightforward checklist and sample system drawing that homeowners can easily print and include in their application.

Education and Acceptance

Public awareness and interest in graywater has increased since the 2010 IRP, largely due to drought conditions, mandatory water use restrictions, and the new opportunities for laundry-to-landscape systems that are now legal and simple to implement. There are ongoing educational efforts by organizations such as Greywater Action and local agencies. For example, West Basin Municipal Water District is currently researching the ability to provide free graywater workshops in its service area.

LESSONS LEARNED

Costs and Limitations

Customers need to be made aware of potentially prohibitive costs and technical limitations. Of the six permitted graywater systems in the city of Santa Monica that were discussed in the 2010 IRP Issue Paper on graywater, only one remains. The others were removed or abandoned because maintenance was more than expected. An unintended consequence was that users had less motivation to use water-efficient clothes washers, or to wash clothes efficiently, in order to produce enough graywater for irrigation.

Permitting

Customers can be intimidated by permitting requirements, even with the revisions made to the California Plumbing Code since 2009. Administrative burden on customers can be eased and still be in compliance with regulations. Many local jurisdictions can further streamline their permit processes.

Additional information can also be found in a recently published report by the National Academies of Science, Engineering, and Medicine entitled *Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits.*[35]

RECOMMENDATIONS

Research

Continue to encourage research on graywater potential and impacts. Through Metropolitan's Innovative Conservation Program, Metropolitan supported a 2009 field study of the water-use efficiency potential for in-home graywater in California with the AQUS® system that captured the untreated graywater from the bathroom lavatory sink, filtered and disinfected it, and used it to flush a tank-type gravity-fed toilet, thereby conserving the potable water normally used for flushing.[36]

Education

Complementing the need for technical research, public information efforts are needed to increase consumer awareness of current graywater opportunities as well as understanding of overall benefits and costs.

[35] National Academies of Sciences, Engineering, and Medicine. December 2015. Using Graywater and Stormwater to Enhance Local Water Supplies: An Assessment of Risks, Costs, and Benefits. Available at http://www.nap.edu/catalog/21866/using-graywater-and-stormwater-to-enhance-local-water-supplies-an

[36] Koeller and Company. January 2010. Field Study of the AQUS® Water Saving Device: Report to the Metropolitan Water District of Southern California in support of the Innovative Conservation Program Grant. Available at http://www.bewaterwise.com/icp/AQUS-Report.pdf

9. Resource Interrelations

The purpose of this section is to discuss common issues and opportunities that may relate to multiple resources. A similar section was referred to as "Synergy" in the 2010 IRP.

BACKGROUND

During the 2010 IRP technical workgroup process, several of the workgroups identified similar recommendations with respect to Metropolitan's participation in legislative affairs, increased public education, and coordinating funding efforts. To streamline these ideas, a Synergy Workshop was held on April 20, 2009, which included participants from the groundwater, stormwater, and recycled water IRP technical workgroups. Synergy Workshop participants identified opportunities to work together to optimize the use of groundwater, recycled water, and stormwater in Metropolitan's service area.

The 2015 IRP Issue Paper Addendum combines all the resources into one comprehensive document, which allows for easier identification of common elements and resource interconnections.

SHARED CHALLENGES

The common challenges in developing additional local water supplies and demand management include:

- Water quality issues
- Regulatory constraints
- Prohibitive costs and limited funding
- Lack of public support and negative perceptions

Water Quality

Water quality is clearly an issue across many resources, and the effluent for one resource can be the influent for another. Conjunctive use of surface and groundwater supplies may face hurdles when the native groundwater quality differs (e.g., more contaminated or more pristine) from imported or recycled recharge water. Recharged water may move contaminant plumes or mix with existing contamination. Recharge constituents such as total dissolved solids, chloride, sulfate, and nitrate are common problems. Basin Plans adopted by Regional Water Quality Control Boards are required to protect existing high quality waters from degradation, but may limit the use of recycled water and/or imported water supplies. With increasing levels of recycled water, basin salt loading becomes more of an issue. Stormwater recharge may additionally impact groundwater quality.

Also, demand management strategies may incidentally impact source water quality and quantity for recycled water. Seawater desalination subsurface intakes may impact the nearby groundwater basin.

Regulatory Challenges

Regulatory challenges are common across all resources. The regulatory path to a successful project can be a lengthy and costly one regardless of the resource. With the constantly changing regulatory environment, projects are often delayed.

Prohibitive Costs and Limited Funding

One of the key barriers to implementing local resource projects is cost. In some areas (e.g., stormwater), upfront capital can be provided via grants or agency capital improvement programs, but funding for operations and maintenance may not be fully funded. In other areas (e.g., recycled water), efforts such as Metropolitan's LRP provide incentives upon production, but upfront capital costs may be difficult to secure. Overall, projects tend to cost more as regulations become more stringent (e.g., for seawater desalination) and as the lower-cost projects have already been implemented.

Difficulty in quantifying/measuring benefits versus costs also poses a challenge to selecting investment options. For stormwater and recycled water projects, project scale is an important aspect— whether to invest limited resources into large regional projects or smaller distributed projects. Distributed projects may play a role in demand reduction, but can be very expensive to implement and may have little contribution to groundwater infiltration. For recycled water, regulatory uncertainty increases the potential for stranded facilities and makes it difficult to determine whether to invest in non-potable reuse, indirect potable reuse, or direct potable reuse.

Lack of Public Support and Negative Perceptions

Public acceptance and engagement are critical to all resource and demand management options. Ongoing drought conditions, public outreach, and ongoing success of local projects have helped to gradually increase the public's awareness of water conservation and acceptance of alternative supply sources. However, these projects may continue to lack public support due to negative perception of these types of projects.

OPPORTUNITIES

Multi-Benefit Approaches

It is important to recognize opportunities for the development of multi-benefit projects. These types of projects and partnerships improve collaboration and maximize water supply development in the region. An example is a green street project that incorporates various stormwater best management practices and brings together multiple agencies to address the multiple needs of flooding, groundwater recharge, and street services.

Funding

Grant funding and cost sharing may also provide an opportunity for agencies to collaborate.

Technology, Research, and Information Sharing

New technology in one resource area may often benefit another area. For example, brine concentration technology for groundwater recovery projects can also benefit recycled water projects. There is opportunity for combining research and sharing information to streamline the development of local resources in the future. An example of a regional approach to research in partnership with local agencies is Metropolitan's Foundational Actions Funding Program.

Drought Conditions Facilitate Regulatory Reforms

The recent drought conditions have opened up regulatory pathways and heightened awareness of water issues. For example, Governor Brown's Executive Order (April 1, 2015, Executive Order B-29-15) calls for "prioritized review by state agencies for permitting for projects that increase water supplies." In addition, the drought has also improved the public perception of alternative water supplies.

Optimizing Resource Interactions

Each water resource is connected with the others, and there are opportunities to optimize these resource interactions. Areas of potential optimization include:

- Interactions between stormwater, recycled water, imported water, seawater desalination, and groundwater
- Storage: groundwater, surface water, in-region, out-of-region

There is also an opportunity to develop regional plans that analyze integrating and optimizing resources.

RECOMMENDATIONS

- Explore partnership opportunities for multi-benefit approaches
- Explore research and technology development opportunities and programs
- Investigate integrating regulatory, public outreach, and education efforts
- Explore integrating resource, program, and planning opportunities
- Explore funding strategies that improve economic feasibility of multi-benefit projects

10. Conclusion

This Issue Paper Addendum provides an understanding of the local water resource obstacles facing the region in order to determine potential pathways to overcome them. There has been significant progress made in each resource area and more can be done, as identified through the recommendations in this report.

One of the major themes observed in each resource area is that the region is in a critical time of heightened public awareness of water and increased public engagement due to the current drought. There is great opportunity for shifting public behavior/perception, institutional reform, regulatory enhancements, and partnerships. Another major theme observed is that new technologies, research, and information sharing could significantly address the issues through technological developments and by providing the data needed to inform regulations.

Next Steps

Overall, agencies must decide where and how to focus resources. As stated previously, this paper aims to help advance that regional discussion on water resource issues, policy, and implementation programs. For Metropolitan, that discussion with its Board of Directors will follow the completion of the 2015 IRP Update.

Acknowledgements

Thank you to all the member agency participants and external experts for providing input and direction on the development of this Issue Paper Addendum in collaboration with Metropolitan staff resource area experts. The following is a list of the contributing workgroups:

- IRP Member Agency Technical Workgroup
- Member Agency Water Use Efficiency Meetings
- LRP Coordinators Meeting

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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Appendix 3

Central Valley Storage and Transfer Programs

Appendix 3 – Central Valley Storage and Transfer Programs

Metropolitan has been successful in implementing and operating voluntary water banking programs with partners in the Central Valley, with hundreds of thousands of acre-feet stored and recovered in response to water supply conditions. In addition, withdrawals of water from these programs have consistently exceeded contract minimums, increasing the confidence of having unused capacity available to Metropolitan during times of need.

However, there have been impacts to the banking programs as a result of the reduction of both the quantity and frequency of surplus water supplies for storage due to environmental and regulatory restrictions in the Delta. Although these restrictions do not significantly impact dry year supplies, they significantly impact average and wet year supplies. The success of operating the Central Valley banking programs relies upon having surplus water to refill storage for use in times of need. If the conditions affecting the loss of surplus water continue, the banking programs will lose their effectiveness as part of the IRP portfolio.

The environmental and regulatory restrictions are also impacting access to additional voluntary water transfers. Water supplies for the entire state are being affected, which in turn affects the price and quantity of water that can be procured under option agreements or through spot-market purchases like the California Drought Water Bank.

Another challenge for voluntary water transfers is the difficulty and implications of environmental review, documentation, and permitting for multi-year agreements.

Metropolitan has developed the following programs as part of its core resources strategy to develop storage and create opportunities for water transfers in the Central Valley.

SEMITROPIC STORAGE PROGRAM

Metropolitan has a groundwater storage program with Semitropic Water Storage District located in the southern part of the San Joaquin Valley. The groundwater storage agreement provides a maximum storage capacity of the program is 350,000 acre-feet, and the Third Amendment to the agreement provides an additional 44,700 acre-feet of minimum pumpback return capability annually. The specific amount of water Metropolitan can store in and subsequently expect to receive from the programs depends upon hydrologic conditions, any regulatory requirements restricting Metropolitan's ability to export water for storage, and the demands placed on the Semitropic Program by other program participants. During FY 2014/15, Metropolitan received 39,361 acre-feet from Semitropic. During wet years, Metropolitan has the discretion to use the program to store portions of its SWP entitlement water that are in excess of the amounts needed to meet Metropolitan's service area demand. In Semitropic, the water is delivered to district farmers who use the water in-lieu of pumping groundwater. During dry years, the districts return Metropolitan's previously stored water to Metropolitan by direct groundwater pump-in return and the exchange of SWP entitlement water.

ARVIN-EDISON STORAGE PROGRAM

Metropolitan has a groundwater storage program with Arvin-Edison Water Storage District with program storage capacity of 350,000 acre-feet. The specific amount of water Metropolitan can expect to store in and subsequently receive from the programs depends upon hydrologic conditions and any regulatory requirements restricting Metropolitan's ability to export water for storage. The storage program is estimated to deliver 75,000 acre-feet in dry years. During wet years, Metropolitan has the discretion to use the program to store portions of its SWP Table A supplies which are in excess of the amounts needed to meet Metropolitan's service area demand. The water can be either directly recharged into the groundwater basin or delivered to district farmers who use the water in-lieu of pumping groundwater. During dry years, the district returns Metropolitan's previously stored water to Metropolitan by direct groundwater pump-in return or by exchange of surface water supplies.

SAN BERNARDINO VALLEY MWD STORAGE PROGRAM

The San Bernardino Valley MWD Storage program allows for Metropolitan to the purchase of a portion of San Bernardino Valley MWD's SWP supply. The program includes a minimum purchase provision of 20,000 acre-feet and the option of purchasing additional supplies when available. This program can deliver between 20,000 acre-feet and 70,000 acre-feet in dry years, depending on hydrologic conditions. The expected delivery for a single dry year similar to 1977 is up to 70,000 acre-feet. The agreement with San Bernardino Valley MWD also allows Metropolitan to carry over up to 50,000 acre-feet of purchased water for use in dry years.

KERN DELTA WATER DISTRICT STORAGE PROGRAM

This groundwater storage program has 250,000 acre-feet of storage capacity. When fully developed, it should be capable of providing 50,000 acre-feet of dry year supply. The water can be either directly recharged into the groundwater basin or delivered to district farmers who use the water in-lieu of pumping groundwater. During dry years, the district returns Metropolitan's previously stored water to Metropolitan by direct groundwater pump-in return or by exchange of surface water supplies.

MOJAVE STORAGE PROGRAM

Metropolitan entered into a groundwater banking and exchange transfer agreement with Mojave Water Agency that provides Metropolitan cumulative storage of up to 390,000 acre-feet. The water is returned by exchange of Mojave's SWP entitlement water. Through 2021, and when the SWP allocation is 60 percent or less, Metropolitan can annually withdraw the Mojave Water Agency's SWP contractual amounts in excess of a 10 percent reserve. When the SWP allocation is over 60 percent, the reserved amount for Mojave's local needs increases to 20 percent. Under a 100 percent allocation, the State Water Contract provides Mojave Water Agency 828,000 acre-feet of water.

Transfer Programs

Metropolitan secures Central Valley water transfer supplies via spot markets and option contracts to meet its service area demands when necessary. Hydrologic and market conditions, and regulatory measures governing Delta pumping plant operations, determine the amount of water transfer activity occurring in any year. Recent transfer market activity, described below, provide examples of how Metropolitan has secured water transfer supplies as a resource to fill anticipated supply shortfalls needed to meet Metropolitan's service area demands.

- In 2003, Metropolitan secured options to purchase approximately 145,000 acre-feet of water from willing sellers in the Sacramento Valley during the irrigation season. These options protected against potential shortages of up to 650,000 acre-feet within Metropolitan's service area that might have arisen from a decrease in Colorado River supply or as a result of drier-than-expected hydrologic conditions. Using these options, Metropolitan purchased approximately 125,000 acre-feet of water for delivery to the California Aqueduct;
- In 2005, Metropolitan, in partnership with seven other State Water Contractors, secured options to purchase approximately 130,000 acre-feet of water from willing sellers in the Sacramento Valley, of which Metropolitan's share was 113,000 acre-feet. Metropolitan also had the right to assume the options of the other State Water Contractors if they chose not to purchase the transfer water. Due to improved hydrologic conditions, Metropolitan and the other State Water Contractors did not purchase these options;
- In 2008, Metropolitan, in partnership with seven other State Water Contractors, secured approximately 40,000 acre-feet of water from willing sellers in the Sacramento Valley, of which Metropolitan's share was approximately 27,000 acre-feet.
- In 2009, Metropolitan, in partnership with eight other buyers and 21 sellers, participated in a statewide Drought Water Bank, which secured approximately 74,000 acre-feet, of which Metropolitan's share was approximately 37,000 acre-feet.

- In 2010, Metropolitan in partnership with three other State Water Contractors, secured approximately 100,000 acre-feet of water from willing sellers in the Sacramento Valley, of which Metropolitan's share was approximately 88,000 acre-feet.
- In 2010, Metropolitan purchased approximately 18,000 acre-feet of water from Central Valley Project Contractors located in the San Joaquin Valley. In addition, Metropolitan entered into an unbalanced exchange agreement that resulted in Metropolitan receiving approximately 37,000 acre-feet.
- In 2015, it is anticipated that Metropolitan in partnership with eight other State Water Contractors, will secure approximately 20,000 acre-feet of water from willing sellers in the Sacramento Valley, of which Metropolitan's share would be approximately 13,000 acre-feet.
- In addition, in 2013 and 2015, Metropolitan secured 30,000 acre-feet and 1,300 acre-feet of water transfer supplies, respectively, under the Multi-Year Water Pool Demonstration Program.
- Finally, between 2008 and 2015, Metropolitan has secured approximately 170,000 acre-feet water transfer supplies under the Yuba Accord, which is a long-term transfer agreement.

Table A.3-1
Central Valley Storage Take Capacities (Acre-Feet)

Current Storage Programs	Contract Minimum	Contract Capability
Semitropic	45,000	133,000
Arvin Edison	40,000	75,000
San Bernardino Valley MWD	20,000	50,000
Kern Delta	50,000	50,000
Mojave	0	75,000
Total Take Capacity	155,000	383,000

Table A.3-1 shows the estimated development for Central Valley storage programs. Note that two figures are shown for each program, the Contract Minimum as well as the Contract Capability. The reason for the two figures is that, with the Central Valley Banking Programs, the contracts obligate Metropolitan's partner agency to a minimum yield. However, those contracts also allow Metropolitan to use other contractor's unused capacity in the same programs. These are also shown on the table because actual operational history has shown additional capacity above Contract Minimums to be available to Metropolitan.

The Central Valley storage and transfer programs have served to demonstrate the value of partnering, and increasingly, Central Valley agricultural interests see partnership with

Metropolitan as a sensible business practice beneficial to their local district and regional economy. In addition, Metropolitan staff has demonstrated the ability to work with DWR and USBR staff to facilitate Central Valley storage and transfer programs.

Metropolitan's recent water transfer activities have demonstrated Metropolitan's ability to develop and negotiate water transfer agreements either working directly with the agricultural districts who are selling the water or through a statewide Drought Water Bank. Because of the complexity of cross-Delta transfers and the need to optimize the use of both Central Valley Project and SWP facilities, DWR and USBR are critical players in the water transfer process, especially when shortage conditions increase the general level of demand for transfers and amplify ecosystem and water quality issues associated with through-Delta conveyance of water. Therefore, Metropolitan views state and federal cooperation to facilitate voluntary, market-based exchanges and sales of water as a critical component of its overall water transfer strategy.

Metropolitan is continuing to pursue transfer agreements and relationships with entities in the Central Valley, with an eye toward developing multi-year option transfer agreements.

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Appendix 4

In-Region Storage Programs

Appendix 4 – In-Region Storage Programs

IN-REGION GROUNDWATER STORAGE PROGRAMS

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

Metropolitan has developed its groundwater storage programs to increase local groundwater storage in the region. These programs allow Metropolitan to deliver water into a groundwater basin in advance of agency demands. Metropolitan programs to encourage the development of projects to enhance groundwater recharge include:

Cyclic Storage

Unlike the Replenishment program, the Cyclic Storage program involves executed storage agreements with member agencies. These agreements allow pre-delivery of surplus imported water for recharge into groundwater basins in excess of an agency's planned and budgeted deliveries. This water is then purchased at a later time when the agency has need for groundwater replenishment deliveries. There are currently two Cyclic Storage agreements in effect at this time: a 100,000 acre-feet program with Upper San Gabriel Water District and a 40,000 acre-feet program with Three Valleys Municipal Water District, both in the Main San Gabriel Basin.

Conjunctive Use

The Conjunctive Use program also involves specific agreements s for storage of imported water that can be called for use by Metropolitan. During a dry year or an emergency, Metropolitan has the option to call water stored in the groundwater basins pursuant to its contractual Conjunctive Use agreements. The stored water is paid for only when called. Metropolitan initially executed ten agreements with member and retail agencies for groundwater storage within the service area. The Las Posas agreement, which was the first project initiated, was terminated in 2011. The remaining nine agreements provide Metropolitan with about 210,000 acre-feet of additional storage within its service area with a contractual yield of about 70,000 acre-feet per year during dry, drought, and emergency conditions.

Cooperative Storage

Under this program, water is delivered for storage and it is paid for at a later time at the prevailing rate under which it went in. This program ended in 2000. Most of the Cooperative Storage water was rolled into the Conjunctive use accounts. However, the City of Pasadena does not have a Conjunctive Use program so it remains in their Cooperative Storage account. **Table A.4-1** shows the storage capacities and dry-year yields for in-basin groundwater storage programs.

Table A.4-1
In-Region Groundwater Program Capacities and Dry-Year Yields (Acre-Feet)

Current Programs	Capacity	Dry Year Yield
Chino Basin CUP	100,000	33,000
Compton CUP	2,300	800
Elsinore CUP	12,000	4,000
Foothill CUP	9,000	3,000
Lakewood CUP	3,600	1,200
Live Oak CUP	3,000	1,000
Long Beach CUP	13,000	4,300
Orange County CUP	66,000	22,000
Upper Claremont CUP	3,000	1,000
Pasadena CSP	17,617	4,000
Cyclic Agreements	140,000	46,667
Total	**369,517**	**120,967**

Over the past several years, Metropolitan has drawn on dry-year supply from cyclic storage accounts with several member agencies, long-term replenishment programs, and conjunctive use programs to address shortages. Metropolitan storage accounts have produced more than 270,000 acre-feet of supplies from the in-basin groundwater storage programs since 2007, replacing imported water deliveries at the service connection. It is expected, if drought conditions continue, that the Conjunctive Use accounts will be empty by the end of fiscal year 2016.

Groundwater storage programs also face the same major changed conditions and challenges as the Central Valley banking programs: the reduction of both the quantity and frequency of surplus water supplies for storage due to environmental and regulatory restrictions in the California Bay-Delta. If the conditions affecting the loss of surplus water continue, the groundwater storage programs will lose its effectiveness as part of the IRP portfolio. Environmental and regulatory restrictions are also impacting access to replenishment supplies by the member agencies. This is leading to additional stress on the groundwater basins, which may in turn lead to reduced groundwater production.

IN-REGION SURFACE WATER STORAGE PROGRAMS

Metropolitan's in-region surface water storage consists of storage reservoirs owned by Metropolitan and by DWR. These facilities are described in more detail below. In addition, **Table A.4-2** shows the capacity of emergency, dry-year, and total in-region surface water storage available to Metropolitan.

Metropolitan Storage Reservoirs

Diamond Valley Lake – Diamond Valley Lake is located near the community of Hemet in Riverside County. Diamond Valley Lake has a total storage capacity of 810,000 acre-feet.

Lake Mathews – Lake Mathews is the terminal reservoir for Metropolitan's Colorado River Aqueduct (CRA) and is located near the city of Riverside. Lake Mathews has a total storage capacity of 182,000 acre-feet.

Lake Skinner – Lake Skinner is located to the south of Diamond Valley Lake in Riverside County. Lake Skinner has a total storage capacity of 44,000 acre-feet.

SWP Storage Reservoirs

Under the 1994 Monterey Agreements, Metropolitan received operational control of approximately 219,000 acre-feet in the SWP reservoirs at the southern terminals of the California Aqueduct. Control of this storage capacity in Castaic Lake (154,000 acre-feet) and Lake Perris (65,000 acre-feet) gives Metropolitan greater flexibility in handling supply shortages.

Pyramid Lake - Pyramid Lake is located on the West Branch of the California Aqueduct in northern Los Angeles County. Pyramid Lake has a total storage capacity of 171,000 acre-feet, a portion of which is available to Metropolitan for emergency storage use.

Castaic Lake - Castaic Lake is located at the terminus of the West Branch of the California Aqueduct in northern Los Angeles County. Castaic Lake has a total storage capacity of 325,000 acre-feet, a portion of which is available to Metropolitan for flexible and emergency storage use.

Lake Perris - Located at the terminus on the East Branch of the California Aqueduct, with a total storage capacity of 131,000 acre-feet. In 2005, seismic concerns arose regarding Perris

Dam. In response, DWR reduced the storage amount at Lake Perris by half until those concerns could be addressed; however Metropolitan's operational storage remained the same. Since then, Metropolitan has continued to withdraw and replace water from the reservoir operating from the lower storage level. DWR is currently upgrading the seismic safety of Perris Dam. Construction activities began in October 2014 and are expected to continue for three years.

Table A.4-2
In-Region Surface Storage; Dry-Year and Emergency Storage Capacities Available to Metropolitan

	Reservoir	Emergency Storage Capacity	Dry-Year Storage Capacity	Total Storage Capacity
Metropolitan	Lake Mathews	79,000	100,000	179,000
	Lake Skinner	34,000	10,000	44,000
	Diamond Valley	200,000	610,000	810,000
	Subtotal	*313,000*	*720,000*	*1,033,000*
Department of Water Resources	Pyramid Lake	158,000	-	158,000
	Castaic Lake	171,000	154,000	325,000
	Lake Perris	5,000	65,000	70,000
	Subtotal	*334,000*	*219,000*	*553,300*
	Total	647,000	939,000	1,586,000

Metropolitan has been very successful in developing surface water storage in its service area. In 2009 Metropolitan also completed the tunneling of the Inland Feeder Project, which greatly increases the ability to move large quantities of water into Diamond Valley Lake in shorter periods of time.

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Appendix 5

Local Resources Projects

Appendix 5 – Local Resources Projects

Metropolitan is committed to playing a key role in developing local resources including water recycling, groundwater recovery, and seawater desalination to meet its supply reliability goals in a cost effective manner. While recycled water and groundwater recovery projects in the Southern California region are primarily developed by local water agencies, many newer projects have been developed with financial incentives provided through Metropolitan's (Local Resources Program) LRP. Since 1982, Metropolitan executed LRP contracts for 99 recycled water and groundwater recovery projects, of which 86 produced about 224,000 acre-feet in FY 2014/15. Local projects not receiving funding from Metropolitan provide an additional 205,000 acre-feet of recycled water and groundwater recovery to the region.

In addition to LRP, Metropolitan created the Seawater Desalination Program to provide financial incentives for the development of seawater desalination projects. Since the program's inception in 2001, Metropolitan has entered into agreements with its member agencies to fund three local seawater desalination projects amounting to 46,000 acre-feet per year of potential production. The three projects are currently in the planning stages. During FY 2014/15, Metropolitan continued coordinating regulatory policy for seawater desalination through financial support to, and participation in, CalDesal, a consortium of California water agencies that works with state lawmakers and regulatory agencies to advance seawater and groundwater desalination.

In October 2014, Metropolitan adopted additional refinements to LRP to further encourage development of additional 63,000 acre-feet per year of local resources in response to current drought conditions. These refinements include: increasing the LRP incentive to $340/acre-foot; providing several incentive payment options; including on-site retrofit cost in project costs; including seawater desalination projects in LRP; and providing reimbursable services to member agencies for design, construction, and operation of local projects.

The following tables include local projects, both Metropolitan funded and non-Metropolitan funded, that were identified through various collaborations with member agencies and updated through the IRP process. Those projects in existence or under construction are considered existing supplies, with the exception of the Carlsbad desalination project which is included in the Core Resources Strategy. Projects in less advanced stages of development are considered to be available to meet 20x2020 Retail Compliance and Local Resources Augmentation under the Core Resources Strategy, as well as the 20x2020 Regional Compliance and as needed Local Resource Augmentation under the Uncertainty Buffer. **Tables A.5-1** through **A.5-3** provide a listing of all of the existing and future local projects.

Table A.5-1
Existing and Planned Local Recycling Projects

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Anaheim		
Anaheim Water Recycling Demonstration Project	110	2012
OCWD Groundwater Replenishment System - Anaheim Canyon Power Plant	200	2011
OCWD Groundwater Replenishment System - Anaheim Regional Transportation Intermodal Center	10	2014
City of Burbank		
Burbank Recycled Water System Expansion Phase 2 Project	960	2009
Burbank Reclaimed Water System Expansion Project	850	1995
BWP Power Plant	1,500	1985
Calleguas Municipal Water District		
Oxnard Advanced Water Purification Facility Ph. 1	2,310	2011
Camrosa Water District Recycling System	1,230	2005
Camrosa Water District Recycling System	450	1990
Lake Sherwood Reclaimed Water System	400	1997
VCWWD No. 1 WWTP Recycled Water Distribution System	2,200	2003
VCWWD No. 8 Recycled Water Distribution System	1,100	2001
Central Basin Municipal Water District		
Century/Rio Hondo Reclamation Program	10,500	1992
Montebello Forebay	50,000	1990
Cerritos Reclaimed Water Project	4,000	1993
Eastern Municipal Water District		
Eastern Reach 1, Phase II Water Reclamation Project	1,700	2000
Eastern Regional Reclaimed Water System Reach 3 Reach 7	4,830	2013
Eastern Recycled Water Expansion Project	5,000	2013
Recycled Water Pipeline Reach 16 Project	820	2006
Rancho California Reclamation Expansion Project	6,000	1993
Rancho California Reclamation	4,950	1993
Eastern Regional Reclaimed Water System (Non-LRP)	21,200	1989
Eastern Regional Reclaimed Water System (Non-LRP)	22,400	1975
Foothill Municipal Water District		
La Canada-Flintridge Country Club	90	1962
City of Glendale		
Glendale Water Reclamation Expansion Project	500	1992

Glendale Verdugo-Scholl Canyon Brand Park Reclaimed Water Project	2,225	1995
Glendale Grayson Power Plant Project	460	1986
Glendale Water Reclamation Expansion Project	100	2013
Inland Empire Utilities Agency		
IEUA Regional Recycling Water Distribution System	3,500	1998
IEUA Regional Recycling Water Distribution System	13,500	1998
IEUA Regional Recycled Water Distribution System (Non-LRP)	7,550	2007
IEUA Regional Recycled Water Distribution System (Non-LRP)	15,000	1997
IEUA Regional Recycled Water Distribution System (Non-LRP) (IPR)	13,850	2005
Las Virgenes Municipal Water District		
Calabasas Reclaimed Water System	4,000	1997
Las Virgenes Valley Reclaimed Water System	500	1997
City of Long Beach		
Alamitos Barrier Recycled Water Expansion Project	3,475	2013
Alamitos Barrier Reclaimed Water Project	3,025	2005
Long Beach Reclaimed Water Master Plan, Phase I System Expansion	2,750	1986
Long Beach Reclamation Project (Non-LRP Floor)	2,100	2004
THUMS	1,429	1981
City of Los Angeles		
Hansen Area Water Recycling Project, Phase 1	2,115	2008
Hansen Dam Golf Course Water Recycling Project	500	2015
Harbor Water Recycling Project	50	2005
Harbor Water Recycling Project	4,950	2005
Sepulveda Basin Water Recycling Project Phase IV	550	2009
Los Angeles Taylor Yard Park Water Recycling Project	150	2009
Van Nuys Area Water Recycling Project	150	2009
Griffith Park	900	1997
MCA/Universal	300	1997
Municipal Water District of Orange County		
El Toro Recycled Water System Expansion	1,175	2015
Green Acres Reclamation Project - Coastal	320	1991
San Clemente Water Reclamation Project	500	1990
Trabuco Canyon Reclamation Expansion Project	800	1992
Green Acres Reclamation Project - Orange County	2,160	1991
Capistrano Valley Non Domestic Water System Expansion	2,360	2006
(SMWD Chiquita) Development Of Non-Domestic Water System Expansion in Ladera Ranch & Talega Valley.	2,772	2005
Michelson – Los Alisos WRP Upgrades	8,500	2007
Moulton Niguel Water Reclamation Project/Moulton Niguel Phase 4	9,276	2006

Reclamation System Expansion		
OCWD Groundwater Replenishment System Seawater Barrier Project	35,000	2008
OCWD Groundwater Replenishment System Spreading Project	35,000	2008
South Coast WD South Laguna Reclamation Project	1,450	2004
IRWD Michelson Reclamation Project	8,200	1997
OCWD Groundwater Replenishment System Spreading Project, Phase II	30,000	2015
Trabuco Canyon Reclamation Expansion Project (Non-LRP Floor)	280	1992
SMWD purchase from IRWD	321	2001
Trabuco Canyon Reclamation Expansion Project (Non-LRP)	350	1992
MNWD Moulton Niguel Water Reclamation Project (Non-LRP Floor)	470	2006
El Toro WD Recycling	500	1997
San Clemente Water Reclamation Project (Non-LRP)	500	1997
SJC Capistrano Valley Non-Domestic Water System Expansion (Non-LRP)	565	1999
IRWD Los Alisos Water Reclamation Plant	1,500	1997
OCWD Groundwater Replenishment System Spreading Project	2,500	2008
OCWD Groundwater Replenishment System Seawater Barrier Project (Non-LRP Floor/old Water Factory 21)	5,000	1975
City of Santa Ana		
Green Acres Reclamation Project - Santa Ana	320	1991
City of Santa Monica		
Dry Weather Runoff Reclamation Facility (SMURRF)	280	2005
San Diego County Water Authority		
Oceanside Water Reclamation Project	200	1992
Santa Maria Water Reclamation Project	400	1999
San Elijo Water Reclamation System	640	2000
Escondido Regional Reclaimed Water Project	650	2004
Padre Dam Reclaimed Water System, Phase 1	850	1998
San Elijo Water Reclamation System	960	2000
Fallbrook Public Utility District Water Reclamation Project	1,200	1990
Olivenhain Recycled Project – Southeast Quadrant (4S Ranch WRF)	1,788	2003
Encina Basin Water Reclamation Program - Phase I and II	5,000	2005
Otay Water Reclamation Project, Phase I/Otay Recycled Water System	7,500	2005
North City Water Reclamation Project	11,000	1998
Camp Pendleton	680	1997
Camp Pendleton	1,020	1997
Fairbanks Ranch	308	1997
North City Water Reclamation Project - City of Poway	750	2009
Olivenhain Northwest Quadrant Recycled Water Project (Meadowlark WRF) (Vallecitos)	1,000	2009

Olivenhain Recycled Project (SE Quad) - RG San Diego	1,000	2009
Olivenhain Southeast Quadrant Recycled Water Project (Non-LRP) (Santa Fe Valley WRF)	100	2005
Padre Dam MWD Recycled Water System (Non-LRP Floor)	65	1998
San Vincente Water Recycling Project (Non-LRP)	235	2003
San Vincente Water Recycling Project (Non-LRP)	350	1996
Rancho Santa Fe Water Pollution Control Facility	500	1997
Rincon del Diablo MWD Recycled Water Program (Non-LRP)	3,426	2006
San Diego Wild Animal Park	168	1997
South Bay Water Reclamation Project	1,520	2006
Valley Center - Lower Moosa Canyon	493	1974
Valley Center MWD - Woods Valley Ranch	84	2005
Whispering Palms	179	1997
Whispering Palms	269	1997
Three Valleys Municipal Water District		
City of Industry Regional Recycled Water Project - Suburban (7%)	228	2012
City of Industry Regional Recycled Water Project - Rowland	1,536	2012
City of Industry Regional Recycled Water Project - Walnut Valley	2,531	2008
Pomona Reclamation Project	9,320	1975
Pomona Reclamation Project - Cal-Poly Pomona	1,500	1997
Rowland Reclamation Project	2,000	1997
Fairway, Grand Crossing, Industry & Lycoming Wells into Reclamation System	1,184	1997
Walnut Valley Reclamation Project	2,550	1985
City of Torrance		
Edward C. Little Water Recycling Facility (ELWRF) Treatment Facility, Ph. I-IV	7,800	1995
Upper San Gabriel Valley Municipal Water District		
Direct Reuse Project Phase IIA	2,258	2006
City of Industry Regional Recycled Water Project - Suburban (93%)	3,032	2011
Direct Reuse, Phase I	1,000	2003
Direct Reuse, Phase IIA Expansion/Rosemead Extension Project	720	2012
Direct Reuse, Phase IIB - Industry (Package 2)	360	2012
Direct Reuse, Phase IIB - Industry (Package 3)	310	2012
Direct Reuse, Phase IIB - Industry (Package 4)	210	2012
Los Angeles County Sanitation District Projects	4,375	1985
Norman's Nursery	100	1997
West Basin Municipal Water District		
West Basin Water Recycling Phase V Expansion Project	8,000	2013
Edward C. Little Water Recycling Facility (ELWRF) Treatment Facility, Phase I-IV	10,500	1995
Edward C. Little Water Recycling Facility (ELWRF) Treatment Facility, Phase I-IV	25,556	1995

Western Municipal Water District of Riverside County		
Elsinore Valley (Wildomar) Recycled Water System - Phase I Project	300	2013
City of Corona Reclaimed Water Distribution System	16,800	1968
Elsinore Valley/Horse Thief Reclamation	560	1997
Elsinore Valley/ Railroad Canyon Reclamation	1,050	1997
March Air Reserve Base Reclamation Project	896	1997
Rancho California Reclamation	4,950	1997

Under Construction Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Glendale		
Glendale Public Works Yard	80	2016
City of Los Angeles		
South Griffith Park Recycled Water Project	370	2017
Harbor Industrial Recycled Water Project	9,300	2015
North Atwater, Chevy Chase Park, Los Feliz Water Recycling Project	50	2015
Municipal Water District of Orange County		
San Clemente Water Reclamation Project Expansion	1,000	2017
San Diego County Water Authority		
Olivenhain Northwest Quadrant Recycled Water Project, Phase B	300	2016
Valley Center MWD - Wood Valley Water Recycling Facility Phase II Expansion	196	2020
Escondido Regional Reclaimed Water Project (Easterly Ag Distribution & MFRO with Mains and Brine)/Primary	1,258	2019
Western Municipal Water District of Riverside County		
March Air Reserve Base Reclamation Project Expansion	448	2012

Full Design & Appropriated Funds Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Los Angeles		
Terminal Island Expansion Project	7,880	2018
San Diego County Water Authority		
Encina Basin Water Reclamation Program - Phase III	3,314	2016
City of San Diego PURE Water - Phase 1 North City	33,630	2022
Escondido Regional Reclaimed Water Project (HARRF Upgrades)/Primary	2,492	2019
Upper San Gabriel Valley Municipal Water District		
Direct Reuse, Future Extensions of the Recycled Water Program	130	2016
Direct Reuse, Phase I - Rose Hills Expansion	600	2016
Indirect Reuse Replenishment Project (IRRP)	10,000	2018

Western Municipal Water District of Riverside County		
Elsinore Valley/Tuscany, Phase IA	1,225	2017

Advanced Planning (EIR/EIS Certified) Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Calleguas Municipal Water District		
VCWWD No. 8 Recycled Water Distribution System	1,250	2020
Central Basin Municipal Water District		
West San Gabriel Recycled Water Expansion Project	500	2018
East Los Angeles Recycled Water Expansion Project	1,000	2021
Foothill Municipal Water District		
Recycled Water Scalping Plant	300	2018
Inland Empire Utilities Agency		
IEUA Regional Recycled Water Distribution System/IEUA Regional Recycled Water Distribution System (Non-LRP)	20,000	2020
City of Long Beach		
Long Beach Reclamation Project Expansion, Phase II Boeing/Douglas Park	450	2020
City of Los Angeles		
Downtown Water Recycling Project	2,350	2020
Sepulveda Basin Water Recycling Project Phase IV Expansion	250	2017
Municipal Water District of Orange County		
SMWD Chiquita Development of Non-Domestic Water System Expansion I	3,360	2018
SMWD Chiquita Development of Non-Domestic Water System Expansion II	5,600	2018
City of Pasadena		
Pasadena Non-Potable Water Project	3,056	2019
San Diego County Water Authority		
Escondido Regional Potable Reuse Project	5,000	2025
Live Oak WRF	42	2020
North District Recycled Water System	1,200	2020
Western Municipal Water District of Riverside County		
Elsinore Valley/Summerly	1,380	2020

Feasibility Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Anaheim		
OCWD Groundwater Replenishment System - Anaheim Resort and Platinum Triangle	1,100	2017
Calleguas Municipal Water District		
Oxnard Advanced Water Purification Facility Ph. 2	5,000	2020

Eastern Municipal Water District		
EMWD Indirect Potable Reuse (IPR)	15,000	2020
Rancho Indirect Potable Reuse	9,070	2020
Las Virgenes Municipal Water District		
Woodland Hills Golf Course Extension	324	2018
City of Los Angeles		
San Pedro Waterfront Water Recycling Project	100	2022
Water Recycling Small Pipeline Extension Projects	1,000	2020
Woodland Hills Water Recycling Project	290	2019
Tillman Groundwater Replenishment System	30,000	2022
Los Angeles Greenbelt Project Extension	250	2018
LA Zoo Water Recycling Project	85	2020
LAX Cooling Towers	240	2021
Elysian Park Tank & Pumping Station Water Recycling Project	400	2022
Garber Street Tank Water Recycling Project	500	2018
Municipal Water District of Orange County		
South Coast WD J.B. Latham AWT Joint project	7,841	2020
San Diego County Water Authority		
Oceanside IPR Project	2,500	2020
Olivenhain Joint RW Transmission Project with SFID and OMWD	1,200	2020
Otay WD - North District Recycled Water System	4,400	2025
Padre Dam Phase 1 East County, 2.2 mgd Potable Reuse	2,464	2019
Padre Dam Phase 1 East County, T22 Expansion from 2 to 6 mgd	1,008	2019
Padre Dam Phase 2 East County,11.6 mgd Potable Reuse	12,992	2022
Santa Maria Water Reclamation Project	3,000	2020
Santa Fe ID Eastern Service Area Recycled Water Project	689	2025
Santa Fe ID Western Service Area Recycled Water System Expansion Project	111	2020
Upper San Gabriel Valley Municipal Water District		
Miller Coors Direct Reuse and Groundwater Recharge Project	1,000	2020
West Basin Municipal Water District		
Carson Regional Water Recycling Facility (CRWRF) Phase III Expansion Project - BP Expansion	2,100	2018
Western Municipal Water District of Riverside County		
Rancho California Reclamation Expansion/demineralization Western AG	13,800	2018

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Burbank		
Direct potable reuse of recycled water	4,000	2025

Foothill Municipal Water District		
Verdugo Basin Project	560	2020
City of Los Angeles		
Natural Advanced Treatment Concept	19,000	2025
Encino Reservoir Recycled Water Storage Concept	1,550	2025
LA Westside Title 22	5,500	2030
Harbor Area Water Recycling Expansion and Storage	12,220	2022
Municipal Water District of Orange County		
IRWD Michelson Reclamation Project Expansion, Phase II	2,300	2025
OCWD Groundwater Replenishment System Spreading Project, Phase III	30,000	2025
LBCWD Laguna Canyon Recycling Project	200	2025
El Toro WD Recycling/El Toro Recycled Water System Expansion II	225	2025
San Diego County Water Authority		
City of San Diego PURE Water - Phase 2 Central Area	42,598	2035
City of San Diego PURE Water - Phase 3 South Bay	16,815	2035
Lake Turner Non-Potable Distribution System	440	2025
Lakeside Riverview Well Field Groundwater Recovery	500	2020
Olivenhain Wanket Reservoir RW Conversion	200	2020
Santa Fe ID Advanced Water Purification Project	1,100	2030
Valley Center MWD - Welk WRF	84	2025
Valley Center MWD - Lilac Ranch WRF	140	2020
Lower Moosa Canyon WRF - AWT Upgrade	280	2020
Valley Center MWD - Woods Valley Ranch WRF Phase 3 Expansion	179	2020
City of Torrance		
Joint Water Pollution Control Plant (JWPCP)	5,000	2020
Upper San Gabriel Valley Municipal Water District		
Direct Reuse, Phase II - Satellite Treatment Plant	500	2020
Western Municipal Water District of Riverside County		
City of Riverside Recycled Water Program	2,270	2025
City of Riverside Recycled Water Program Expansion	19,130	2025
City of Riverside Recycled Water Program Expansion	20,000	2025

Table A.5-2
Existing and Planned Local Groundwater Recovery Projects

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Beverly Hills		
Beverly Hills Desalter Project	3,120	2003
City of Burbank		
Burbank Operable Unit/Lockheed Valley Plant	11,000	1996
Calleguas Municipal Water District		
Round Mountain Water Treatment Plant	1,000	2013
Tapo Canyon Water Treatment Plant	1,445	2010
Central Basin Municipal Water District		
Water Quality Protection Project	5,807	2004
Eastern Municipal Water District		
Menifee Basin Desalter Project	4,032	2002
Perris Desalter	4,500	2006
Foothill Municipal Water District		
Glenwood Nitrate Water Reclamation Project	150	2003
City of Glendale		
San Fernando Wells Basin - Glendale Operable Units	8,469	2001
Verdugo Basin Wells A & B	2,750	1997
Inland Empire Utilities Agency		
Chino Basin Desalination Program, Phase I / Inland Empire	17,500	2000
Municipal Water District of Orange County		
Capistrano Beach Desalter Project	1,560	2007
Tustin Desalter Project (17th St.)	3,840	1996
San Juan Basin Desalter Project	5,760	2004
IRWD Wells 21 & 22	6,400	2013
Irvine Desalter Project	6,700	2007
Colored Water Treatment Facility Project	11,300	2001
IRWD DATS Project	8,300	2001
Tustin Main Street Nitrate	2,000	1997
Well 28	4,300	1997
San Diego County Water Authority		
Lower Sweetwater River Basin Groundwater Demineralization Project, Ph. I	3,600	2000
Oceanside Desalter Project/Oceanside (Mission Basin) Desalter Expansion Project	7,800	2003
San Vicente & El Capitan Seepage Recovery	500	2015
Three Valleys Municipal Water District		

Cal-Poly Pomona Water Treatment Plant	250	2013
Pomona Well #37 – Harrison Well Groundwater Treatment Project	1,000	2006
City of Pomona VOC Plant	4,678	1997
Pomona Well #37 – Harrison Well Groundwater Treatment Project (Non-LRP)	1,200	2011
City of Torrance		
Madrona Desalination Facility (Goldsworthy Desalter)	2,880	2002
Western Municipal Water District of Riverside County		
Temescal Basin Desalting Facility Project	10,000	2001
Chino Basin Desalination Program, Phase I / Western	17,500	2000
Temescal Basin Desalting Facility Project (Non-LRP)	5,600	2001

Under Construction Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Eastern Municipal Water District		
Moreno Valley Groundwater Development Program	2,000	2018
City of Glendale		
Verdugo Basin Rockhaven Well	500	2016
San Diego County Water Authority		
Lower Sweetwater Desalter, Phase II	5,200	2017

Full Design & Appropriated Funds Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Eastern Municipal Water District		
Brackish Wells 94, 95, and 96	2,250	2018
Perris Desalter II	4,000	2020
San Diego County Water Authority		
Rancho del Rey Well Desalination	400	2025
City of Torrance		
Madrona Desalter (Goldsworthy) Expansion	2,400	2017

Advanced Planning (EIR/EIS Certified) Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Calleguas Municipal Water District		
North Pleasant Valley Desalter	7,300	2020
City of Los Angeles		
Tujunga Well Treatment	24,000	2020
Municipal Water District of Orange County		

SJC San Juan Desalter Project Expansion	2,000	2020
Tustin Legacy Well # 1	2,200	2020

Feasibility Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Beverly Hills		
Groundwater Development	2,000	2023
Calleguas Municipal Water District		
Moorpark/South Las Posas Desalter Phase 1	5,000	2020
West Simi Desalter (District 8)	2,800	2025
Eastern Municipal Water District		
Perris Groundwater Development (Well and Pipeline)	1,000	2018
Municipal Water District of Orange County		
IRWD Wells 51, 52 & 53 Potable (Non-exempt)	2,400	2020
City of San Marino		
San Marino GWR Project	2,500	2018
San Diego County Water Authority		
Middle Sweetwater River Basin Groundwater Well System (Otay WD)	1,500	2025
Mission Valley Brackish Groundwater Recovery Project (City of San Diego)	1,680	2025
Oceanside Mission Basin Desalter Expansion/Seawater Recovery and Treatment	5,600	2025
Otay Mesa Lot 7 Well Desalination (Otay WD)	400	2025
San Diego Formation / Diamond BID Pilot Production Well	1,600	2025
San Paqual Brackish Groundwater Recovery Project (City of San Diego)	1,619	2020
Sweetwater Authority/Otay WD San Diego Formation Recovery	3,900	2025

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
City of Beverly Hills		
Shallow Groundwater Development	500	2020
Calleguas Municipal Water District		
Camrosa Santa Rosa Basin Desalter	1,000	2022
Municipal Water District of Orange County		
LBCWD Groundwater Facility	2,025	2025
Mesa Colored Water Treatment Facility Project, Phase II	5,650	2018
South Coast WD Capistrano Beach Desalter Expansion	1,200	2025
San Diego County Water Authority		
San Dieguito River Basin Brackish GW Recovery and Treatment	1,500	2025

Western Municipal Water District of Riverside County		
Arlington Basin Desalter Project Expansion	2,000	2020
Arlington Basin Desalter Project Expansion Advanced Brine Treatment	1,900	2020
Arlington Basin Desalter Project Expansion Biological Denitrification	4,100	2020

Table A.5-3
Existing and Planned Local Seawater Desalination Projects

Existing Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
San Diego County Water Authority		
Carlsbad Seawater Desalination Project	56,000	2015

Advanced Planning (EIR/EIS Certified) Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Municipal Water District of Orange County		
Huntington Beach Seawater Desalination Project	56,000	2017

Feasibility Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
San Diego County Water Authority		
Rosarito Beach Seawater Desalination Feasibility Study (Otay WD)	28,000	2025
West Basin Municipal Water District		
West Basin Seawater Desalination Project	22,400	2022

Conceptual Projects	Ultimate Yield/Capacity (Acre-Feet)	Online Date
Municipal Water District of Orange County		
South Orange (Dana Point) Coastal Ocean Desalination Project	16,800	2020
San Diego County Water Authority		
Camp Pendleton Seawater Desalination Project	56,000	2035

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Integrated Water Resources Plan Update 2015

Appendix 6

Comparison of Regional Demographic Projections for Metropolitan's 2015 Retail Demand Forecast

Appendix 6 - Comparison of Regional Demographic Projections for Metropolitan's 2015 Retail Demand Forecast

Abstract

SCAG 2012 demographic forecasts for four key water demand drivers have significantly lower values and trends compared with SCAG 2008 forecasts used in Metropolitan's 2010 Integrated Water Resources Plan. Differences in the SCAG 2008 and 2012 forecasts for 2035 are as follows:

- *Population:* *1.2 million fewer people*
- *Households:* *135,000 fewer households*
- *Employment:* *893,000 fewer jobs*

All other things being equal, new projections of retail water demand are expected to decrease relative to the forecast in Metropolitan's 2010 Integrated Water Resources Plan.

The Metropolitan Water District of Southern California

November 4, 2015

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Summary

This paper compares regional growth forecasts, developed in different years, by the Southern California Association of Governments (SCAG) for its Regional Transportation Plan (RTP) and by the San Diego Association of Governments (SANDAG). SCAG's most recent growth forecast, RTP-12, was adopted in April 2012. The previous forecast, RTP-08, was adopted in May 2008. In the four years in between 2008 and 2012, the RTP was updated to reflect changes in demographic and economic conditions and trends. Since 2008, the U.S. economy and the Southern California region experienced a recession and its protracted aftermath. The economic downturn was characterized by declining housing prices and job losses. In addition, the U.S. Census Bureau released the 2010 Census in March 2011 that showed an overall lower population count for California than was previously projected for 2010.

RTP-12 anticipates lower growth for all major demographic variables as compared with RTP-08. The 2010 Census data and 2011 CA Employment Development Department data used by RTP-12 indicated lower population, households, and employment for year 2010 than forecasted in RTP-08. The slower growth pattern experienced in the last decade is projected to continue into the future.

The San Diego Association of Governments (SANDAG) adopted its Series 12 forecast for San Diego County in February 2010. SANDAG Series 12 did not incorporate the 2010 Census. In October 2013, the SANDAG Board of Directors adopted its Series 13 Regional Growth Forecast, with forecasts for the years 2020-2050. For the 2015 Integrated Water Resources Plan Update, Metropolitan uses SANDAG Series 12 for forecast years before 2020 and Series 13 for years 2020-2035 for demographic estimates in the county of San Diego and uses SCAG's RTP-12 estimates for the five other counties it serves (see Table S.1). This paper will focus primarily on SCAG's projections and specifically on the differences between SCAG's previous and current forecasts, RTP-08 and RTP-12. Tables S.1 to S.4 compare the two sets of forecasts for population, occupied housing units, median household income, and urban employment for the years 2010 through 2035. Population, households, income, and employment are drivers for Metropolitan's retail water demand forecast model.

Table S.1 – Metropolitan Service Area Total Population

Population	2010	2015	2020	2025	2030	2035
RTP-08 & Series 11	19,215,936	20,000,633	20,725,950	21,369,670	21,977,334	22,543,090
RTP-12 & Series 13[1]	18,264,623	18,948,605	19,449,433	20,097,679	20,720,851	21,313,956
Difference	951,313	1,052,028	1,276,517	1,271,991	1,256,483	1,229,134
Percentage Difference	-5.0%	-5.3%	-6.2%	-6.0%	-5.7%	-5.5%

Table S.2 – Metropolitan Service Area Total Households

Households	2010	2015	2020	2025	2030	2035
RTP-08 & Series 11	6,132,195	6,414,999	6,678,756	6,885,393	7,079,035	7,253,654
RTP-12 & Series 13	5,948,920	6,176,110	6,435,447	6,673,049	6,901,946	7,118,704
Difference	183,275	238,889	243,309	212,344	177,089	134,950
Percentage Difference	-3.0%	-3.7%	-3.6%	-3.1%	-2.5%	-1.9%

Table S.3 – Metropolitan Service Area Total Urban Employment

Urban Employment	2010	2015	2020	2025	2030	2035
RTP-08 & Series 11	8,596,958	8,986,730	9,314,268	9,629,234	9,943,941	10,248,295
RTP-12 & Series 13	7,548,054	8,225,825	8,537,906	8,874,766	9,166,239	9,355,599
Difference	1,048,904	760,906	776,362	754,468	777,702	892,696
Percentage Difference	-12.2%	-8.5%	-8.3%	-7.8%	-7.8%	-8.7%

Conclusion

SCAG prepares its growth projections through a complex process with many sources of information, and their different forecasts may not be directly comparable on a one-to-one basis. Changes in SCAG's projections for population and households are not necessarily proportional when compared with prior projections. Differences in the 2010 IRP Update and 2015 IRP Update demographic forecasts for the year 2035 are as follows:

- Population: 1.2 million fewer people
- Households: 135,000 fewer households
- Employment: 893,000 fewer jobs

All other things being equal, projections of retail water demand in Metropolitan's 2015 Integrated Water Resources Plan (IRP) are expected to decrease relative to the forecast in the 2010 IRP.

[1] SANDAG Series 12 forecast is used for 2010 and 2015. SANDAG Series 13 forecast is used for 2020-2035.

Section 1 – Introduction

The Metropolitan Water District of Southern California (Metropolitan) uses forecasts developed by two government agencies – the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG) – as inputs to its retail demand model to estimate water use for the municipal and industrial (M&I) sector. SCAG and SANDAG are regional transportation planning agencies for Southern California. 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.[2] SANDAG is the regional planning agency for San Diego County. See Table 1.1.

Table 1.1 – Counties Served by SCAG, SANDAG, and Metropolitan

Metropolitan serves territory in portions of six counties, not including Imperial County. These counties are also served by regional planning agencies, SCAG and SANDAG, who provide the demographic forecast data used by Metropolitan.

County Served	SCAG RTP-08 & RTP-12	SANDAG Series 13	Metropolitan* Retail Demand Forecast	% of County Area in Metropolitan's Service Area	% of County Pop. Served by Metropolitan in 2010
Imperial	✓			0%	0%
Los Angeles	✓		✓	34%	92%
Orange	✓		✓	88%	~100%
Riverside	✓		✓	15%	74%
San Bernardino	✓		✓	1%	40%
Ventura	✓		✓	20%	75%
San Diego		✓	✓	34%	96%

*Metropolitan service area may not cover the entire county

Together, SCAG and SANDAG's official forecasts comprise the best available data concerning anticipated growth in their respective regions. The official forecasts of SCAG and SANDAG undergo extensive review, drawing from several data sources and corroborated with local governments which have land use development jurisdiction. The forecasts are developed over several years in a highly transparent process and are approved by their respective boards in public hearings. Significantly, SCAG and SANDAG official growth projections are backed by

[2] Metropolitan does not serve territory in Imperial County.

Environmental Impact Reports. The high spatial resolution of their forecasts allows the data to be aggregated to represent the unique service areas of each Metropolitan's member agencies, and of Metropolitan as a whole. For these reasons, their regional growth forecasts provide the core assumptions underlying Metropolitan's retail demand forecasting model. Table 1.2 depicts SCAG and SANDAG forecasts that Metropolitan has used for its own recent retail water demand modeling efforts.

Table 1.2 – SCAG and SANDAG Regional Forecasts

Regional plans by SCAG and SANDAG provide the demographic forecast data that Metropolitan uses for its retail demand forecasts. This table shows which regional plans were used as input for retail demand forecasts in recent Metropolitan publications.

Agency	Regional Plan Title	Adoption Date	Used by Metropolitan
SCAG	2008 Regional Transportation Plan (RTP-08)	8-May-08	2010 IRP Update and 2010 UWMP
	2012-2035 Regional Transportation Plan/Sustainable Communities Strategy (RTP-12)	12-Apr-2012	2015 IRP Update
SANDAG	Series 11 - 2030 Regional Growth Forecast Update (Series 11)	8-Sep-06	2010 IRP Update
	Series 12 - 2050 Regional Growth Forecast (Series 12)	26-Feb-10	2010 UWMP
	Series 13 – 2050 Regional Growth Forecast (Series 13)	25-Oct-13	2015 IRP Update

As shown in Table 1.2, Metropolitan used SCAG's RTP-08 and SANDAG's Series 11 forecasts for its retail water demands projections published in the 2010 Integrated Water Resources Plan IRP). Metropolitan used SCAG's RTP-08 and SANDAG's Series 12 for projections in the 2010 Urban Water Management Plan (UWMP). In April 2012, SCAG released a new forecast, the *2012-2035 Regional Transportation Plan/Sustainable Communities Strategy*, also known as RTP-12. The RTP-12 incorporated updated data and assumptions that reflected the 2007-2009 economic recession[3], the 2010 Census count, and 2011 employment data from the California Employment Development Department (EDD). By contrast, when SCAG's previous forecast, RTP-08, was published in May 2008, indicators pointed toward a much more robust regional economy.

Due to the changes in circumstances, RTP-12 demographic projections are noticeably different from RTP-08 projections. In general, RTP-12 anticipates lower growth for all major demographic variables as compared with RTP-08. SANDAG published its Series 11 forecast for San Diego County in September 2006. SANDAG's Series 11 and Series 12 did not incorporate the 2010 Census count. SANDAG released its most recent forecast, Series 13, in October 2013. For the 2015 IRP Update, Metropolitan uses SANDAG Series 13 for the county

[3] Southern California is challenged by the recent economic recession that began in December 2007. Although the economic recession officially ended in 2009, the region still struggles to bring its economy back to the pre-recession level. During 2007-2010, the six counties in SCAG's planning area lost approximately 800,000 jobs.

of San Diego and SCAG's RTP-12 estimates for the five other counties it serves (see **Table 1.1**). This paper will focus primarily on SCAG's projections rather than SANDAG, and specifically on the differences between SCAG's previous and current forecasts, RTP-08 and RTP-12.

Notes about RTP-12

SCAG prepares its growth projections through a complex process with many sources of information, and their different forecasts may not be directly comparable on a one-to-one basis. SCAG's RTP-12 long-term projections differ greatly from prior SCAG growth projections (see **Figure 2.2** of Attachment 1). RTP-12 short-term growth projections were heavily influenced by the 2010 Census data and the recession, and these influences appear to continue into the long-term. SCAG acknowledged that they had extraordinary challenges when developing the 2012 projections in light of rapidly-changing economic circumstances and the release of the new census data.

Conversion to Metropolitan Service Area

SCAG builds its forecast data at a high spatial resolution, at the level of transportation analysis zones.[4] This resolution allows SCAG forecast data to be aggregated to correspond to the shapes and boundaries of different jurisdictions by using geographic information system (GIS) to overlay each member agency's service area boundary with land use and forecast data. When a transportation analysis zone spans across two or more member agency boundaries, the splits are distributed among the adjacent agencies. The sum of the member agency service areas represents the Metropolitan's total service area as a whole. With RTP-12, SCAG provided estimates for each of Metropolitan's member agency service areas. With RTP-08, Metropolitan performed its own calculations using a GIS software program called LANDAT (Land Use Demographics Analysis Tool). Differences in the methodology used to aggregate data to member agency boundaries may account for some of the discrepancies at the member agency-level between RTP-08 and RTP-12 forecasts.

[4] A traffic analysis zone (TAZ) is the unit of geography used in conventional transportation planning models. The size of a zone varies depending on its location and usually consists of one or more census blocks, block groups, or census tracts.

Section 2: Population Projections

SCAG developed its population growth forecasts using information from government agencies that included the California Department of Finance (DOF) and the U.S. Census Bureau. For RTP-12, SCAG's population estimates were derived using demographic trends and perspectives that reflected the 2010 Census count. For RTP-08, SCAG's population forecast and reflected estimates based on the 2000 Census count and was not calibrated to 2010 Census data. As a result of the 2010 Census, Metropolitan's total service area population estimate in 2010 was adjusted downward from 19.2 million to 18.1 million.

EFFECTS OF 2010 CENSUS ON RTP-12 FORECAST

The 2010 Census count showed less population for the Southern California counties than had been estimated by DOF. DOF's population models were benchmarked to the 2000 Census. As a normal practice, DOF re-benchmarked and calibrated population models to the 2010 Census and revised intercensal (2001-2009) estimates. DOF's recalibration affected the population estimates of Metropolitan's service area for the years since the 2000 Census.

SCAG had developed its earlier RTP-08 growth forecast using information available at the time. When SCAG adopted the RTP-08 forecast in May 2008, economic indicators were pointing toward a robust economy. Consequently, the population growth forecast for RTP-08 overestimated population, according to the 2010 Census. There are six counties within Metropolitan's service area, five of which are included in SCAG's forecast. Shown in **Table 2.1** below, SCAG benchmarked its population model for the RTP-12 forecast to the 2010 Census. Therefore the 2010 population for RTP-12 is nearly identical with the 2010 Census.

Table 2.1 –Population Estimates for Five-County SCAG Region

This table illustrates differences in population estimates relative to the 2010 Census. RTP-08, which was benchmarked to the 2000 Census, overestimated population relative to the 2010 Census count by 1.3 million people. RTP-12 was benchmarked to the 2010 Census.

Year	RTP-08	RTP-12	2010 Census
2010	19,210,840	17,886,332	17,877,006

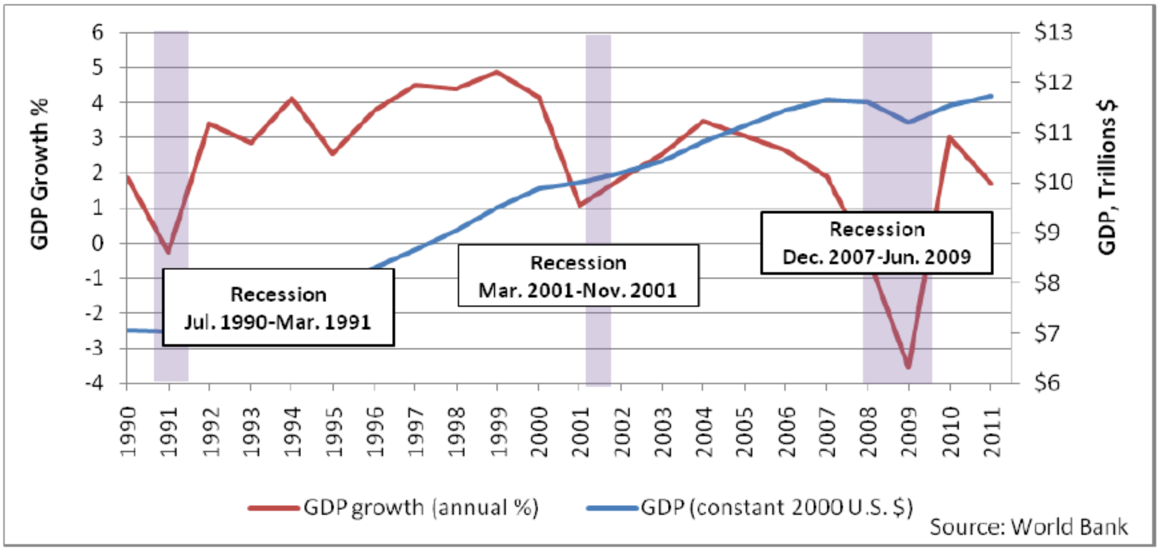
EFFECTS OF RECESSION ON RTP-12 FORECAST

In addition to adjustments made for the 2010 Census, SCAG's RTP-12 population projections are affected by the impacts of the 2007-2009 recession. The region's economic growth is usually a major factor in net migration and consequently population growth. Job availability attracts people to the region. When jobs are scarce, people tend to migrate away from the region. [5]

SCAG develops its regional employment growth forecast using a top-down shift-share model which calculates regional employment as a share of the national employment. Since 1990, the U.S. economy is characterized by extended periods of economic growth interrupted by three recessions. During the first two recessions, Gross Domestic Product (GDP) growth slowed but mostly remained positive. In late 2007, the nation and Southern California were affected by the most severe recession since the Great Depression in the 1930s. For the first time since 1991, the nation experienced negative GDP annual growth. Between 2008 and 2009, GDP fell by more than 3.5 percent, or $400 billion.

Figure 2.1 – U.S. Historical Economic Growth

This figure depicts historical growth in the U.S. economy, with GDP growth rates and annual GDP as economic indicators.

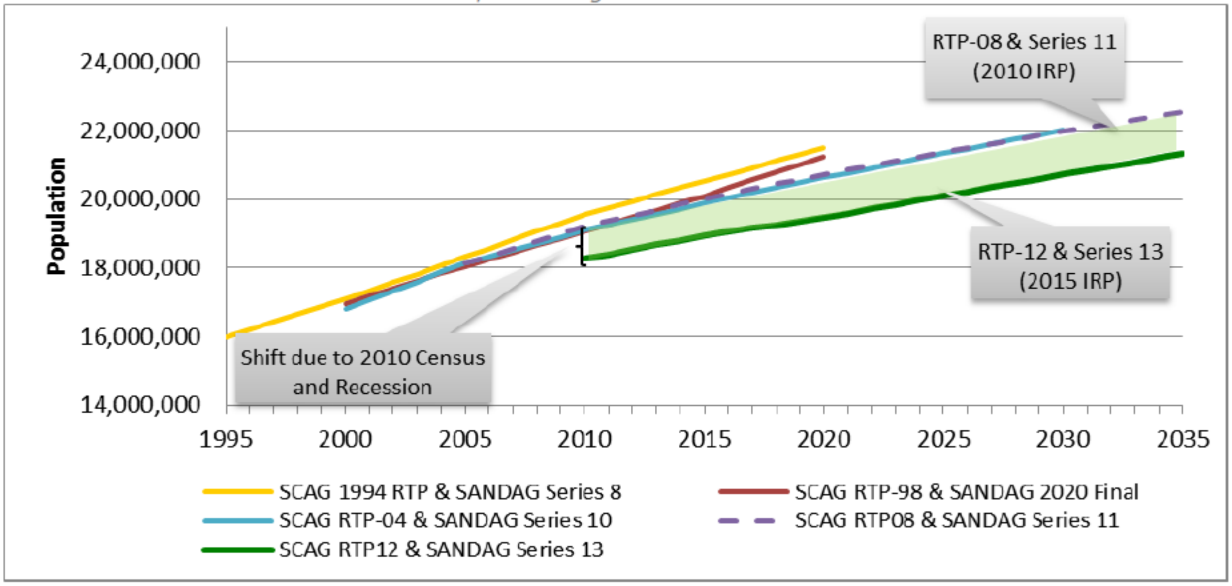


[5] Southern California Association of Governments, *2012-2035 Regional Transportation Plan/Sustainable Communities Strategy*, pg. 4, available at http://rtpscs.scag.ca.gov/Documents/2012/draft/SR/2012dRTP_GrowthForecast.pdf

During the 2007-2010 period, the SCAG region lost 800,000 jobs and the unemployment rate reached 12.3 percent. SCAG observed that the state and region experienced disproportionate job losses compared with the overall U.S. in 2008 and 2009. Because patterns of migration are influenced by job availability, the SCAG region saw net outbound domestic migration.

Figure 2.2 – Comparison of Different Population Forecasts for Metropolitan Service Area

This chart depicts SCAG and SANDAG population projections for Metropolitan's service area that had been used for Metropolitan's retail demand forecasting. SCAG RTP growth projections reflect both short term and long term perspectives. The most recent SCAG projection, RTP-12, are noticeably lower than previous forecasts. In the short term, 2010 Census data and 2011 CA Employment Development Department data indicated much lower population, households, and employment for year 2010 than previously assumed. Losses in jobs from the recession resulted in a permanent shift downward in total population. Over the long-term period (2015-2035), SCAG RTP-12 assumes a return to a normal pattern of growth.



SCAG's demographic projections reflect both short term and long term perspectives. As noted previously, SCAG produces official forecasts approximately every four years. SCAG adjusts its RTP projections over time to reflect updated conditions, shown in **Figure 2.2** above,

The projections for RTP-12 differ significantly from SCAG's previous estimates. SCAG faced particular challenges when developing the RTP-12, due to the major gap between the U.S. Census Bureau and DOF estimates during the 2001-2009 intercensal period as well as acute short-term economic uncertainties from the 2007-2009 recession. The 2010 Census showed that the population in the SCAG region was almost 1 million lower (4.9 percent) than SCAG's preliminary projections for 2010, which had been based on pre-Census estimates by

DOF. The 2010 Census household figure for the SCAG region was about 85,000 lower (1.4 percent) than SCAG's preliminary household projections for 2010, which were based on household estimates from DOF. In March 2011, the CA Employment Development Department released data showing that job losses were much more severe in Los Angeles, Orange and Ventura Counties than previously projected and that the region lost almost 800,000 jobs (7.9 percent) from 2007 to 2010.

RTP-08 VS. RTP-12

Figure 2.3 below depicts how post-2000 historical and projected population estimates were altered due to the 2010 Census count. It also shows the extent to which the RTP-12 forecast has lowered expected future population growth for the region. Historical DOF data is shown from 1990 to 2009, then projected SCAG data from 2010 to 2035. The RTP-12 forecast is benchmarked to 2010 Census data. By contrast, the RTP-08 forecast was benchmarked to 2000 Census data. As shown by **Figure 2.3**, the lower RTP-12 population forecast is consistent with the revised DOF historical estimates that have been benchmarked to 2010 Census count, whereas the higher RTP-08 forecast was consistent with previous DOF historical estimates for years 2001 to 2009 before they had been recalibrated to the 2010 Census.

Figure 2.3: Five-County SCAG Region Population, Historical and Projected

This graphic depicts the historical and projected county-level population data used for Metropolitan's retail demand forecasts. Observe that DOF and RTP-08 had overestimated population relative to the 2010 Census count. DOF and SCAG later lowered their population estimates for consistency with the 2010 Census. Similar slopes for RTP-08 and RTP-12 population growth trends result in parallel linear growth over time.

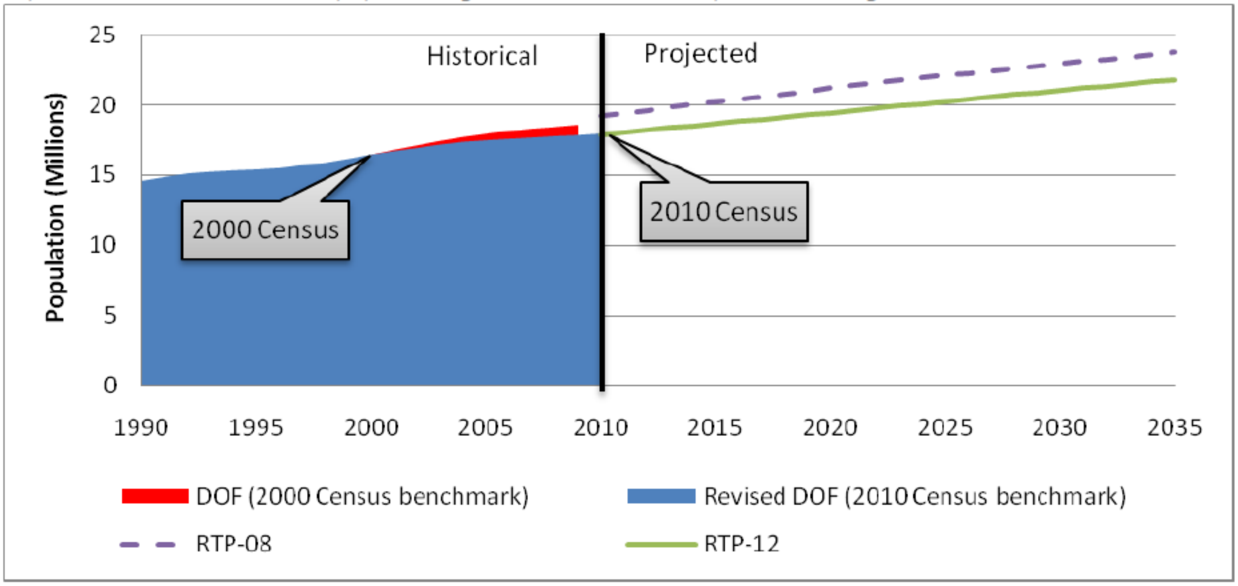


Table 2.2 below shows county-level population differences between RTP-08 and the RTP-12. Compared with RTP-08, RTP-12 projects about 1.5 million and 1.9 million fewer people in 2015 and 2035, respectively, for the Los Angeles, Orange, San Bernardino, Riverside, and Ventura counties. The differences are attributed to SCAG's re-benchmark to the 2010 Census population count. SCAG assumes the region's economy will rebound to normal in the long-term with reasonable labor force participation rates and unemployment levels.[6] Economy is assumed have direct correlation with population growth.

Table 2.2 – Population Forecasts, RTP-08 vs. RTP-12, by County

This table compares RTP-08 and RTP-12 population projections by county. RTP-12 projects less population than RTP-08 across all counties and all forecast years. The differences are consistently between 7-8%, resulting in a parallel linear growth trends.

County		2010*	2015	2020	2025	2030	2035
Los Angeles County	RTP-08	10,610,492	10,965,568	11,322,978	11,670,855	12,007,401	12,329,373
	RTP-12	9,818,764	10,118,895	10,403,981	10,715,323	11,035,195	11,353,047
	% Change	-7%	-8%	-8%	-8%	-8%	-8%
Orange County	RTP-08	3,314,950	3,451,754	3,533,938	3,586,283	3,629,537	3,653,981
	RTP-12	3,019,375	3,154,580	3,266,107	3,349,157	3,410,773	3,421,228
	% Change	-9%	-9%	-8%	-7%	-6%	-6%
Riverside County	RTP-08	2,242,744	2,509,330	2,809,006	3,090,001	3,343,778	3,596,681
	RTP-12	2,189,663	2,397,121	2,592,437	2,835,503	3,079,906	3,324,240
	% Change	-2%	-4%	-8%	-8%	-8%xx	-8%
San Bernardino County	RTP-08	2,182,048	2,385,762	2,582,772	2,773,937	2,957,754	3,133,799
	RTP-12	2,035,212	2,155,872	2,267,519	2,428,349	2,589,137	2,749,807
	% Change	-7%	-10%	-12%	-12%	-12%	-12%
Ventura County	RTP-08	860,606	900,354	937,372	968,698	996,106	1,013,756
	RTP-12	823,318	857,751	888,961	910,752	932,554	954,327
	% Change	-4%	-5%	-5%	-6%	-6%	-6%
SCAG County Total	RTP-08	19,210,840	20,212,768	21,186,066	22,089,774	22,934,576	23,727,590
	RTP-12	17,886,332	18,684,219	19,419,005	20,239,084	21,047,565	21,802,649
	% Change	-7%	-8%	-8%	-8%	-8%	-8%

2010 are projected data from the RTP-08 and RTP-12 forecasts. They do not represent historical data from DOF or the Census.

Total population for Metropolitan's service area is the aggregate of the population estimates of the 26 member agencies in the six counties (including San Diego County). Between 2015 and 2035, there is expected growth of 13 percent increase in total population for the service area. Rates of growth vary in different parts of service area. Inland areas are anticipated to have higher growth compared to the rest of the service area. Although RTP-08 and RTP-12 forecasts both anticipate total population growth of 13 percent for the Metropolitan service area between 2015 and 2035, the two forecasts project different rates of growth among the individual member agencies. Table 2.5 shows the differences between RTP-12 and RTP-08, by member agency, for each forecast year in the time horizon.

[6] 2012-2035 Regional Transportation Plan and Sustainable Communities Strategy - Growth Forecast Appendix (Proposed Final), SCAG, March 2012, p. 15

Table 2.3 – Population Forecasts, RTP-08 vs. RTP-12, by Member Agency (with SANDAG Series 11 & 13)

This table compares RTP-08 and RTP-12 population projections by member agency. SANDAG Series 11 and 13 is used for San Diego County Water Authority. RTP-12 projects less population than RTP-08 for the total service area across all forecast years. Differences are approximately 5% to 6% for each forecast year, resulting in parallel linear growth trends.

Member Agency		2010*	2015	2020	2025	2030	2035	2015-2035 Growth
Anaheim, City of	RTP-08	369,584	389,826	402,713	413,942	424,869	438,573	13%
	RTP-12	347,961	368,959	380,821	388,449	403,473	409,792	11%
	% Change	-6%	-5%	-5%	-6%	-5%	-7%	
Beverly Hills, City of	RTP-08	45,177	45,632	46,148	46,646	47,126	47,587	4%
	RTP-12	42,270	43,276	43,114	43,459	44,426	44,807	4%
	% Change	-6%	-5%	-7%	-7%	-6%	-6%	
Burbank, City of	RTP-08	111,676	115,986	120,428	124,732	128,888	132,877	15%
	RTP-12	105,147	108,934	112,451	113,179	114,850	115,680	6%
	% Change	-6%	-6%	-7%	-9%	-11%	-13%	
Calleguas Municipal Water District	RTP-08	632,399	659,330	682,651	702,386	719,655	730,788	11%
	RTP-12	614,474	636,275	656,804	671,353	681,549	695,854	9%
	% Change	-3%	-3%	-4%	-4%	-5%	-5%	
Central Basin Municipal Water District	RTP-08	1,654,866	1,689,064	1,720,700	1,751,519	1,781,368	1,809,737	7%
	RTP-12	1,531,453	1,590,037	1,603,549	1,632,666	1,691,205	1,722,317	8%
	% Change	-7%	-6%	-7%	-7%	-5%	-5%	
Compton, City of	RTP-08	91,992	92,226	92,578	92,920	93,244	93,566	1%
	RTP-12	89,624	91,014	90,218	90,189	90,589	90,633	0%
	% Change	-3%	-1%	-3%	-3%	-3%	-3%	
Eastern Municipal Water District	RTP-08	720,984	811,452	897,393	975,903	1,043,977	1,112,430	37%
	RTP-12	745,650	807,406	864,590	949,376	1,028,270	1,112,617	38%
	% Change	3%	0%	-4%	-3%	-2%	0%	
Foothill Municipal Water District	RTP-08	89,108	92,165	95,281	98,286	101,190	103,965	13%
	RTP-12	80,321	82,650	82,875	84,277	88,652	90,221	9%
	% Change	-10%	-10%	-13%	-14%	-12%	-13%	
Fullerton, City of	RTP-08	137,140	140,225	142,762	144,249	146,199	147,015	5%
	RTP-12	128,473	133,717	137,707	149,787	150,885	152,559	14%
	% Change	-6%	-5%	-4%	4%	3%	4%	
Glendale, City of	RTP-08	198,689	201,698	204,987	208,149	211,197	214,091	6%
	RTP-12	180,527	184,531	185,783	188,544	193,789	196,746	7%
	% Change	-9%	-9%	-9%	-9%	-8%	-8%	
Inland Empire Utilities Agency	RTP-08	859,721	914,800	968,087	1,019,799	1,069,527	1,117,179	22%
	RTP-12	806,557	848,889	888,858	947,352	1,000,595	1,058,666	25%
	% Change	-6%	-7%	-8%	-7%	-6%	-5%	
Las Virgenes Municipal Water District	RTP-08	78,266	80,275	83,169	86,097	88,902	91,589	14%
	RTP-12	68,160	70,436	71,237	72,768	74,707	76,320	8%
	% Change	-13%	-12%	-14%	-15%	-16%	-17%	
Long Beach, City of	RTP-08	505,549	519,592	534,289	548,446	562,097	575,159	11%
	RTP-12	470,247	482,440	492,689	504,600	525,221	537,728	11%
	% Change	-7%	-7%	-8%	-8%	-7%	-7%	

Member Agency		2010*	2015	2020	2025	2030	2035	2015-2035 Growth
Los Angeles, City of	RTP-08	4,100,260	4,172,760	4,250,861	4,326,012	4,398,408	4,467,560	7%
	RTP-12	3,857,967	3,885,392	4,026,891	4,168,131	4,210,042	4,351,408	12%
	% Change	-6%	-7%	-5%	-4%	-4%	-3%	
Municipal Water District of Orange County	RTP-08	2,441,958	2,549,018	2,610,396	2,647,895	2,676,283	2,685,946	5%
	RTP-12	2,213,360	2,308,935	2,390,426	2,441,910	2,482,556	2,484,951	8%
	% Change	-9%	-9%	-8%	-8%	-7%	-7%	
Pasadena, City of	RTP-08	175,957	180,691	185,640	190,436	195,089	199,562	10%
	RTP-12	161,864	166,291	169,493	173,508	181,466	185,702	12%
	% Change	-8%	-8%	-9%	-9%	-7%	-7%	
San Diego County Water Authority	Series 11	3,136,156	3,318,203	3,500,250	3,656,244	3,812,237	3,968,231	20%
	Series 13**	3,230,273	3,401,208	3,435,713	3,575,041	3,714,370	3,853,698	13%
	% Change	3%	3%	-2%	-2%	-3%	-3%	
San Fernando, City of	RTP-08	25,665	26,040	26,444	26,834	27,209	27,565	6%
	RTP-12	23,896	24,243	24,510	24,900	25,314	25,722	6%
	% Change	-7%	-7%	-7%	-7%	-7%	-7%	
San Marino, City of	RTP-08	13,765	13,787	13,826	13,862	13,895	13,924	1%
	RTP-12	13,263	13,479	13,305	13,297	13,413	13,417	0%
	% Change	-4%	-2%	-4%	-4%	-3%	-4%	
Santa Ana, City of	RTP-08	366,268	372,685	378,067	380,197	382,186	382,447	3%
	RTP-12	324,328	332,597	336,682	336,338	339,193	334,973	1%
	% Change	-11%	-11%	-11%	-12%	-11%	-12%	
Santa Monica, City of	RTP-08	91,129	91,243	91,487	91,716	91,926	92,124	1%
	RTP-12	89,982	91,047	92,293	93,557	93,585	94,906	4%
	% Change	-1%	0%	1%	2%	2%	3%	
Three Valleys Municipal Water District	RTP-08	573,009	600,012	629,075	657,982	685,863	712,554	19%
	RTP-12	494,171	526,643	547,723	561,158	591,965	608,067	15%
	% Change	-14%	-12%	-13%	-15%	-14%	-15%	
Torrance, City of	RTP-08	138,252	140,490	142,893	145,214	147,438	149,559	6%
	RTP-12	134,279	138,049	138,557	139,963	144,342	145,895	6%
	% Change	-3%	-2%	-3%	-4%	-2%	-2%	
Upper San Gabriel Valley Municipal Water District	RTP-08	926,100	964,441	1,001,607	1,038,042	1,073,164	1,106,637	15%
	RTP-12	842,890	868,892	878,904	895,073	926,489	943,758	9%
	% Change	-9%	-10%	-12%	-14%	-14%	-15%	
West Basin Municipal Water District	RTP-08	853,377	874,219	892,116	909,498	926,592	942,893	8%
	RTP-12	799,342	819,738	823,886	837,059	864,523	878,666	7%
	% Change	-6%	-6%	-8%	-8%	-7%	-7%	
Western Municipal Water District	RTP-08	878,889	944,773	1,012,102	1,072,664	1,128,805	1,179,532	25%
	RTP-12	868,144	923,527	960,354	1,001,745	1,045,382	1,088,853	18%
	% Change	-1%	-2%	-5%	-7%	-7%	-8%	
		2,441,958	2,549,018	2,610,396	2,647,895	2,676,283	2,685,946	5%
MWD Total	RTP-08	19,215,936	20,000,633	20,725,950	21,369,670	21,977,334	22,543,090	13%
	RTP-12	18,264,623	18,948,605	19,449,433	20,097,679	20,720,851	21,313,956	12%
	% Change	-5%	-5%	-6%	-6%	-6%	-5%	

*2010 are projected data from the RTP-08 and RTP-12 forecasts. They do not represent historical data from DOF or the Census.

**SANDAG Series 13 forecast is used for 2010 and 2015. SANDAG Series 13 forecast is used for 2020-2035.

Section 3: Household Projections

A household includes all the persons who occupy a housing unit as their usual place of residence. According to the U.S. Census Bureau, the count of households or householders is the same as the count of occupied housing units for 100-percent tabulations. Vacant housing units are not included in the household projections.

Within the five SCAG counties in Metropolitan's service area, the number of total households is projected to grow from about 6.1 million in 2015 to about 7.2 million in 2035. Of these, single family households are expected to grow from about 4.0 million in 2015 to about 4.4 million in 2035. During the same 20-year time period, multi-family households are projected to increase from about 2.3 million to about 2.9 million.

RTP-08 VS. RTP-12

Figure 3.1: Five-County SCAG Region Total Households, Historical and Projected

This graphic depicts county-level historical and projected total household data used for Metropolitan's retail demand forecasts. Observe that DOF and RTP-08 had overestimated housing relative to the 2010 Census count. DOF and SCAG later lowered their household estimates for consistency with the 2010 Census. Similar slopes for RTP-08 and RTP-12 housing growth trends result in parallel linear growth over time.

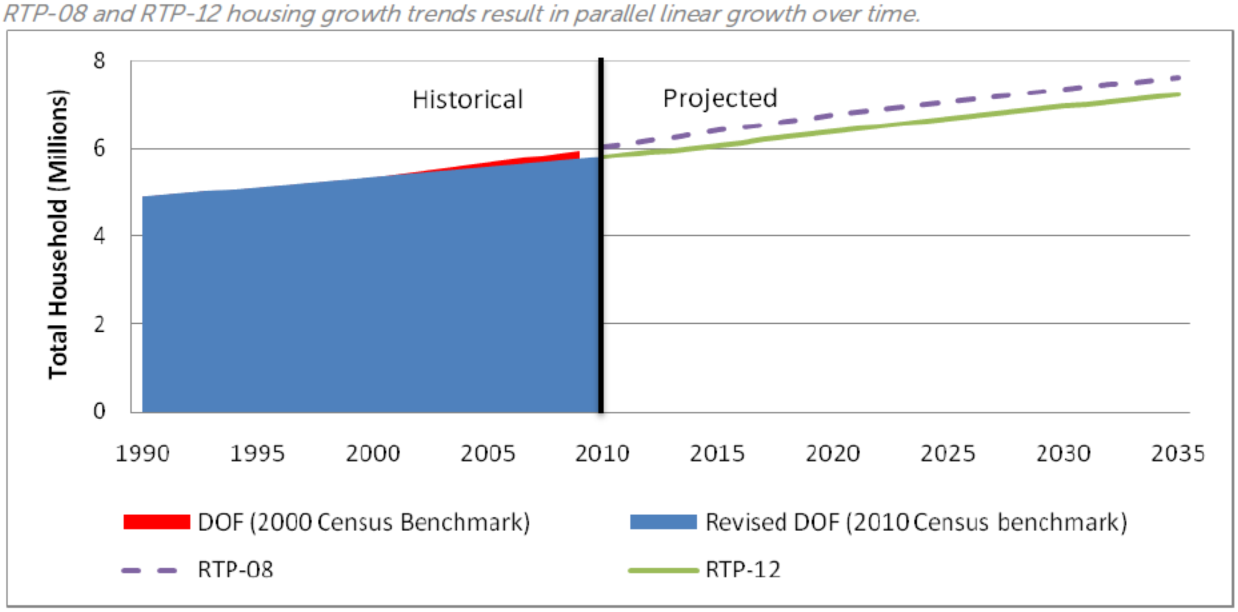


Figure 3.1 and **Table 3.1** show county-level differences in predicted households between RTP-08 and the RTP-12. Compared with RTP-08, RTP-12 projects five percent fewer households by 2035 for the Los Angeles, Orange, San Bernardino, Riverside, and Ventura counties. Differences are attributed to SCAG's re-benchmark to the 2010 Census. SCAG

assumes the region's economy will rebound to normal in the long-term with reasonable labor force participation rates and unemployment levels.[7] Economy is directly correlated with population growth.

Table 3.1 – Total Household Forecasts, RTP-08 vs. RTP-12, by County

This table compares RTP-08 and RTP-12 total household projections by county. RTP-12 projects less population than RTP-08 across all counties and all forecast years. The differences are consistently 4% to 5% for each forecast year, resulting in a parallel linear growth trends.

County		2010*	2015	2020	2025	2030	2035
Los Angeles County	RTP-08	3,356,398	3,507,938	3,664,775	3,786,770	3,904,631	4,001,184
	RTP-12	3,241,207	3,366,553	3,511,970	3,624,713	3,738,205	3,851,170
	% Change	-3%	-4%	-4%	-4%	-4%	-4%
Orange County	RTP-08	1,039,209	1,071,806	1,088,355	1,102,346	1,110,662	1,118,497
	RTP-12	993,921	1,019,886	1,048,952	1,083,893	1,104,380	1,124,733
	% Change	-4%	-5%	-4%	-2%	-1%	1%
Riverside County	RTP-08	720,536	811,508	913,205	1,008,909	1,097,953	1,183,072
	RTP-12	686,261	755,638	834,223	920,025	1,006,167	1,092,154
	% Change	-5%	-7%	-9%	-9%	-8%	-8%
San Bernardino County	RTP-08	637,241	718,575	787,139	852,985	914,569	972,570
	RTP-12	611,617	651,743	698,438	748,141	797,831	847,535
	% Change	-4%	-9%	-11%	-12%	-13%	-13%
Ventura County	RTP-08	275,123	290,990	302,948	312,926	321,790	330,200
	RTP-12	266,916	278,188	291,945	300,480	308,981	317,516
	% Change	-3%	-4%	-4%	-4%	-4%	-4%
SCAG Region Total	RTP-08	6,028,507	6,400,817	6,756,422	7,063,936	7,349,605	7,605,523
	RTP-12	5,799,922	6,072,008	6,385,528	6,677,252	6,955,564	7,233,108
	% Change	-4%	-5%	-5%	-5%	-5%	-5%

*2010 are projected data from the RTP-08 and RTP-12 forecasts. They do not represent historical data from DOF or the Census.

[7] 2012-2035 Regional Transportation Plan and Sustainable Communities Strategy - Growth Forecast Appendix (Proposed Final), SCAG, April 2012, p. 15

Table 3.3 – Total Households, RTP-08 vs. RTP-12, by Member Agency (with SANDAG Series 11 & 13)

This table compares RTP-08 and RTP-12 total household projections by member agency. SANDAG Series 11 and Series 13 are used for San Diego County Water Authority. RTP-12 projects fewer households than RTP-08 for the total service area across all forecast years. Differences are approximately 3% to 4% for each forecast year, resulting in parallel linear growth trends.

Member Agency		2010*	2015	2020	2025	2030	2035	2015-2035 Growth
Anaheim, City of	RTP-08	102,310	106,991	110,635	114,073	116,658	120,523	13%
	RTP-12	100,568	104,399	109,435	112,859	118,629	123,423	18%
	% Change	-2%	-2%	-1%	-1%	2%	2%	
Beverly Hills, City of	RTP-08	21,125	21,365	21,619	21,821	22,017	22,174	4%
	RTP-12	20,347	20,485	20,680	20,866	21,040	21,227	4%
	% Change	-4%	-4%	-4%	-4%	-4%	-4%	
Burbank, City of	RTP-08	43,966	45,744	47,614	49,071	50,482	51,641	13%
	RTP-12	42,602	43,977	46,002	46,334	46,666	46,998	7%
	% Change	-3%	-4%	-3%	-6%	-8%	-9%	
Calleguas Municipal Water District	RTP-08	197,544	207,832	215,258	221,449	226,953	232,176	12%
	RTP-12	194,907	202,196	211,182	216,624	222,047	227,489	13%
	% Change	-1%	-3%	-2%	-2%	-2%	-2%	
Central Basin Municipal Water District	RTP-08	427,455	438,720	449,239	457,260	465,088	471,357	7%
	RTP-12	416,097	424,086	432,981	440,640	448,519	456,240	8%
	% Change	-3%	-3%	-4%	-4%	-4%	-3%	
Compton, City of	RTP-08	20,900	20,989	21,072	21,147	21,207	21,261	1%
	RTP-12	21,401	21,431	21,526	21,535	21,404	21,411	0%
	% Change	2%	2%	2%	2%	1%	1%	
Eastern Municipal Water District	RTP-08	230,460	260,930	291,832	317,815	342,401	366,487	40%
	RTP-12	226,970	248,360	272,000	302,466	333,181	363,733	46%
	% Change	-2%	-5%	-7%	-5%	-3%	-1%	
Foothill Municipal Water District	RTP-08	30,177	31,436	32,746	33,767	34,754	35,574	13%
	RTP-12	27,966	28,526	28,994	29,541	30,120	30,670	8%
	% Change	-7%	-9%	-11%	-13%	-13%	-14%	
Fullerton, City of	RTP-08	44,920	45,546	45,741	45,971	46,396	46,652	4%
	RTP-12	43,044	43,887	44,857	48,895	49,665	50,763	18%
	% Change	-4%	-4%	-2%	6%	7%	9%	
Glendale, City of	RTP-08	69,791	71,096	72,478	73,548	74,585	75,436	6%
	RTP-12	68,356	69,333	70,740	71,845	72,943	74,050	7%
	% Change	-2%	-2%	-2%	-2%	-2%	-2%	
Inland Empire Utilities Agency	RTP-08	233,377	252,824	269,236	284,979	299,716	313,609	24%
	RTP-12	231,974	245,552	261,554	277,701	293,893	310,049	26%
	% Change	-1%	-3%	-3%	-3%	-2%	-1%	89%
Las Virgenes Municipal Water District	RTP-08	26,584	27,405	28,553	29,486	30,368	31,101	13%
	RTP-12	24,661	25,319	25,927	26,476	27,001	27,550	9%
	% Change	-7%	-8%	-9%	-10%	-11%	-11%	
Long Beach, City of	RTP-08	170,365	176,071	182,082	186,773	191,295	195,040	14%
	RTP-12	166,054	170,140	176,118	180,570	185,053	189,505	14%
	% Change	-3%	-3%	-3%	-3%	-3%	-3%	
Los Angeles, City of	RTP-08	1,391,796	1,450,082	1,511,516	1,559,537	1,605,826	1,643,948	13%
	RTP-12	1,350,156	1,406,551	1,479,490	1,535,871	1,592,928	1,649,518	17%
	% Change	-3%	-3%	-2%	-2%	-1%	0%	

Member Agency		2010*	2015	2020	2025	2030	2035	2015-2035 Growth
Municipal Water District of Orange	RTP-08	815,610	842,174	854,636	864,725	869,961	873,605	4%
County	RTP-12	776,392	795,237	814,115	836,907	849,545	862,183	8%
	% Change	-5%	-6%	-5%	-3%	-2%	-1%	
Pasadena, City of	RTP-08	64,272	66,486	68,830	70,656	72,415	73,874	11%
	RTP-12	63,232	64,845	67,003	68,704	70,423	72,129	11%
	% Change	-2%	-2%	-3%	-3%	-3%	-2%	
San Diego County	Series 11	1,089,488	1,145,767	1,202,046	1,238,328	1,274,608	1,310,890	14%
Water Authority**	Series 13**	1,064,538	1,116,246	1,167,953	1,219,534	1,271,114	1,312,408	18%
	% Change	-2%	-3%	-3%	-2%	0%	0%	
San Fernando, City of	RTP-08	5,995	6,130	6,275	6,386	6,493	6,582	7%
	RTP-12	6,026	6,131	6,281	6,388	6,492	6,598	8%
	% Change	1%	0%	0%	0%	0%	0%	-53%
San Marino, City of	RTP-08	4,360	4,365	4,373	4,375	4,381	4,384	0%
	RTP-12	4,383	4,384	4,387	4,387	4,385	4,386	0%
	% Change	1%	0%	0%	0%	0%	0%	
Santa Ana, City of	RTP-08	76,369	77,095	77,343	77,577	77,647	77,717	1%
	RTP-12	73,423	73,971	74,029	74,106	74,567	74,746	1%
	% Change	-4%	-4%	-4%	-4%	-4%	-4%	-1%
Santa Monica, City of	RTP-08	45,989	46,150	46,321	46,453	46,573	46,684	1%
	RTP-12	46,993	47,892	49,212	49,942	50,667	51,399	7%
	% Change	2%	4%	6%	8%	9%	10%	
Three Valleys Municipal	RTP-08	161,093	169,405	178,946	186,431	193,609	199,435	18%
Water District	RTP-12	149,193	157,069	165,211	169,156	173,552	178,083	13%
	% Change	-7%	-7%	-8%	-9%	-10%	-11%	
Torrance, City of	RTP-08	51,743	52,527	53,355	53,995	54,611	55,129	5%
	RTP-12	51,611	52,237	53,134	53,720	54,297	54,882	5%
	% Change	0%	-1%	0%	-1%	-1%	0%	
Upper San Gabriel Valley Municipal Water	RTP-08	250,959	262,783	274,573	283,816	292,682	299,925	14%
District	RTP-12	240,930	245,911	252,020	256,797	261,779	266,572	8%
	% Change	-4%	-6%	-8%	-10%	-11%	-11%	
West Basin Municipal	RTP-08	286,864	293,759	299,729	304,119	308,472	311,952	6%
Water District	RTP-12	280,778	284,637	289,670	294,293	298,966	303,598	7%
	% Change	-2%	-3%	-3%	-3%	-3%	-3%	
Western Municipal	RTP-08	268,683	291,327	312,708	331,835	349,837	366,498	26%
Water District	RTP-12	256,318	273,308	290,946	306,892	323,070	339,094	24%
	% Change	-5%	-6%	-7%	-8%	-8%	-7%	
MWD Total	RTP-08	6,132,195	6,414,999	6,678,756	6,885,393	7,079,035	7,253,654	13%
	RTP-12	5,948,920	6,176,110	6,435,447	6,673,049	6,901,946	7,118,704	15%
	% Change	-3%	-4%	-4%	-3%	-3%	-2%	

*2010 are projected data from the RTP-08 and RTP-12 forecasts. They do not represent historical data from DOF or the Census.

**SANDAG Series 13 forecast is used for 2010 and 2015. SANDAG Series 13 forecast is used for 2020-2035.

Section 4: Median Household Income Projections

Median household income is the median value of household income for all households within a zone. Household income includes the income, from all sources, for all persons aged 15 years or older within a household. Historical median household income data are from the U.S. Census Bureau, obtained through the American Community Survey (ACS).

Table 4.1 shows the projected median household income growth by the 26 member agencies in Metropolitan's service area in real terms (1990 dollars), for both the RTP-08 and RTP-12 regional growth forecasts. Compared with RTP-08, the RTP-12 forecast generally anticipates slightly higher median household income in the year 2015.

By the year 2035, however, RTP-12 indicates significantly lower income growth than had been predicted in RTP-08. As shown in **Table 4.1**, compared with RTP-08, RTP-12 anticipates less median household income growth for 20 of the 26 member agencies. In real terms, projected median household income actually falls for 12 of the 26 the member agencies between the years 2015 and 2035. For the same 20-year timeframe, RTP-08 anticipated median household income to decrease in real terms for only 2 member agencies.

The comparative decline in projected median household income under the RTP-12 forecast is consistent with comparisons of the population, housing, and employment projections. Much of the projected decline in median income can be attributed the lasting effects of the 2009 recession and the job losses incurred in the SCAG region. Decline in median household income is also an indication of permanent restructuring of jobs in the region, with less relative employment growth in the professional, manufacturing, and construction industries and more growth in the lower-paid service industries.

Table 4.1 –Median Household Income Forecasts by Member Agency (in 1990 Dollars)

This table compares RTP-08 and RTP-12 median household income by member agency, inflation-adjusted to 1990 dollars. SANDAG Series 11 and Series 13 are used for San Diego County Water Authority. In general, RTP-12 predicts lower median household income values than RTP-08, reflecting economic recession and permanent restructuring of the regional industries.

	RTP-08 & Series 11		RTP-12 & Series 13*		% Change RTP-08 vs. RTP-12	
Member Agency	2015	2035	2015	2035	2015	2035
Anaheim, City of	$43,276	$47,931	$45,017	$45,657	4.0%	-4.7%
Beverly Hills, City of	$63,470	$73,402	$64,325	$64,352	1.3%	-12.3%
Burbank, City of	$41,987	$48,168	$41,451	$41,604	-1.3%	-13.6%
Calleguas Municipal Water District	$59,218	$66,304	$57,503	$57,449	-2.9%	-13.4%
Central Basin Municipal Water District	$35,685	$36,509	$35,502	$35,264	-0.5%	-3.4%
Compton, City of	$27,431	$27,868	$27,569	$27,686	0.5%	-0.7%
Eastern Municipal Water District	$38,306	$40,346	$40,058	$40,703	4.6%	0.9%
Foothill Municipal Water District	$67,449	$68,074	$65,077	$66,107	-3.5%	-2.9%
Fullerton, City of	$46,996	$54,566	$48,435	$46,843	3.1%	-14.2%
Glendale, City of	$39,745	$41,537	$38,291	$38,588	-3.7%	-7.1%
Inland Empire Utilities Agency	$44,618	$47,223	$46,416	$45,585	4.0%	-3.5%
Las Virgenes Municipal Water District	$83,949	$100,330	$80,925	$81,544	-3.6%	-18.7%
Long Beach, City of	$35,356	$39,437	$34,603	$34,745	-2.1%	-11.9%
Los Angeles, City of	$36,748	$39,244	$35,787	$35,584	-2.6%	-9.3%
Municipal Water District of Orange County	$58,676	$64,872	$60,959	$60,539	3.9%	-6.7%
Pasadena, City of	$44,024	$54,880	$43,557	$44,165	-1.1%	-19.5%
San Diego County Water Authority**	$49,642	$56,667	$47,957	$59,397	-3.4%	4.8%
San Fernando, City of	$32,002	$31,227	$32,293	$32,367	0.9%	3.7%
San Marino, City of	$101,086	$103,651	$106,328	$106,279	5.2%	2.5%
Santa Ana, City of	$37,009	$37,334	$37,694	$37,597	1.9%	0.7%
Santa Monica, City of	$50,185	$61,908	$46,518	$46,754	-7.3%	-24.5%
Three Valleys Municipal Water District	$49,661	$52,891	$48,913	$50,151	-1.5%	-5.2%
Torrance, City of	$48,739	$52,093	$49,170	$49,073	0.9%	-5.8%
Upper San Gabriel Valley Municipal Water District	$39,520	$39,500	$39,854	$39,702	0.8%	0.5%
West Basin Municipal Water District	$51,028	$57,640	$47,800	$47,572	-6.3%	-17.5%
Western Municipal Water District	$44,892	$50,857	$45,434	$45,902	1.2%	-9.7%

*Forecasts for San Diego County Water Authority in the 2015 IRP Update used SANDAG Series 13 for 2015 and SANDAG Series 13 for 2035

Section 5: Employment Projections

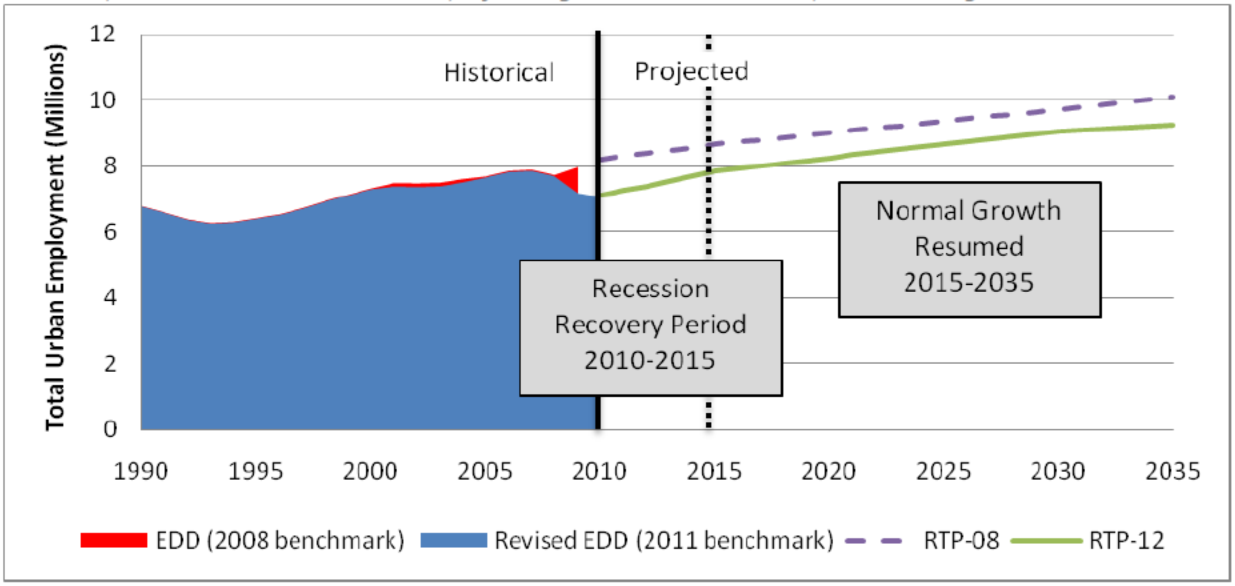
Economic trends are captured by tracking regional employment growth and the changing mix of industries. Metropolitan tracks non-farm employment and includes estimates for self-employment. There are six counties in Metropolitan's service area, five of which are included in SCAG's forecast. SCAG's county-level projections are discussed first, followed by service area projections.

RTP-08 VS. RTP-12

The differences in employment between SCAG's RTP-08 and the RTP-12 are 1.1 million and 823,000 fewer jobs in 2010 and 2035, respectively, for Los Angeles, Orange, San Bernardino, Riverside, and Ventura counties. **Figure 5.1** compares RTP-08 and RTP-12 and depicts the extent to which the RTP-12 forecast has lowered expected job growth for the region. Historical EDD employment data is shown from 1990 to 2010, then projected data from 2010 to 2035. The RTP-12 forecast is benchmarked to 2010 EDD data. By contrast, RTP-08 forecast for 2010 diverges from historical data because it had been benchmarked to an earlier EDD estimate that did not anticipate the 2007-2009 recession. It is important to note that SCAG projections do not assume economic cycles but long-term trends. Had existing trends continued from 2008 onwards, then the RTP-08's trajectory would have been consistent with historical data.

Figure 5.1: Five-County SCAG Region Total Urban Employment, Historical and Projected

This graphic depicts county-level historical and projected total urban employment data used for Metropolitan's retail demand forecasts. Observe that EDD and RTP-08 had overestimated employment relative to the 2011 EDD estimates. SCAG later lowered employment estimates for consistency with the 2011 EDD data. Note that RTP-12 grows at an accelerated rate during an assumed recession recovery period between 2010 and 2015. After 2015, similar slopes for RTP-08 and RTP-12 employment growth trends result in parallel linear growth over time.



RTP-12 anticipates a more rapid pace of growth early in the forecast than later in the time horizon. In Figure 5.1, the year 2015 is an inflection point where the RTP-12 projection line pivots its trajectory and decreases its slope from that point onward. This is because SCAG assumes a recovery period of accelerated job growth between the years 2010 and 2015 as the region recovers from the 2007-2009 economic recession. After year 2015, SCAG assumes a resumption of normal long-term employment growth. However, the RTP-12 forecast does not ever catch up to the RTP-08 forecast values. RTP-12's lower job projections for 2010 and beyond is an indication of the severity of the recent recession and its long-term impact to what is assumed to the normal pattern of growth.

Metropolitan's service area contained approximately 88 percent of employment in the six Southern California counties in 2010. It is expected that SCAG's employment projections at the county level will also be reflected in its estimates for Metropolitan's service area. Table 5.1 shows RTP-12 employment projections for years 2015 and 2035 for each Metropolitan member agency.

Table 5.1 – Total Urban Employment Forecasts, RTP-08 vs. RTP-12, by County

This table compares RTP-08 and RTP-12 total urban employment projections by county. RTP-12 projects fewer jobs than RTP-08 across all counties and all forecast years. Beginning in 2015, differences are 7% to 9% for each forecast year, resulting in parallel linear growth trends after 2015.

County		2010	2015	2020	2025	2030	2035
Los Angeles County	RTP-08	4,537,105	4,661,313	4,740,530	4,833,559	4,932,858	5,027,920
	RTP-12	4,110,683	4,413,041	4,544,488	4,665,895	4,761,479	4,814,062
	% Change	-9%	-5%	-4%	-3%	-3%	-4%
Orange County	RTP-08	1,748,270	1,830,558	1,889,903	1,925,503	1,953,039	1,974,298
	RTP-12	1,485,624	1,541,529	1,619,647	1,678,696	1,731,729	1,772,552
	% Change	-15%	-16%	-14%	-13%	-11%	-10%
Riverside County	RTP-08	768,122	894,863	1,025,278	1,151,916	1,278,770	1,397,176
	RTP-12	571,532	812,498	920,957	1,054,030	1,159,686	1,224,918
	% Change	-26%	-9%	-10%	-8%	-9%	-12%
San Bernardino County	RTP-08	805,374	892,317	960,305	1,039,657	1,128,833	1,248,147
	RTP-12	637,681	746,543	806,531	908,470	996,365	1,054,860
	% Change	-21%	-16%	-16%	-13%	-12%	-15%
Ventura County	RTP-08	348,094	369,772	389,725	407,020	421,615	434,660
	RTP-12	298,589	337,596	357,883	374,931	385,596	393,074
	% Change	-14%	-9%	-8%	-8%	-9%	-10%
SCAG Region Total	RTP-08	8,206,965	8,648,823	9,005,740	9,357,655	9,715,117	10,082,201
	RTP-12	7,104,109	7,851,207	8,249,506	8,682,022	9,034,856	9,259,466
	% Change	-13%	-9%	-8%	-7%	-7%	-8%

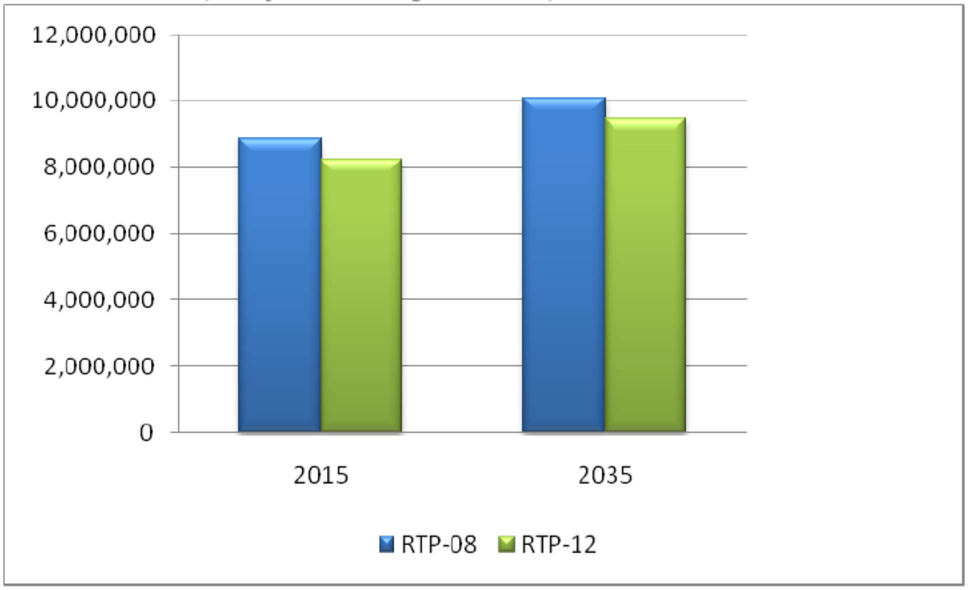
Employment for Metropolitan's entire service area (including San Diego County Water Authority) is estimated at 8.34 million jobs in 2015 and 9.63 million in 2035. These figures do not include potential changes to SANDAG's Series 13. Employment growth rates are anticipated to vary across the Metropolitan's member agencies. Among the fastest growing member agencies are Eastern Municipal Water District, Inland Empire Utilities Agency, and Western Municipal Water District, which are projected to grow by 71 percent, 38 percent, and 36 percent over the 20 years between 2015 and 2035. This is consistent with SCAG's general observation that Riverside and San Bernardino Counties will grow faster and increase their share of regional jobs while Los Angeles and Orange Counties decrease their share.[8]

As compared with RTP-08, the RTP-12 anticipates more modest job growth, with about 523,000 fewer jobs in 2015 and about 468,000 fewer jobs in 2035 for Metropolitan's member agencies within the Los Angeles, Orange, San Bernardino, Riverside, San Diego, and Ventura counties. Projections for San Diego County remained constant with data from the SANDAG Series 13 forecast. Figure 5.2 compares the RTP-08 and RTP-12 estimates for Metropolitan's service area.

[8] SCAG, *2012-2035 Regional Transportation Plan Growth Forecast Appendix*, April 2012, pg. 16, http://rtpscs.scag.ca.gov/Documents/2012/final/SR/2012fRTP_GrowthForecast.pdf

Figure 5.2 – Comparison of RTP-08 and RTP-12 Total Urban Employment growth forecasts, 2015 and 2035, with SANDAG Series 13

This chart compares RTP-08 and RTP-12 total urban employment projections for Metropolitan's total service area. SANDAG Series 13 is used for the San Diego County Water Authority. RTP-12 predicts fewer total jobs than RTP-08 across the forecast time horizon. Some of the decrease can be attributed to lower population estimates in RTP-12 and consequently a smaller regional labor pool over time.



The entire area served by Metropolitan has been challenged by the recent economic recession that began in December 2007. The region lost approximately 800,000 jobs from 2007 to 2010. Although the economic recession officially ended in 2009, the regional economy is yet to regain its pre-recession level. The six counties in Metropolitan's service area experienced job losses in 2008, 2009 and 2010 as reported by EDD. The region experienced declines in the level of residential and nonresidential construction since 2007. As a result, job losses in construction related industries were large relative to job losses in these industries nationally. The disproportionate loss in construction activity is a contributing factor toward why job losses in Metropolitan's service area exceeded those in the nation. As an example, Figure 5.3 shows SCAG's reduced expectations for future construction industry employment relative to its previous forecast.

Figure 5.3: Construction Industry Employment Projections, 2015 and 2035, Metropolitan Service Area

This chart compares RTP-08 and RTP-12 employment projections for the construction industry Metropolitan's total service area. SANDAG Series 13 is used for the San Diego County Water Authority. The recessionary impact on the regional construction industry was severe, as shown in the large relative decrease in projected number of construction jobs for 2015 for RTP-12. Even by 2035, the forecasted number of construction industry jobs does not recover to previously assumed levels in RTP-08. The RTP-08 employment projections did not anticipate the recession.

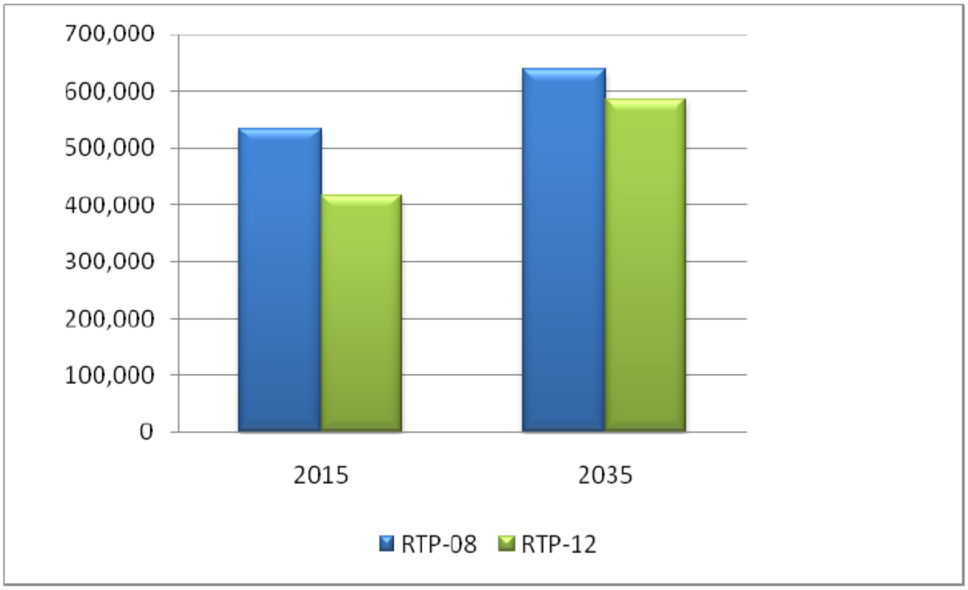


Table 5.2 – Total Urban Employment Forecasts, RTP-08 vs. RTP-12, by Member Agency (with SANDAG Series 11 & 13)

This table compares RTP-08 and RTP-12 total urban employment projections by member agency. SANDAG Series 11 and Series 13 are used for San Diego County Water Authority. In general, RTP-12 projects fewer jobs than RTP-08 for the total service area across all forecast years. However, there are variations in employment growth patterns among the different member agencies, with some agencies experiencing increased job growth. Beginning in 2015, differences between the forecasts for the total Metropolitan service area stabilize 8% to 9% for each forecast year, resulting in a parallel linear growth trends after 2015.

Member Agency		2010	2015	2020	2025	2030	2035	2015-2035 Growth
Anaheim, City of	RTP-08	201,713	208,651	212,972	217,299	219,080	220,777	6%
	RTP-12	175,197	182,431	193,532	203,387	219,880	226,291	24%
	% Change	-13%	-13%	-9%	-6%	0%	2%	
Beverly Hills, City of	RTP-08	75,810	77,184	78,047	79,085	80,188	81,244	5%
	RTP-12	67,576	72,499	75,349	77,231	78,755	79,891	10%
	% Change	-11%	-6%	-3%	-2%	-2%	-2%	
Burbank, City of	RTP-08	95,126	99,869	102,889	106,445	110,242	113,871	14%
	RTP-12	89,467	97,677	104,363	108,881	112,732	116,441	19%
	% Change	-6%	-2%	1%	2%	2%	2%	
Calleguas Municipal Water District	RTP-08	240,986	255,445	269,123	281,002	290,973	299,921	17%
	RTP-12	216,044	245,232	259,804	270,202	278,695	282,188	15%
	% Change	-10%	-4%	-3%	-4%	-4%	-6%	
Central Basin Municipal Water District	RTP-08	553,727	563,417	569,641	576,934	584,740	592,147	5%
	RTP-12	546,627	582,355	597,299	607,087	615,477	617,966	6%
	% Change	-1%	3%	5%	5%	5%	4%	
Compton, City of	RTP-08	21,312	21,745	22,015	22,336	22,677	23,003	6%
	RTP-12	21,897	23,001	23,566	23,680	24,014	24,064	5%
	% Change	3%	6%	7%	6%	6%	5%	
Eastern Municipal Water District	RTP-08	180,083	217,366	256,469	292,820	329,442	362,745	67%
	RTP-12	134,125	200,024	236,665	281,925	318,698	342,616	71%
	% Change	-26%	-8%	-8%	-4%	-3%	-6%	
Foothill Municipal Water District	RTP-08	21,325	21,808	22,082	22,418	22,775	23,114	6%
	RTP-12	18,051	19,471	20,205	21,107	21,756	21,901	12%
	% Change	-15%	-11%	-9%	-6%	-4%	-5%	
Fullerton, City of	RTP-08	72,555	73,467	75,036	75,508	76,527	76,688	4%
	RTP-12	56,422	57,424	57,979	67,280	81,996	85,493	49%
	% Change	-22%	-22%	-23%	-11%	7%	11%	
Glendale, City of	RTP-08	91,619	93,496	94,661	96,064	97,545	98,967	6%
	RTP-12	83,523	89,385	92,106	94,716	96,445	96,687	8%
	% Change	-9%	-4%	-3%	-1%	-1%	-2%	
Inland Empire Utilities Agency	RTP-08	357,598	387,467	411,016	438,324	469,138	510,246	32%
	RTP-12	297,428	345,831	366,679	413,438	453,145	476,893	38%
	% Change	-17%	-11%	-11%	-6%	-3%	-7%	
Las Virgenes Municipal Water District	RTP-08	53,785	55,217	56,114	57,181	58,306	59,386	8%
	RTP-12	45,546	48,238	49,117	50,700	52,028	52,669	9%
	% Change	-15%	-13%	-12%	-11%	-11%	-11%	
Long Beach, City of	RTP-08	180,317	184,299	186,876	189,900	193,137	196,185	6%
	RTP-12	159,482	169,524	173,650	177,681	179,967	182,575	8%
	% Change	-12%	-8%	-7%	-6%	-7%	-7%	
Los Angeles, City of	RTP-08	1,837,415	1,881,758	1,910,010	1,943,224	1,978,773	2,012,664	7%
	RTP-12	1,658,724	1,793,212	1,840,887	1,885,588	1,922,628	1,939,460	8%
	% Change	-10%	-5%	-4%	-3%	-3%	-4%	

Member Agency		2010	2015	2020	2025	2030	2035	2015-2035 Growth
Municipal Water District of Orange County	RTP-08	1,289,152	1,358,247	1,409,430	1,438,507	1,462,847	1,482,076	9%
	RTP-12	1,065,584	1,118,922	1,174,471	1,207,065	1,230,646	1,259,511	13%
	% Change	-17%	-18%	-17%	-16%	-16%	-15%	
Pasadena, City of	RTP-08	124,860	128,985	131,588	134,653	137,921	141,047	9%
	RTP-12	112,320	119,866	123,383	127,252	130,008	132,210	10%
	% Change	-10%	-7%	-6%	-5%	-6%	-6%	
San Diego County Water Authority**	Series 11	1,486,249	1,563,849	1,641,450	1,719,829	1,798,208	1,876,587	20%
	Series 13**	1,351,248	1,446,465	1,470,261	1,519,021	1,557,700	1,604,184	11%
	% Change	-9%	-8%	-10%	-12%	-13%	-15%	
San Fernando, City of	RTP-08	14,966	15,221	15,382	15,576	15,780	15,976	5%
	RTP-12	14,524	15,342	15,643	15,863	15,985	16,020	4%
	% Change	-3%	1%	2%	2%	1%	0%	
San Marino, City of	RTP-08	5,019	5,171	5,264	5,378	5,496	5,612	9%
	RTP-12	4,185	4,477	4,621	4,798	4,931	4,934	10%
	% Change	-17%	-13%	-12%	-11%	-10%	-12%	
Santa Ana, City of	RTP-08	184,529	189,873	192,154	193,884	194,283	194,456	3%
	RTP-12	175,933	175,904	177,142	174,124	176,702	175,814	1%
	% Change	-5%	-7%	-8%	-10%	-9%	-10%	
Santa Monica, City of	RTP-08	100,567	102,433	103,552	104,939	106,388	107,773	5%
	RTP-12	94,209	99,344	100,773	102,164	103,178	103,560	4%
	% Change	-6%	-3%	-3%	-3%	-3%	-4%	
Three Valleys Municipal Water District	RTP-08	225,353	230,731	234,081	238,061	242,320	246,363	7%
	RTP-12	173,811	184,783	191,287	196,408	199,959	201,807	9%
	% Change	-23%	-20%	-18%	-17%	-17%	-18%	
Torrance, City of	RTP-08	101,888	103,597	104,655	105,942	107,279	108,572	5%
	RTP-12	99,364	105,349	108,310	109,812	111,159	111,644	6%
	% Change	-2%	2%	3%	4%	4%	3%	
Upper San Gabriel Valley Municipal Water District	RTP-08	342,633	350,688	356,074	362,242	368,919	375,199	7%
	RTP-12	273,273	288,983	293,252	298,934	302,417	303,383	5%
	% Change	-20%	-18%	-18%	-17%	-18%	-19%	
West Basin Municipal Water District	RTP-08	386,070	392,203	396,123	400,741	405,666	410,341	5%
	RTP-12	349,145	370,083	377,214	386,162	392,785	394,839	7%
	% Change	-10%	-6%	-5%	-4%	-3%	-4%	
Western Municipal Water District	RTP-08	352,301	404,543	457,564	510,942	565,291	613,335	52%
	RTP-12	264,349	370,003	410,348	450,260	484,553	502,558	36%
	% Change	-25%	-9%	-10%	-12%	-14%	-18%	
MWD Total	RTP-08	8,596,958	8,986,730	9,314,268	9,629,234	9,943,941	10,248,295	14%
	RTP-12	7,548,054	8,225,825	8,537,906	8,874,766	9,166,239	9,355,599	14%
	% Change	-12%	-8%	-8%	-8%	-8%	-9%	

*2010 are projected data from the RTP-08 and RTP-12 forecasts. They do not represent historical data.

**SANDAG Series 11 forecast is used for 2010 and 2015. SANDAG Series 13 forecast is used for 2020-2035

Appendix A – SCAG Methodology

SCAG uses cohort-component demographic models to project population, employment, households, income, and other transportation-related planning variables. SCAG's methodology allocates larger area projections down to smaller areas. The basic approach is to allocate county- or city-level projections of population, households, and employment based on the availability of land and land use designation specified by individual jurisdictions. SCAG benchmarked its RTP-12 demographic and employment forecasts using available demographic data from the 2010 Census and March 2011employment data from the EDD.

SCAG POPULATION FORECAST METHODOLOGY

Between 2010 and 2035, SCAG's RTP-12 anticipates a regional annual population growth rate of 0.9 percent, which is lower than the growth rate for the previous 20 years. Most of this growth is expected to occur through natural increase.

Cohort-Component Model

The SCAG cohort-component model computes population at a future point in time by adding to the existing population the number of births and persons moving into the region during a time interval, and by subtracting the number of deaths and the number of persons moving out of the area. Fertility, mortality, and migration rates are projected in 5-year intervals for each age group, for four mutually exclusive ethnic groups.

A second phase links population dynamics to economic trends. It is based on the assumption that patterns of migration into and out of the region are influenced by the availability of jobs. The future labor force is computed from the population projection model. Projected labor force participation rates are applied to the working age population. This labor force number is compared to the number of jobs projected by SCAG's shift/share economic model. If an imbalance occurs between the two figures, it is corrected by adjusting the migration assumptions of the demographic projection model. For the RTP-12 forecast period, international net immigration is kept constant at 104,000, which is an annual average of international net immigration of the SCAG region during the 1990-2010 period.

Local Input

SCAG actively sought local input in development of its growth forecasts. Preliminary projections of population, household and employment growth at the jurisdictional and TAZ level was provided to all local jurisdictions for comments and inputs. SCAG conducted one-on-one meetings with local jurisdictions. For the RTP-12 forecast, over 90 percent of 195 local jurisdictions provided SCAG with input on growth forecast, existing land use, zoning, and general plan land use. The local input resulted in an imbalance of population and employment for the year 2035. The number of jobs in 2035 was larger than that of available labor supply. SCAG eventually adjusted the 2035 employment downward to achieve a balance of population and employment.

Incorporation of Major Development Projects

SCAG incorporates major development projects with regional significance into the TAZ-level population, household, and employment forecasts to assess their impacts on the long term regional transportation system. Major development projects and related growth estimates generally do not influence the overall growth forecast of the local jurisdiction, but they may influence the growth distribution within local jurisdictional boundaries.

Expert Panel Review

To address the uncertainty created by rapidly changing economic conditions, SCAG regularly consulted with expert panels to develop more realistic and accurate growth forecasts. SCAG annually updated its short term forecasts to reflect the quickly changing conditions between 2009 and 2011 before adopting its official growth forecast in April 2012.

SCAG HOUSEHOLD FORECAST METHODOLOGY

A household includes all the persons who occupy a housing unit as their usual place of residence. According to the U.S. Census Bureau, the count of households or householders is the same as the count of occupied housing units for 100-percent tabulations. Vacant housing units are not included in the household projections.

Consistent with the U.S. Census, SCAG's household data are based on housing structures: single family detached, single family attached, multi-family, mobile homes, and other. Metropolitan uses the following definitions for single family and multi-family (group quarters are not counted as households):

- Single family[9] = single family detached + single family attached
- Multi-family[10] = multi-family + mobile homes + other

[9] Single family attached units (i.e. townhouses) are included in the single family sector because they typically have individual water meters. Many retail agencies classify sectors based on meter type, and this is an attempt to match their single-family classification. One problem with this assumption is that some townhouse communities are partially or completely master metered and may be classified by retail agencies as multi-family or even commercial water use. However, including single family attached in the multi-family projection might create a significant mismatch between Metropolitan's housing projections and how water use is reported at the retail level.

[10] Mobile home communities are typically master metered and are therefore included in the multi-family sector. Multi-family sector excludes group quarters.

Although the U.S. Census and SCAG define single family and multi-family households in terms of housing structure type, water utilities classify household customers by meter connection type. It is important to be aware of this discrepancy because differences in household definitions can result in measurement error when comparing demographic housing data with retail utility customer data.

Headship Rate

The region's households are projected by using projected headship rate. The projected households at a future point in time are computed by multiplying the projected residential population by projected headship rates. Headship rate is the proportion of a population cohort that forms the household.

SCAG EMPLOYMENT FORECAST METHODOLOGY

SCAG uses a multifaceted approach to develop and refine its regional employment forecast. The approach includes the following components:

- Shift-share model to downscale national trends to regional projections (top-down)
- Small area projections based on local data input and review (bottom-up)
- Expert panel review

Top-down method

SCAG forecasts employment using a top-down method known as a shift-share model. Regional job growth projections depend on the number and type of jobs created in the nation and the regional share of these jobs located in California. National population and employment forecasts are used to develop preliminary regional and county-level employment forecasts.

The regional share of national employment is an extrapolation of the historical pattern of the regional share.[11] SCAG determines county shares of the regional time period with a regression analysis of past employment trends using historical data from EDD. After calculating the county totals, SCAG allocates the county estimates among cities based on each city's share of the county's employment level based on data from the local jurisdictions.

SCAG's top-down projection assumes national and state-level economic growth trends will continue and that jobs created in the state will be filled either by the existing labor force, the future local labor force, an increase in local labor force participation, and/or from domestic and international immigrants. In short, this approach assumes local populations grow to fill jobs. Furthermore, there is a constant-share aspect to the model where each jurisdiction's

[11] The RTP-12 assumes the region's share of national jobs to remain at 5.2 percent through the year 2035.

preliminary share of regional jobs for each industry sector is assumed to remain constant throughout the forecast.

Bottom-up method

To avoid relying solely upon national/state-level trends and constant share assumptions as the only premise for regional growth, SCAG also uses a bottom-up approach to refine its projections. Locally-based demographic assumptions and projections may reflect a more realistic trend and short term outlook that a purely top-down shift-share method based on national demographic assumptions. As a check, SCAG reviews local documentation and planning projections to adjust its preliminary projections at the local, county, and regional levels.

Expert Panel Review

To address the uncertainty created by rapidly changing economic conditions, SCAG regularly consulted with expert panels to develop more realistic and accurate growth forecasts. SCAG annually updated its short term forecasts to reflect the quickly changing conditions between 2009 and 2011 before adopting its official growth forecast in April 2012.

NAICS vs. SIC

Metropolitan and SCAG collect historical employment data from EDD. Until the year 1997, EDD data used the Standard Industrial Classification (SIC) system as the basis for the classification of industry. In 1997, EDD switched to North American Industry Classification System (NAICS). NAICS is the product of a cooperative effort of the statistical agencies of the United States, Canada, and Mexico. NAICS focuses on how products and services are created, as opposed to SIC which focuses on what is produced. Using NAICS yields different industry groupings than those produced using SIC. **Table A.1** compares SIC with NAICS.

Table A.1 – Comparison of NAICS and SIC Employment Categories

Metropolitan converts NAICS data categories into SIC categories for its retail demand model for consistency with historical data.

NAICS		SIC	
1	Total Farm (Agriculture & Mining)*	1	Agriculture, Forestry, and Fisheries*
2	Construction	2	Mining Industries*
3	Manufacturing	3	Construction Industries
4	Wholesale Trade	4	Manufacturing
5	Retail Trade	5	Transportation, Communication, and Utilities
6	Transportation, Warehousing & Utilities	6	Wholesale Trade
7	Information	7	Retail Trade
8	Financial Activities	8	Finance, Insurance and Real Estate
9	Professional & Business Services	9	Service Industries
10	Educational & Health Services	10	Public Administration
11	Leisure & Hospitality		
12	Other Services		
13	Government		

*Agricultural and mining-related industries are excluded from Urban Employment

RTP-12 is benchmarked to EDD's 2010 data. Like EDD, SCAG now estimates employment by industry using NAICS. However, Metropolitan's historical data and its previous retail demand projections are based on SIC. In order to maintain consistency with legacy data, Metropolitan converts post-1997 NAICS data categories into SIC categories for its retail demand model.

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Integrated Water Resources Plan Update 2015

Appendix 7

Technical Memo: Methodology for Generating MWDSC Water Demand Forecasts

The Brattle Group

Appendix 7

TECHNICAL MEMO:

METHODOLOGY FOR GENERATING MWDSC WATER DEMAND FORECASTS

January 26, 2015

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Steve Buck, Ph.D.

Prepared for

Metropolitan Water District of Southern California

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I. Motivation for Developing a Revised MWDSC Water Demand Forecasting Model

The current long-term water demand forecasting model, MWD-MAIN, is based on an econometric model of monthly water demand originally developed in the year 1996. The model consists of a separate demand model for each of the single family residential (SFR), multi-family residential (MFR) and the commercial, institutional and industrial (CII) sectors. Each model employs price and consumption data from the year 1980 through 1994, and uses data representative of 12-14 Metropolitan Water District of Southern California's (MWDSC) member agencies.

At the time of its initial development the MWD-MAIN model was arguably the best model that could be estimated to forecast long-term water demands; however, the model is now based on data two to three decades old. There is no evidence that water consumption behavior from the 1980s persists to the 2010s. In fact, there is evidence consumption behavior has changed. For example, the introduction of high efficiency clothes washers has significantly reduced water consumption[1,2]. Adoption of other water efficient technologies and conservation practices also make recent water consumption patterns more relevant for demand modeling than consumption patterns from the 1980s. Further, improvements in record keeping have allowed for more uniform collection of price and consumption data across urban utilities. For example, water price and consumption data in the single family residential sector now exists for all 26 member agencies, and similar data exists for nearly all member agencies in the MFR and CII sectors. The availability of a more spatially expansive dataset strengthens the underlying forecasting assumption that estimated demand relationships are representative of all service areas falling under the umbrella of MWDSC. For these reasons alone, there is sufficient argument to estimate a new water demand forecast model for MWDSC.

[1] Davis, Lucas W. "Durable goods and residential demand for energy and water: evidence from a field trial." The RAND Journal of Economics 39.2 (2008): 530-546.

[2] Tomlinson, J. J., and D. T. Rizy. Bern clothes washer study. Final report. No. ORNL/M--6382. Oak Ridge National Lab., TN (US), 1998.

Consistent with this, the technical report "Development and Verification of Sectorial Water Demand Forecasting Models for the Metropolitan Water District of Southern California"[3], which describes the development of the forecasting models that are the basis for the current MWD-MAIN model, makes an explicit recommendation to gather new utility data and update the demand forecast procedures every two to five years. The same technical report recognizes that "out of sample agencies may have unique patterns of water use that could not be captured in the current [MWD-MAIN] model". Therefore, the technical report recommends expanding the spatial coverage of the modeling database so that all agencies are represented in the development of the forecast model. We summarize the main differences between the old MWD-MAIN model and the new one in Table 1.

Comparison of MWD-MAIN Model and New Model

	MWD-MAIN Model	New Model
Time period of regression data	1980-1992	1994-2009
Spatial coverage of regression data	SFR[a]: 13 Member Agencies MFR[b]: 12 Member Agencies CII[c]: 14 Member Agencies	SFR: 26 Member Agencies MFR: 23 Member Agencies CII: 25 Member Agencies
Periodicity	Monthly	Annual
Price measure	SFR, MFR & CII: Rate at mean level of consumption	SFR: Avg. cost w/ rate on median tier MFR & CII: Rate on median tier

[a]Single Family Residential sector; [b]Multi-Family Residential sector; [c]Commercial, Industrial and Institutional sector.

[3] Kiefer, Jack C., Jerzy W. Kocik and Resources Analysis Unit, Metropolitan Water District of Southern California. "Development and Verification of Sectorial Water Demand Forecasting Models for the Metropolitan Water District of Southern California". Technical Report (August 2010).

II. Overview of Modeling Methods

There exist a variety of methods and models for forecasting urban water demand in the academic and professional literature, including the use of artificial neural networks, time series analysis, simulation, and multivariate regression. Artificial neural networks and time series analysis are often favored in short-term demand analyses, largely because they outperform other methods in the near term in terms of forecasting levels of demand[4][5]. Their use for near-term demand modeling is not surprising since they rely heavily on the recent observed past to predict the near future. The main drawback of these models is that they are almost exclusively statistical in nature, and in that sense, atheoretic with regards to the economic behavior which generates the observed consumption patterns. In contrast, simulation based models such as Demand-Side Management Least-Cost Planning Decision Support System[6] (DSS) assume an underlying economic behavior to make predictions about future consumption. The drawback of these models is that the assumed economic behavior is usually hypothetical instead of being based on observed responses to demand factors. The multiple regression approach we adopt is generally favored by academics and practitioners for long-term water demand analysis because it allows one to use observed demand relationships based on actual behavior to consider the effect of anticipated changes in demand factors on long-term demand[7]. Before describing our regression approach in detail, it is worth discussing two particular modeling choices which make this work distinct from what was done in the past.

First, we consider the periodicity of the data used in the regression analysis. Demand forecasting models have been developed using daily, monthly and annual consumption observations. When forecasting out 10 years or more, it is most common to use an annual time-step because the demand factor variables typically considered (e.g., rates, income, population) generally do not vary significantly over shorter periods, and even if they do, there generally does not exist data on a sub-annual time scale. Further, if a monthly time-step is used then there is likely a high degree of intra-cluster correlation within a retailer, within a

[4] Herrera, Manuel, et al. "Predictive models for forecasting hourly urban water demand." Journal of Hydrology 387.1 (2010): 141-150.

[5] Zhou, Sen-Lin, et al. "Forecasting daily urban water demand: a case study of Melbourne." Journal of Hydrology 236.3 (2000): 153-164.

[6] Created by Maddaus Water Management, Alamo, California.

[7] Donkor, E., Mazzuchi, T., Soyer, R., and Roberson, J.. 2012 . "Urban Water Demand Forecasting: A Review of Methods and Models". *J. Water Resour. Plann. Manage.*.

year so that the standard errors will be downward biased (i.e., too small)[8]. As has been discussed in applied econometric work evaluating clustered data, when there is a high degree of intra-cluster correlation in a data set, then the number of observations effectively collapses to the number of clusters.

In theory there is no significant difference between estimating the model at the monthly versus annual level; however, there are two practical reasons for estimating the model at the annual level. First, retailers keep more accurate records at the annual time step than they do at the monthly time step. This is a consequence of the labor intensive activity of meter reading, which takes place across a month. Therefore, recorded monthly meter readings do not correspond to actual month-to-month consumption. Second, precisely because it is hard to keep accurate monthly records (and perhaps for other administrative reasons), monthly level consumption data is not as readily available for many retailers. One advantage of estimating the regression at the monthly level is the inclusion of monthly weather patterns. From a practical standpoint, weather is likely orthogonal to our demand factors of interest (price, income, lot size) once accounting for climate (e.g., high income earners choose to live in places with nice climate, not nice weather). In summary, there are clear empirical advantages to estimating the model at an annual time-step instead of a monthly time-step, which is why we opt for the former in this current analysis.

In addition to periodicity, another modeling decision which deserves some discussion at the outset is the choice of a price variable. Standard practice is to consider a marginal price of water for estimating demand; however, there is evidence that consumers may respond the average cost of a unit of water[9]. Consistent with this, numerous studies on residential water demand have measured price with an average cost measure[10]. In preliminary analysis we found evidence favoring the explanatory power of the average unit cost (price) as opposed to a measure of marginal cost (price). Based on the literature and our own finding we determined to measure price using the average unit cost in the single family residential sector. We did not use an average cost measure for the MFR and CII sectors as we did not have the data necessary to calculate such a measure. This choice is consistent with theoretical arguments as well; the theory that consumers respond to average price is less appropriate for firms and landlords, which have an explicit objective to minimize costs for a given profit level.

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[8] Cameron, A. Colin, and Pravin K. Trivedi. "Chapter 24: Stratified and Clustered Samples", Microeconometrics: Methods and Applications. Cambridge University Press, NY, 2005.

[9] Ito, Koichiro. November 2012. "Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing". National Bureau of Economic Research Working Paper No. 18533.

[10] Arbues, Fernando, Maria Angeles Garcia-Valinas, and Roberto Martinez-Espineira. 2003. "Estimation of residential water demand: a state-of-the-art review". Journal of Socio-Economics 32, p. 81-102.

A second choice regarding the definition of price relates to how one defines marginal prices, which is necessary for the calculation of average unit price in the SFR sector (and equivalent to defining price in the MFR and CII sectors). Historically, utilities have often offered a uniform price schedule, in which case, the choice of the marginal price definition is a simple one. However, it is common for utilities to use tiered rate schedules, making the choice of the representative marginal rate less obvious. One candidate is the price charged at the mean monthly consumption level; this is the approach used in the MWD-MAIN model. The concern with this approach is that the mean consumption level is by definition a function of consumption; hence, using price at the mean monthly consumption level is clearly endogenous. Instead, in the current analysis we use the price on the median tier of the rate schedule as our measure of marginal price. The advantage of this approach is that the measure is determined prior to the consumption decision, and so does not face the same endogeneity problems as a marginal price measure corresponding to the mean level of consumption.

There are, of course, other essential details to consider when developing a forecast model, and we describe those at length in the remainder of this report.

III. Sample Selection & Data Collection

We determined to focus our data collection on water retailers that reported more than 3,000 single-family residential accounts. According to Public Water System Statistics (PWSS) 2010 survey[11], there are 153 water retailers residing within the MWDSC service area which have over 3,000 SFR accounts, and we estimate that these retailers comprise 99% of all SFR accounts in MWDSC. The data used to develop our models was collected between August 2011 and June 2012. We contacted all 153 retailers reporting more than 3,000 SFR accounts in 2010[12] and requested annual price and consumption data from the 1994-95 Fiscal Year (FY) through the 2010-11 FY for each of the SFR, MFR and CII sectors. Because the SFR sector represents the largest share of water consumption in MWDSC we focused efforts to ensure that retailers provided consumption and price data for the SFR sector. We estimate that the data collected represents over 80% of all SFR accounts in the MWDSC service area; the final SFR dataset includes 1,225 observations from all 26 MWD member agencies. Regarding the MFR sector, we have usable data from 53 retailers, which includes 469 observations from 23 of the 26 member agencies. The three unrepresented retailers (San Marino, Compton and Foothill) are among the four smallest member agencies in terms of MFR housing units. The water rates in the MFR sector are in almost all instances identical to the rates charged in the SFR sector. The consumption data for the MFR sector is based on monthly data reported to the PWSS, and is aggregated to the calendar year. Finally, in the CII sector we have usable data from 75 retailers, which includes 709 observations from 25 of the 26 member agencies; the only unrepresented member agency is San Marino which likely has one of the lowest CII sectors of all member agencies. The CII rate schedules were received directly from retailers; consumption data for the CII sector is based on monthly data reported to the PWSS, and is aggregated to the calendar year. The CII consumption data is augmented with data received directly from retailers. Collectively, this data is perhaps the most comprehensive urban water demand data set ever collected in California.

An equally important objective of the data collection effort was to ensure the reliability of the observations included in the generation of the forecast model. We graphically inspected data within each retailer at the annual time step for the following variables: rate, retailer level aggregate consumption, number of accounts data for each retailer; we also inspected the implied average water use per SFR household, per MFR household and per employee.

[11] When data was not available from the PWSS we used UWMPs from 2005 or 2010 to estimate the number of SFR accounts.

[12] In some instances data was publicly available through the Public Water Systems Statistics or could be downloaded directly from a retailer's website. In these cases we did not directly contact the retailer unless we had a question regarding the publicly available data.

Extreme outliers were deleted from the dataset. In order to minimize the effect of any remaining anomalous data points we consider a robust regression estimation routine which gives less weight to anomalous data points when estimating regression coefficients[13].

In addition to historical rate, consumption and account data we also collected historical data on conservation, socio-demographic, economic and climate characteristics of each retailer included in our analysis. Details on these other data sources can be found in Appendix A.

[13] Greene, William. 2011. Chapter 9: The Generalized Regression Model and Heteroscedasticity". Econometric Analysis, 7th Edition. **We opt for the Ordinary Least Squares estimator for the econometric model of multi-family residential demand.**

IV. Single Family Residential Water Demand Model

We model SFR water demand as a function of price, weather, retailer level housing and socio-demographic characteristics, and member agency level fixed effects. We select a parsimonious regression model for forecasting SFR water demand that accounts for common determinants of water demand. Further, all explanatory variables in our empirical model are in logarithmic form which allows us to interpret their corresponding regression coefficients as elasticities. Each of these elasticities tells us how much a one percent change in the relevant explanatory variable relates to a percentage change in the outcome variable, average monthly household water consumption. The explicit functional form of the empirical model is described by the following regression equation:

$$\ln\left(q_{ijt}^{SFR}\right) = \alpha_1 \ln(ap_{it}) + \alpha_2 \ln(ap_{it}) \cdot \ln(lot\ size_i) + \alpha_3 W_{it} + \alpha_3 X_i + \mu_j^{SFR} + \varepsilon_{ijt}$$

where the dependent variable is the natural logarithm of the average monthly household water consumption (ccf), $\ln\left(q_{ijt}^{SFR}\right)$, in the SFR sector for retailer *i* of member agency *j* in year *t*. This is a pre-conservation measure of consumption. We construct q_{ijt}^{SFR} by taking the total retailer SFR demand reported within a fiscal year and dividing this by 12 to recover average monthly retailer SFR demand. We divide the average monthly retailer SFR demand by the reported number of SFR accounts to recover the average monthly SFR household demand within a retailer for a given year. Next, we subtract monthly conservation savings per SFR household to recover a measure of pre-conservation demand. The right hand side variables are as follows:

- ap_{it} is the average price per ccf for retailer *i* of year *t* with average price measured as the average total cost per ccf inclusive of fixed charges and surcharges. We choose average total cost per ccf as the relevant measure of price based on its explanatory power. There is also evidence which suggests that consumers may respond to measures of average price as a proxy for marginal price rather than responding to the true marginal price[14]. There are also theoretical grounds for letting regions vary in their price responsiveness. For example, areas with larger median lot sizes have more outdoor water use and that outdoor water use has a lower marginal value than indoor water use; therefore, areas with larger median lot sizes would be more forthcoming in

[14] Ito, Koichiro. November 2012. "Do Consumers Respond to Marginal or Average Price? Evidence from Nonlinear Electricity Pricing". National Bureau of Economic Research Working Paper No. 18533.

demand reduction as a response to a price increase[15]. Consistent with this economic logic, we interact our price measure with a retailer-level measure of median lot size ($lot\ size_i$) on the basis that areas with larger median lot sizes may be more price responsive. Retailer specific average price elasticities for each retailer *i* can be recovered by taking the first derivative of the regression equation with respect to $\ln(ap_{it})$. Taking this derivative yields the following expression: $\text{average price elasticity}_i = \alpha_1 + \alpha_2 \ln(lot\ size_i)$.

- W_{it} represents measures of weather for retailer *i* in year *t* and includes both the natural logarithm of annual precipitation and the natural logarithm of annual average daily maximum temperature. These are measures of weather that are likely to affect water demand. Notably, we select annual average daily maximum temperature rather than summer average daily maximum temperature because the former has more explanatory power.

- X_i represents measures of housing and socio-demographics for retailer *i* and includes the natural logarithm for the variables median lot size for single family residences, median household income, and average household size.

- μ_j^{SFR} represents member agency specific intercepts (constant terms often referenced as fixed effects). These member agency fixed effects account for all time-invariant unobservable factors common to a retailer.

- ε_{ijt} is an error term which includes the effects of all remaining unobserved factors in retailer *i*, member agency *j*, or year *t* affecting the outcome variable.

The ideal criteria for selecting a forecast model would be to measure its performance at predicting future consumption, but this is an impossible task. Absent such a performance measure we select the above model based on a combination of statistical and economic considerations including the explanatory power of the forecasting covariates (price, income, average household size), the overall explanatory power of the model, the range of implied price elasticities, and general consistency of the model with economic logic. Regarding the statistical criteria, the coefficients on all of the covariates are statistically significant at conventional levels and the model has an R-squared of 0.7. Regarding the economic criteria, the majority of implied price elasticities lie between 0 to -.5 which is similar to the range of estimates found in the water demand literature. Further, the signs of the other variables accord with economic thought. For example, water demand is higher in areas with larger

[15] Mansur, Erin T., and Sheila M. Olmstead. "The value of scarce water: Measuring the inefficiency of municipal regulations." Journal of Urban Economics (2011).

median lot size. These areas are also more responsive to price changes, which is consistent with the convention that outdoor water use has a lower marginal value than indoor water use.

Table 1. Single-Family Residential: Robust Regression w/ Member Agency specific intercepts

Dependent variable: SFR avg. monthly household consumption (ccf) - pre-conservation						
Variable	Coef.	Std. Err.	t-stat	p-value	[95% Conf.	Interval]
ln(total avg. cost)	4.18	0.46	9.04	0.00	3.27	5.09
ln(total avg. cost)xln(median lot size)	-0.49	0.05	-9.40	0.00	-0.59	-0.39
ln(annual precipitation)	-0.02	0.01	-2.41	0.02	-0.04	0.00
ln(avg. max. temperature)	0.95	0.11	8.44	0.00	0.73	1.17
ln(median income)	0.29	0.03	11.07	0.00	0.24	0.34
ln(avg. household size)	0.10	0.05	1.93	0.05	0.00	0.21
ln(median lot size)	0.69	0.03	20.06	0.00	0.63	0.76
Anaheim	-10.81	0.91	-11.86	0.00	-12.60	-9.03
Beverly Hills	0.55	0.08	7.12	0.00	0.40	0.70
Burbank	0.19	0.07	2.83	0.01	0.06	0.32
Calleguas MWD	0.02	0.05	0.34	0.74	-0.08	0.12
Central Basin MWD	-0.11	0.05	-2.16	0.03	-0.20	-0.01
Compton	-0.25	0.14	-1.75	0.08	-0.52	0.03
Eastern MWD	-0.15	0.06	-2.36	0.02	-0.28	-0.03
Foothill MWD	0.22	0.06	3.53	0.00	0.10	0.34
Fullerton	-0.04	0.07	-0.68	0.50	-0.17	0.08
Glendale	0.06	0.08	0.68	0.50	-0.11	0.22
IEUA	0.22	0.05	4.14	0.00	0.11	0.32
Las Virgenes MWD	0.12	0.07	1.69	0.09	-0.02	0.25
Long Beach	-0.08	0.07	-1.10	0.27	-0.21	0.06
Los Angeles	0.05	0.07	0.77	0.44	-0.09	0.19
MWDOC	-0.08	0.05	-1.69	0.09	-0.17	0.01
Pasadena	0.01	0.07	0.08	0.93	-0.13	0.15
San Diego CWA	-0.17	0.05	-3.32	0.00	-0.28	-0.07
San Fernando	0.00	0.08	0.06	0.95	-0.16	0.17
San Marino	-0.36	0.07	-5.04	0.00	-0.49	-0.22
Santa Ana	-0.05	0.07	-0.83	0.41	-0.18	0.07
Santa Monica	-0.02	0.08	-0.31	0.76	-0.17	0.13
Three Valleys MWD	-0.02	0.05	-0.39	0.70	-0.13	0.09
Torrance	-0.15	0.09	-1.64	0.10	-0.32	0.03
Upper San Gabriel Valley MWD	0.04	0.05	0.74	0.46	-0.06	0.14
West Basin MWD	-0.02	0.05	-0.28	0.78	-0.12	0.09
Western MWD	-0.05	0.05	-0.87	0.38	-0.15	0.06
Observations	1225		R-squared	0.70		

Note: Regression coefficients for the Member Agency specific intercepts Beverly Hills through Western MWD are all relative to Anaheim.

V. Multi-Family Residential Model

We model MFR water demand as a function of price, retailer level socio-demographic characteristics, and member agency level fixed effects. Similar to the SFR sector, we select a parsimonious regression model for forecasting MFR water demand that accounts for common determinants of water demand. Again, all explanatory variables in our empirical model are in logarithmic form which allows us to interpret their corresponding regression coefficients as elasticities. The explicit functional form of the empirical model is described by the following regression equation:

$$\ln\left(q_{ijt}^{MFR}\right) = \beta_1 \ln\left(mp_{it}^{MFR}\right) + \beta_2 Z_i + \mu_j^{MFR} + \vartheta_{ijt}$$

where the dependent variable, $\ln\left(q_{ijt}^{MFR}\right)$, is the natural logarithm of the average monthly household water consumption (ccf) in the MFR sector for retailer *i* of member agency *j* in year *t*. We construct q_{ijt}^{MFR} by taking the total retailer MFR demand reported within a fiscal year and dividing this by 12 to recover average monthly retailer MFR demand. We divide the average monthly retailer MFR demand by the number of MFR households to recover the average monthly MFR household demand within a retailer for a given year. The total number of MFR households within a retailer in a given year is calculated based on Census tract count data from the 2000 Census and annual count data from 1990 – 2010 at the member agency level provided by MWDSC. We use geographic information systems software to aggregate Census tract MFR count data to a given retailer *i*. In a second step, we calculate the share in year 2000 of MFR households in member agency *j* which are located in retailer *i*; call this share s_i and assume it is constant across all years between 1994 – 2010. We calculate retailer specific counts of MFR households for each year by multiplying the member agency MFR counts received from MWDSC by s_i. Finally, we obtain pre-conservation demands by subtracting monthly conservation savings per SFR household. The right hand side variables are as follows:

- mp_{it}^{MFR} is the median tier price per ccf for retailer *i* of year *t* with median tier price measured as the price on the median tier of the retailer's rate schedule; this price measure is inclusive of volumetric surcharges but does not incorporate any fixed fees. For empirical reasons, we choose the median tier price as the relevant measure of price for the MFR sector. In particular, there is no reliable way to calculate an average price at the household level because fixed charges are assigned to a service account. Because we do not observe the number of households per service account, we are unable to calculate the average price measure used in the SFR sector.

- Z_i represents measures of socio-demographics for retailer *i* and includes the natural logarithm of the variables median household income, median lot size, and average household size.
- μ_j^{MFR} represents member agency specific intercepts (constant terms often referenced as fixed effects). These member agency fixed effects account for all time-invariant unobservable factor common to a retailer.
- ϑ_{ijt} is an error term which includes the effects of all unobserved factors in retailer *i*, member agency *j*, or year *t* affecting the outcome variable.

As in the model for the SFR sector, we select the MFR model based on a combination of statistical and economic considerations including the explanatory power of the forecasting covariates (price, income, lot size, average household size, the overall explanatory power of the model), the overall explanatory power of the model, the implied price elasticities, and the general consistency of the model with economic logic. Regarding the statistical criteria, the coefficients on price, income, median lot size and average household size are all statistically significant. The model has predictive power within sample as indicated by an R-squared of 0.56. Regarding the economic criteria, we expect the MFR sector to be less price responsive given that multi-family households rarely see their water bills. Consistent with this, the implied price elasticity in the MFR sector is -0.11. Further, the signs of the variables income and average household size accord with economic thought. For example, water demand is higher in areas with larger median income with an income elasticity of 0.166.

Table 2. Multi-Family Residential: Regression w/ Member Agency specific intercepts

Dependent variable: MFR avg. monthly household consumption (ccf) - pre-conservation						
	Coef.	Std. Err.	t-stat	p-value	[95% Conf.	Interval]
ln(median tier price)	-0.11	0.04	-3.16	0.00	-0.18	-0.04
ln(median income)	0.17	0.06	2.88	0.00	0.05	0.28
ln(median lot size)	0.16	0.03	5.77	0.00	0.10	0.21
ln(avg. hh size in mfr sector)	0.14	0.08	1.76	0.08	-0.02	0.30
Anaheim	0.79	0.27	2.91	0.00	0.26	1.33
Beverly Hills	-0.39	0.13	-3.04	0.00	-0.65	-0.14
Burbank	-0.33	0.15	-2.15	0.03	-0.63	-0.03
Calleguas MWD	-0.22	0.08	-2.71	0.01	-0.38	-0.06
Central Basin MWD	0.22	0.08	2.85	0.01	0.07	0.37
Eastern MWD	-0.20	0.09	-2.20	0.03	-0.37	-0.02
Fullerton	-0.03	0.08	-0.38	0.70	-0.20	0.13
Glendale	-0.18	0.10	-1.80	0.07	-0.37	0.02
IEUA	0.32	0.12	2.59	0.01	0.08	0.56
Las Virgenes MWD	-0.03	0.09	-0.34	0.73	-0.21	0.15
Long Beach	-0.07	0.09	-0.75	0.45	-0.25	0.11
Los Angeles	-0.12	0.09	-1.27	0.20	-0.30	0.06
MWDOC	-0.21	0.07	-2.91	0.00	-0.35	-0.07
Pasadena	-0.17	0.15	-1.07	0.28	-0.47	0.14
San Diego CWA	-0.38	0.08	-4.82	0.00	-0.53	-0.22
San Fernando	-0.50	0.15	-3.33	0.00	-0.79	-0.20
Santa Ana	0.11	0.11	0.99	0.32	-0.11	0.32
Santa Monica	-0.50	0.10	-5.20	0.00	-0.69	-0.31
Three Valleys MWD	0.13	0.08	1.73	0.08	-0.02	0.28
Torrance	-0.30	0.13	-2.29	0.02	-0.56	-0.04
Upper San Gabriel Valley MW	0.23	0.10	2.29	0.02	0.03	0.43
West Basin MWD	-0.43	0.10	-4.32	0.00	-0.62	-0.23
Western MWD	-0.02	0.08	-0.26	0.80	-0.18	0.14
Observations	469		R-squared	0.56		

Note: Regression coefficients for the Member Agency specific intercepts Beverly Hills through Western MWD are all relative to Anaheim.

VI. Commercial, Institutional and Industrial Model

We model CII water demand as a function of price, weather, share of employment in the manufacturing sector and member agency level fixed effects. Similar to the residential sectors, we select a parsimonious regression model for forecasting CII water demand that accounts for common determinants of water demand. Again, all explanatory variables in our empirical model are in logarithmic form (except manufacturing share) which allows us to interpret their corresponding regression coefficients as elasticities. The explicit functional form of the empirical model is described by the following regression equation:

$$\ln\left(q_{ijt}^{CII}\right) = \gamma_1 \ln\left(mp_{it}^{CII}\right) + \gamma_2 WC_{it} + \gamma_3 MS_{it} + \gamma_4 \ln\left(mp_{it}^{CII}\right) * MS_{it} + \mu_j^{CII} + \delta_{ijt}$$

where the dependent variable, $\ln\left(q_{ijt}^{CII}\right)$, is the natural logarithm of the average annual water consumption (ccf) per employee in the CII sector for retailer *i* of member agency *j* in year *t*. We construct q_{ijt}^{CII} by taking the total retailer CII demand reported within a calendar year and dividing by the number of employees to recover the average annual water demand per employee within a retailer for a given year. The total number of employees within a retailer in a given year is calculated based on annual non-governmental employee count data provided at the zip code level from the annual Zip Code Business Statistics prepared by the U.S. Census Bureau, and annual total employee count data provided at the member agency level received from MWDSC. We use geographic information systems software to aggregate zip code level non-governmental employee count data to a given retailer *i* and to its corresponding member agency *j*. In a second step, we use the aggregated zip code data to calculate for each year the share (σ_i) of non-governmental employees in member agency *j* which reside in retailer *i* (that is, the numerator is the count of non-governmental employees in retailer *i* and the denominator is the count of non-governmental employees in member agency *j*). Next, we assume the share (σ_i) of non-governmental employees in member agency *j* residing in retailer *i* is equivalent to the share of total employees in member agency *j* residing in retailer *i*. We multiply the member agency level total employee count measure received from MWDSC by σ_i to recover the comparable total employee count in retailer *i*. Next we divide the total reported CII demand within a retailer by the retailer level total employee count. Finally, we obtain pre-conservation demands by subtracting conservation savings per employee to compute our dependent variable, annual pre-conservation water consumption per employee, q_{ijt}^{CII}. The right hand side variables are as follows:

- mp_{it}^{CII} is the median tier price per ccf for retailer *i* of year *t* with median tier price measured as the price on the median tier of the retailer's CII rate schedule; this price measure does not include volumetric surcharges or fixed fees. We choose the median tier price as the relevant measure of price for the CII sector for theoretical reasons. Businesses use water on a much larger scale than individual households, and therefore may benefit from dedicating more resources to identifying the optimal level of water use; such an optimization problem depends on marginal price rather than average price. We do not include volumetric surcharges because they are not reliably reported for this sector. However, based on follow-up investigation we do not think this significantly affects our results because surcharges represent a small fraction of the marginal price.

- WC_{it} represents measures of weather for retailer *i* in year *t* and includes both the natural logarithm of annual average daily maximum temperature and cooling degree days. These are measures of weather that are likely to affect water demand.

- MS_{it} represents the share of employment within the service area working in the manufacturing sector.

- μ_j^{CII} represents member agency specific intercepts (constant terms often referenced as fixed effects). These member agency fixed effects account for all time-invariant unobservable factor common to a retailer.

- δ_{ijt} is an error term which accounts for all unobserved factors in retailer *i*, member agency *j*, or year *t* affecting the outcome variable.

As in the models for the residential sectors, we select the CII model based on a combination of statistical and economic considerations including the explanatory power of the forecasting covariates (price, cooling degree days), the overall explanatory power of the model, the implied price elasticities, and the general consistency of the model with economic logic. Regarding the statistical criteria, the coefficients on price, cooling degree days, temperature and manufacturing share are statistically significant at conventional levels and the model has an R-squared of 0.55. Regarding the economic criteria, the implied median elasticity is -0.43.

Table 3. Commercial, Industrial & Institutional: Regression w/ Member Agency specific intercepts

Dependent variable: CII avg. annual water-use per employee (ccf) - pre-conservation

	Coef.	Std. Err.	t-stat	p-value	[95% Conf.	Interval]
ln(median tier price)	-0.43	0.13	-3.22	0.00	-0.70	-0.17
ln(cooling degree days)	0.11	0.05	2.33	0.02	0.02	0.20
ln(avg. max. temperature)	0.34	0.27	1.26	0.21	-0.19	0.87
Share of employment in manuf.	0.93	0.74	1.26	0.21	-0.52	2.38
ln(median tier price)xShare of employment in manuf.	2.65	0.90	2.95	0.00	0.89	4.40
Anaheim	1.47	2.08	0.70	0.48	-2.62	5.56
Beverly Hills	-1.32	0.24	-5.55	0.00	-1.79	-0.85
Burbank	-0.83	0.18	-4.60	0.00	-1.19	-0.48
Calleguas MWD	-0.24	0.16	-1.50	0.13	-0.54	0.07
Central Basin MWD	-0.35	0.15	-2.27	0.02	-0.65	-0.05
Compton	-2.49	0.24	-10.25	0.00	-2.97	-2.01
Eastern MWD	-0.75	0.17	-4.31	0.00	-1.09	-0.41
Foothill MWD	0.07	0.20	0.36	0.72	-0.33	0.48
Fullerton	-0.20	0.18	-1.13	0.26	-0.54	0.15
Glendale	-0.79	0.20	-3.98	0.00	-1.18	-0.40
IEUA	-0.12	0.17	-0.71	0.48	-0.45	0.21
Las Virgenes MWD	-1.19	0.18	-6.69	0.00	-1.54	-0.84
Long Beach	-0.32	0.18	-1.79	0.07	-0.66	0.03
Los Angeles	-0.27	0.18	-1.47	0.14	-0.62	0.09
MWDOC	-0.28	0.16	-1.82	0.07	-0.59	0.02
Pasadena	-1.95	0.24	-8.01	0.00	-2.42	-1.47
San Diego CWA	-0.58	0.16	-3.67	0.00	-0.90	-0.27
San Fernando	-1.16	0.19	-6.05	0.00	-1.54	-0.79
Santa Ana	-0.78	0.21	-3.72	0.00	-1.20	-0.37
Santa Monica	-0.94	0.19	-4.95	0.00	-1.31	-0.57
Three Valleys MWD	-0.49	0.16	-3.03	0.00	-0.81	-0.17
Torrance	-0.50	0.23	-2.18	0.03	-0.96	-0.05
Upper San Gabriel Valley MWD	-0.74	0.16	-4.58	0.00	-1.05	-0.42
West Basin MWD	-0.97	0.17	-5.60	0.00	-1.31	-0.63
Western MWD	-0.29	0.16	-1.77	0.08	-0.61	0.03
Observations	709		R-squared	0.55		

Note: Regression coefficients for the Member Agency specific intercepts Beverly Hills through Western MWD are all relative to Anaheim.

VII. Implementation and Summary of Resulting Forecasts

IMPLEMENTATION OF THE FORECAST MODEL

The sectorial models estimated in this technical memo can be organized in spreadsheets to calculate forecasts in a relatively straight-forward manner. Step-by-step instructions for the implentation of forecasts are provided in Appendix B.

SUMMARY OF FORECASTS

Tables 4 and 5 summarize the resulting water demand forecasts in five year increments between the year 2015 and 2050 with the year 2013 as the base year. In Table 4 we observe demands aggregated to the level of Metropolitan's service area. The M&I demands recorded in the final column reflect total aggregate demand less system losses; the measure accounts for passive conservation savings. The implied growth in percentage terms between the year 2015 and the year 2040 is close to 6%.

Table 4. Summary of M&I demands (AF) by sector--excluding system losses

Year	SFR	MFR	CII	M&I Total
2013*	1,909,648	630,960	741,884	3,282,492
2015	1,944,782	645,244	799,378	3,389,404
2020	1,953,576	661,988	814,489	3,430,053
2025	1,915,769	706,009	822,744	3,444,523
2030	1,926,562	731,203	827,908	3,485,673
2035	1,950,281	751,921	822,288	3,524,490
2040	1,965,909	783,831	826,401	3,576,142
2045	1,983,610	811,039	824,930	3,619,579
2050	2,000,281	837,861	822,530	3,660,673

*The sum of the year 2013 SFR, MFR and CII are identical to the MWD's recorded 2013 M&I water-use less system losses.
SFR = Single Family Residential
MFR = Multi-family Residential
CII = Commercial, Industrial and Institutional

In Table 5 we observe the M&I demands reported in the final column of Table 4 disaggregated to the Member Agency level. There is significant heterogeneity in growth with agencies growing between -15% and 33% between the year 2015 and the year 2040.

Table 5. Summary of M&I demands (AF) by MWD Member Agency and year--excludes system losses

Agency	2013*	2015	2020	2025	2030	2035	2040	2045	2050
Anaheim	63,692	65,810	66,447	66,795	68,239	69,059	70,499	71,285	71,919
Beverly Hills	11,340	11,538	11,299	11,025	10,826	10,651	10,737	10,806	10,862
Burbank	20,826	21,339	21,504	21,161	20,926	20,749	20,963	21,152	21,340
Calleguas MWD	140,452	145,753	148,957	147,818	148,003	148,210	149,934	151,565	153,094
Central Basin MWD	201,002	206,586	205,948	203,481	203,034	202,520	206,125	209,395	212,482
Compton	6,332	6,360	6,196	6,005	5,864	5,763	5,868	5,965	6,056
Eastern MWD	168,538	178,760	192,707	205,947	220,796	235,920	238,031	239,979	241,995
Foothill MWD	18,337	18,683	18,378	18,101	17,994	17,840	17,788	17,837	17,870
Fullerton	28,015	28,710	28,121	29,141	31,119	30,927	31,259	31,603	31,884
Glendale	28,657	29,444	29,586	29,301	29,260	29,243	29,826	30,403	30,976
IEUA	220,301	231,379	241,018	252,879	262,261	270,788	274,404	277,384	280,126
Las Virgenes MWD	27,534	28,005	27,390	26,888	26,494	26,209	26,216	26,165	26,064
Long Beach	59,263	60,984	60,585	59,944	60,033	60,217	61,225	62,160	63,093
Los Angeles	540,311	553,389	542,330	530,242	530,405	534,291	540,993	546,831	552,452
MWDOC	415,208	428,188	427,539	425,492	423,399	419,713	429,109	435,613	441,262
Pasadena	30,489	31,053	30,768	30,616	30,556	30,693	31,035	31,333	31,608
San Diego CWA	546,902	560,185	578,952	589,449	600,668	610,938	621,784	631,157	640,558
San Fernando	2,543	2,601	2,539	2,500	2,477	2,458	2,484	2,511	2,535
San Marino	4,929	4,974	4,799	4,647	4,500	4,354	4,353	4,341	4,320
Santa Ana	38,376	39,172	37,934	36,077	35,454	34,621	35,392	35,869	36,245
Santa Monica	12,714	13,003	11,755	11,346	11,111	10,976	11,061	11,125	11,186
Three Valleys MWD	120,055	124,159	126,991	126,355	126,880	127,492	129,154	130,578	131,922
Torrance	27,502	28,319	28,275	27,943	27,842	27,703	28,166	28,583	28,980
USGV	157,725	161,191	160,042	158,511	157,574	156,836	158,892	160,657	162,299
West Basin MWD	149,941	152,705	151,002	147,852	146,725	146,127	148,089	149,857	151,479
Western MWD	241,510	257,114	268,990	275,006	283,235	290,194	292,757	295,427	298,066

*The agency-specific M&I demands for the year 2013 are equal to the 2013 MWD recorded M&I demands less system losses.

Appendix A: Description of Data Used for Developing MWDSC Forecasts

Summary. We develop a water demand forecast model for the service area of Metropolitan Water District of Southern California. Our model generates sector specific forecast for the single family residential, multi-family residential (MFR) and commercial, institutional and industrial sectors (CII). Existing models, such as the MWD MAIN models, of MWDSC water demand are based on data from 1980 – 1994, and the data for these models is not widely representative of the entire service area. The basis for our new model is a comprehensive data collection effort which resulted in urban water demand and rate data for the years 1994 to 2010 from over 100 urban retailers in the MWDSC service area. The data we collected represents over 80% of all single family residential accounts in the MWDSC service area; collectively our data is perhaps the most comprehensive urban water demand data set ever collected in California. Data for the MFR and CII sectors are less comprehensive than the SFR sector, but these newly collected data still represent a significant improvement over the data used in the MWD-MAIN model. Overall, the data represents 26 member agencies for the SFR sector; 23 member agencies for the MFR sector; and 25 member agencies for the CII sector.

The remainder of this appendix describes the variables used in the regression models and those variables used to generate forecasts out to the year 2035.

Database Development. We assume that demand for water in the future will be largely driven by the largest users of water today. The single family residential sector is the largest sector for all retailers in MWSDC; therefore, we focused our data collection to water retailers which reported more than 3,000 single-family residential accounts. This is consistent with the strategy employed by the California Department of Water Resources in their Public Water System Survery (PWSS); they only require water utilities with more than 3,000 SFR accounts to reply to their survey. According to water demands in 2010, water retailers residing within MWDSC service area and having over 3,000 SFR accounts comprise 99% of all SFR accounts in MWDSC. The data used to develop our models was collected between August 2011 and June 2012.

We develop a database consisting of retailer specific measures of water demand, water rates, water customer accounts, population, weather, household income, household density, household lot size, vintage of housing stock, employment and residential conservation savings. These data form the basis for the regression data set used to estimate the regression forecast models. The unit of analysis in each regression is the retailer at annual time step; all explanatory variables are reported at the annual time step.

REGRESSION DATA

Consumption. Data on deliveries and number of accounts for each of the single family residential, multi-family residential and CII sectors were provided by the individual retailers, where available, or from the MWDSC annual survey if our data request was not successful. Consumption data was usually recorded monthly or by Fiscal Year. This was convenient since the Fiscal Year corresponds to when most retailers change their rates. When we received monthly data, then we aggregated it to the annual time step so that consumption tracked rates changes. If we received data at the calendar year and rates changed mid-year, then we took the average of calendar years. In cases where we could not obtain data directly from the retailer or MWDSC, the Public Water Systems Statistics database was used. The Public Water Systems Statistics survey is maintained by the California Department of Water Resources, and has consumption data by sector for most retailers with greater than 3,000 single family residential accounts. In the SFR sector, we calculated average monthly household consumption (ccf) by dividing deliveries by the number of retailer reported accounts, and dividing by 12. In the MFR sector, retailers did not report the number of accounts so we had to rely on Census based estimates of the total number of occupied multi-family residential housing units. We calculate average monthly household consumption (ccf) in the MFR sector by dividing reported deliveries by historical estimates of the number of multi-family residential housing units. In the CII sector, we calculate units per employee at the annual level by dividing reported total CII deliveries by historical estimates of the total number of employees within a retailer (see employment description below for calculation of total employees at the retailer level). The consumption measures described above are all post-conservation. However, as described in the Appendix B, the dependent variable in each of the regression models is a pre-conservation measure of demand. Thus, each of these post-conservation demand measures is adjusted to recover measures of pre-conservation demand.

Conservation savings. The measures of conservation savings are sector-specific for each of the single family residential, multi-family residential and commercial, industrial & institutional sectors. The measures of conservation savings are based on passive conservation savings reported in Metropolitan's water conservation model. This model provides historical measures of conservation savings based on historical estimates of users (single family units, multi-family units and employees).

Price: Total Average Cost and Median Tier Rate. For the SFR sector we price as the total average cost rather than a measure of marginal price. We calculate total average cost per ccf by computing the monthly average consumption within a retailer and the total cost (inclusive of access fees, surcharges and tiered rates structures), and then taking their ratio. Retailer monthly average consumption was taken to be *qu*. For data on rates, we contacted individual water retailers directly for data on rates. When rate data could not be provided, we relied on the MWDSC annual survey or the SDCWA survey. Using data we gathered on average monthly household consumption and rates, we calculated monthly bills, per account, for each agency, taking into account tiered rating schemes, meter charges and surcharges. We then divided the monthly bill per account by average monthly household consumption to get the total average cost per unit (ccf) per account. We convert all observations of the total average cost per ccf into year 2000 real dollars. For the MFR and CII sectors we are unable to calculate a total average costs measure, and so we calculate price on the median tier of the rate schedule; rates are reported in year 2000 real dollars.

***Precipitatio*n.** Data on average precipitation were obtained through the use of the geographical information and mapping software system, ArcGIS. We obtained spatially referenced boundaries of state and private water districts from the Cal-Atlas geospatial clearinghouse.[16] These boundaries allowed us to visualize each water district polygon using ArcGIS. We then geo-referenced points at the centroid of each water system polygon, and, based on the resulting set of points, extracted local precipitation data from rasters provided by the PRISM Climate Group.[17]

We were not able to obtain water district boundaries for all retailers included in our model. In such cases, zip codes were used as a geographical proxy. Retailers were assigned representative zip codes on a case by case basis. We then geo-referenced points at the centroid of each zip code polygon, and, based on the resulting set of points, extracted local precipitation data from the rasters provided by the PRISM Climate Group.

The precipitation variable in our dataset is in millimeters of rainfall per year multiplied by 100.

***Maximum and Minimum Temperature*.** Data on maximum and minimum temperature were obtained in the same manner as the precipitation data, described above. Rasters for maximum and minimum temperature data were obtained from PRISM Climate Group.[18] The temperature variables (summer time maximum temperature, year round maximum temperature and year round minimum temperature) are in degrees Celsius multiplied by 100. We use these year round maximum and minimum temperatures to calculate retailer specific cooling degree days.

[16] Cal-Atlas Geospatial Clearing House, accessible: http://atlas.ca.gov/download.html#/casil/boundaries.

[17] PRISM Climate Group, "Near-Real-Time Monthly High-Resolution Precipitation Climate Data Set for the Conterminous United States", raster digital data, accessible: http://www.prism.oregonstate.edu/.

[18] PRISM Climate Group, "Near-Real-Time High-Resolution Monthly Average Maximum/Minimum Temperature for the Conterminous United States", raster digital data, accessible: http://www.prism.oregonstate.edu/.

Median Income. Census tract level data on median household income were collected from the 2000 Census. Using a crosswalk between census tracts and Southern California retailers generated in ArcGIS that shows the area where each tract and retailer intersects, tract level median income was mapped to individual retailers. From the GIS crosswalk, we calculated the share of each census tract that is part of each retailer service area, hereafter referred to as *share of tract*, by dividing the intersection area by the area of the census tract. We multiplied the *share of tract* by total households in the census tract to calculate the total households in the portion of the census tract that belongs to each retailer, giving us the numerator for our weights. To construct the denominator, we added up all the portions of census tracts that belong to one retailer to get total households in that retailer. Dividing the numerator by the denominator gave us our weights. We applied these weights to tract level median household income and summed by retailer to obtain retailer level median household income.

In a similar manner, Census tract level data on median household income were collected and organized from the 2010 Census. Thus, for each retailer we had measures of household income from two points in time. These were combined with county level data on annual income growth to recover historical estimates of median household income for each retailer for each year in the regression data set.

In cases where census tract level data were not available for a retailer, we used zip code level data from the 2000 Census as a proxy. Retailers were assigned representative zip codes on a case by case basis and zip code level data on median income were mapped to individual retailers using the same weighting method as above, except for zip codes instead of census tracts.

The median income variable is in tens of thousands of year 2000 real dollars.

Median Lot Size. We obtained zip level data on median lot size from DataQuick. Using ArcGIS, we generated a crosswalk between zip codes and the water agencies that shows the area where each zip code and water agency intersects. From the GIS crosswalk, we calculated the share of each zip code that is part of each retailer, hereafter referred to as *share of zip*, by dividing the intersection area by the area of the zip code. We multiplied the *share of zip* by total households in the zip code to calculate the total households in the portion of the zip code that belongs to each retailer, giving us the numerator for our weights. To construct the denominator, we added up all the portions of zip codes that belong to one retailer to get total households in that retailer. Dividing the numerator by the denominator gave us our weights. We applied these weights to zip level median lot size and summed by retailer to obtain retailer level median lot size. Median lot size is given in terms of square feet in our dataset.

Average Household Size. Census tract level data on average household size (persons per household) were collected from the 2000 Census. Using a crosswalk between census tracts and Southern California retailers generated in ArcGIS that shows the area where each tract and retailer intersects, tract level median income was mapped to individual retailers. From the GIS crosswalk, we calculated the share of each census tract that is part of each retailer service area, hereafter referred to as *share of tract*, by dividing the intersection area by the area of the census tract. We multiplied the *share of tract* by total households in the census tract to calculate the total households in the portion of the census tract that belongs to each retailer, giving us the numerator for our weights. To construct the denominator, we added up all the portions of census tracts that belong to one retailer to get total households in that retailer. Dividing the numerator by the denominator produces the necessary weights. We applied these weights to tract level measures of average household size and summed by retailer to obtain a measure of retailer level average household size.

In a similar manner, Census tract level data on average household size were collected and organized from the 2010 Census. Thus, for each retailer we had measures of average household size from two points in time. These were averaged to recover historical estimates of average household size for each retailer.

In cases where census tract level data were not available for a retailer, we used zip code level data from the 2000 Census as a proxy. Retailers were assigned representative zip codes on a case by case basis and zip code level data on average household size were mapped to individual retailers using the same weighting method as above, except for zip codes instead of census tracts.

A similar average household size measure for the multi-family residential sector was constructed based on the population of multi-family residents and the number of multi-family residential housing units.

Inflation. All monetary values were converted to constant year 2000 dollars using the US city average Consumer Price Index series available through the Bureau of Labor Statistics.[19]

Employment. We compute total employees within a retailer based on two data sources. Historical annual employment is provided by MWD at the *member agency level* from 1990 to 2010. To calculate employment at the *retailer level* we use the Census's Zip Code Business Statistics, which reports historical employment estimates at the zip code level from 2004 to 2010. The Zip Code Business Statistics only provides employment numbers based on the

[19] Bureau of Labor Statistics, "Consumer Price Index – All Urban Customers", Series ID CUUR0000SA0, accessible: http://data.bls.gov/cgi-bin/surveymost?cu.

majority of sectors (largely excludes non-service oriented government positions) so total employment is not complete. Therefore, we only use the Zip Code Business Statistics (ZCBS) to calculate *the share of employment within a member agency due to a particular retailer*. We calculate the relevant share using a crosswalk between zip codes and retailer level boundaries, and zip codes and member agency level boundaries—again, we are able calculate the share of each member agency's employment due to a particular retailer. Finally, to compute a historically based retailer level total employment measure we multiply the share of employment within a member agency estimated from the ZCBS by the total employment in the member agency as recorded by MWD (EDD based and found in the file "Histroical Demographics by MA 2-24-12.xlsx"). For years prior to 2004 when ZCBS is unavailable, we assume the retailer level average employment shares from 2004 to 2006. That is, for each retailer we assume their share of total employment within a member agency is constant between 1994 and 2003.

FORECAST DATA

Price (Total Average Cost and Median Tier Rate). We use retailer level total average cost from our regression data, described above, and calculate a weighted average by single family residential accounts within each agency. We follow a similar procedure to calculate the median tier rates within each agency. We escalate our price measures by 1.5% annually; this is real growth. All forecasted prices are reported in year 2000 real USD.

Conservation savings. The measures of conservation savings are sector-specific for each of the single family residential, multi-family residential and commercial, industrial & institutional sectors. The measures of conservation savings are based on passive conservation savings reported in Metropolitan's water conservation model. This model provides forecasts in five year increments between 2010 and 2050 for estimates of conservation savings.

Median Lot Size. We assumed retailer level median lot size from our regression data set, described above, and aggregated these data up to the agency level using a weighting scheme based on single family customer accounts. The weights for each retailer were calculated as the number of single family accounts belonging to that retailer divided by the total number of single family accounts belonging to the agency comprising that retailer. We applied the retailer-specific weight to median lot size for each member retailer and then summed up to the agency level.

Precipitation. From our regression dataset, we pulled precipitation by member retailer. For each retailer, we calculated the 30-year historical average precipitation over the period 1980-2010. We then aggregated these data up to the agency level using a weighting scheme based on single family customer accounts. The weights for each retailer were calculated as the number of single family accounts belonging to that retailer divided by the total number of single family accounts belonging to the agency comprising that retailer. We applied the retailer-specific weight to 30-year historical average precipitation for each member retailer and then summed up to the agency level.

Maximum Temperature. As with precipitation, we pulled maximum temperature from our regression data and calculated 30-year averages over the period 1980-2010. We then aggregated up the agency-level using the same method as for precipitation. Cooling degree days is calculated in a similar way.

Median Income. Forecasts of median income were provided by SCAG at the agency level and by SANDAG (for San Diego CWA only) at the 2000 census tract level. The SCAG forecasts were released in 2012 and are given in five-year increments spanning the years 2010-2050. The most recent SANDAG forecasts available to us were done in 2008 and begin in 2008 then jump to 2015 (skipping 2010), continuing in five-year increments thereafter until 2035.

For the SANDAG forecasts, it was necessary to aggregate the forecasts up from the census tract level to the water agency level. Using ArcGIS, we generated a crosswalk between 2000 census tracts and MWD water agencies. This crosswalk provided us with a measure of the share of each census tract comprised by a portion of each water agency, hereafter referred to as *share of tract*. We multiplied the *share of tract* by total households in the census tract to calculate the total households in the portion of the census tract that belongs to each retailer, giving us the numerator for our weights. To construct the denominator, we added up all the portions of census tracts that belong to one retailer to compute total households in that retailer. Dividing the numerator by the denominator gave us our weights.

To obtain agency level median income, we multiplied census tract level median income by the weights described above and then summed over this weighted median income measure for all census tracts within each water agency. Note that this calculation is performed separately for each forecast year. Median household income is given in tens of thousands of dollars.

Average Household Size. Like median income, average household size is derived from data provided in the SCAG and SANDAG forecasts. For the agencies covered by SCAG, we calculated average household size as residential population divided by occupied housing units for each forecast year. For the SANDAG forecasts, we weighted residential population and number of households by share of tract (rather than using weights based on households as with median income) to obtain weighted versions of each measure. We then summed over these weighted measures for residential population and total households for all census tracts within each water agency, separately for each forecast year. We divided the resulting agency level residential population by agency level households to obtain average household size.

Demand Drivers: Single family residential housing units, multi-family residential housing units and total employment. These are SCAG based measures at the Member Agency level and were provided by MWD. We use SANDAG to derive similar agency level measures for San Diego.

Appendix B: Guide to Implement Forecasts

This appendix serves as a guide to implement demand forecasts. We provide instructions describing how to apply econometric equations developed in a separate technical memo to construct Metropolitan's Member Agency-specific M&I water demand forecasts. These instructions are intended to support an Excel spreadsheet that walks the user through the development of demand forecasts. Importantly, the instructions describe:

a. A methodology and procedure to account for or incorporate conservation savings estimates produced by Metropolitan's Conservation Savings Model.

b. A methodology and procedure to address fixed effects and calibration in the water demand forecasting models.

These instructions begin with an overview of how conservation savings and demand calibrations are addressed in the forecast implantation. Then we present step-by-step instructions corresponding to an Excel spreadsheet model of the forecast implementation.

Summary of how conservation savings is accounted for in the model. Modeling conservation savings within the econometric models of sectorial demands is challenging because the structure of conservation will change in the future in ways that are different from the historical evolution of savings. As a consequence, we decide to account for conservation savings outside of the econometric models. We use Metropolitan's Conservation Savings Model to calculate annual historical measures of passive conservation savings per SFR unit, per MFR unit and per employee, which are used to adjust the corresponding historical measures of consumption per SFR unit, per MFR unit and per employee. The historical per user conservation savings are added to the historical per user consumption measures to recover a measure of historical consumption that is pre-conservation. These pre-conservation measures of consumption are used as the dependent variables in the sectorial-specific econometric models. In summary, we develop econometric models of pre-conservation demand, which are used to generate forecasts of pre-conservation demands. The per user demand forecasts are recovered by subtracting the per user conservation savings from the per user pre-conservation demand forecasts.

Summary of how fixed effects and demands are calibrated. MWD Member Agency-Specific demands are calibrated using Member Agency-specific M&I demands for the year 2013 as recorded and reported by MWD. The first step to the calibration process entailed using the sectorial-specific regression models of demand to estimate pre-conservation demands per user for each of the SFR, MFR and CII sectors in the year 2013. In a second step, the conservation savings per user for the year 2013 were subtracted from the pre-conservation demand. In a third, step we aggregated the post-conservation demands per user to the Member Agency level using information on the number of SFR units, MFR units and employees in the year 2013 (based on SCAG and SANDAG). These sectorial-specific 2013 demand estimates were summed within a Member Agency to generate estimates of 2013 M&I demands at the Member Agency level. These are calibrated to the Member Agency level 2013 M&I demands reported by MWD. However, before calibration, the MWD reported estimates were adjusted to remove system losses from the reported M&I demands. This makes MWD's and Brattle's M&I demand forecasts comparable because Brattle's demand estimates are based on end-use demands which do not include system losses. Once accounting for system losses for each Member Agency we calculate the percentage difference between the 2013 M&I demand estimates and those recorded by MWD. We use this percentage difference to adjust the 2013 demand estimates per SFR unit, per MFR unit and per employee. Although the adjustment is made to the demands at the user-level in each sector, the result is an adjusted Brattle estimate of 2013 M&I demand that matches the 2013 M&I demand (less system losses) recorded by MWD. In summary, the Member Agency fixed effects resulting from the sectorial specific regression models are adjusted so that the aggregate 2013 M&I demand estimate is identical to observed demand as recorded by MWD.

GUIDE FOR FORECAST IMPLEMENTATION

STEP I. Obtain regression-based estimates of Member Agency-level M&I demands (AF) for the year 2013. M&I demand is the sum of SFR, MFR and CII demands and does not include system losses.

1. **SFR regression coefficients.** Estimate the regression model for the logarithmic form of SFR monthly water demand (ccf) per unit and extract the regression coefficients. These regression coefficients are reported in the tab "1 sfr forecast factors" and are highlighted in yellow (e.g. *b_l_prec* is the regression coefficient on annual precipitation).

2. **Logarithmic form of estimates for Member Agency-level pre-conservation monthly SFR household demands in 2013 (*l_qu13*).** Estimate *l_qu13* (natural logarithm of SFR monthly demand (ccf) per unit) for each Member Agency using estimated regression coefficients for the SFR sector. These are recorded in the tab "2 sfr 2013 estimates".

3. **Levelized form of estimates for Member Agency-level pre-conservation monthly SFR household demands in 2013 (qu13).** Apply the exponential function to *l_qu13* and multiply by the requisite sigma factor (reported underneath the column heading

sigma_factor in the tab "1 sfr forecast factors" to recover an estimate of SFR monthly demand (ccf) per unit in levels (as opposed to the logarithmic form). This is recorded as *qu13* in the tab "2 sfr 2013 estimates".

4. **Estimates of Member Agency-level post-conservation monthly SFR household demands in 2013 (*qu013*)**. The values recorded under *qu13* represent pre-conservation measures of household demand (ccf). We subtract conservation savings (ccf) per SFR unit from *qu13* to obtain *qu013* (also recorded in the tab "2 sfr 2013 estimates"), where *qu013* reflects an estimate of demands post conservation; that is, demands before taking out conservation. Conservation savings per SFR unit is based on savings (*cons_af13*) and the number of SFR units (*SFUnits13*) assumed in Metropolitan's conservation model. This data is recorded in tab "1 sfr forecast factors" and highlighted in green.

5. **Estimates of Member Agency-level post-conservation annual SFR aggregrate demands in 2013 (*qu0_sfr_agency13*)**. An estimate of Member Agency level post-conservation annual SFR aggregate demand (AF) for the year 2013 is obtained by multiplying *qu013* by 12 to annualize, then by 435.6 to convert to acre-feet, then by the number SFR units for the year 2013 based on SCAG and SANDAG projections (*sf_count13*) to aggregate to the Member Agency level. The SFR unit counts are highlighted in blue in the tab "1 sfr forecast factors". We note that the number of SFR units assumed in Metropolitan's conservation model for the year 2013 (*SFUnits13*) is not identical to the number of SFR units assumed based on SCAG and SANDAG projections (*sf_count13*).

6. **Estimates of Member Agency-level post-conservation annual MFR and CII aggregrate demands in 2013 (*qu0_mfr_agency13 & qu0_cii_agency13*).** Repeat 1-5 for both the MFR sector and CII sectors. Note that the outcome variable in the regression model for the MFR sector is monthly demand per MFR unit (household); the outcome variable in the regression model for the CII sector is annual demand per employee.

7. **Estimates of Member Agency-level post-conservation annual M&I demands in 2013 (*qu0end_mi2013*).** Sum the Member Agency-level demands across the three sectors (SFR, MFR, and CII) to obtain an estimate of the Member Agency-level M&I demands for the year 2013. These demands are recorded in the tab "8 calibration_pct" as *qu0end_mi2013*.

STEP II. Calibrate Brattle's estimates of Member Agency-level post-conservation annual M&I demands in 2013.

8. **Obtain MWD recorded M&I demands less system losses in 2013 (*adj_y2013_qu0_mi*).** Extract MWD recorded M&I demands (*y2013_qu0_mi*) and estimates of system losses (*pct_loss*) in percentage terms. These are recorded in the tab "7 mwd historical demands". We multiply *y2013_qu0_mi* and *pct_loss* to recover Member Agency-level MWD recorded M&I demands less system losses.

9. **Calibration parameter (pct_diff_agency).** The calibration parameter is 1+*pct_diff_agency* where,

$$pct\_diff\_agency = \frac{(adj\_y2013\_qu0\_mi - y2013\_qu0\_mi)}{y2013\_qu0\_mi}.$$

10. **Calibrated estimates of Member Agency-level post-conservation monthly demands in 2013 by sector (*qu013_cal*).** Multiply 1+*pct_diff_agency* by *qu013* to recover a calibrated estimate of monthly demand for the year 2013. This calculation is found in column C of tabs "9 cal_sfr_forecasts" (SFR sector), "10 cal_mfr_forecasts" (MFR sector), and "11 cal_cii_forecasts" (CII sector).

11. **Verify calibration.** Multiply calibrated estimates by the number of SFR units (*sf_count13*), MFR units (*mf_count13*) and employees (*employment_13*) in 2013. Sum these sectorial demands and convert from ccf to AF. Compare these to the MWD recorded M&I demands less system losses in 2013 (*adj_y2013_qu0_mi*). This verification is presented in tab "12 verification".

STEP III. Generate Brattle's forecasts of Member Agency-level post-conservation annual M&I demand for 2015-2050 in five year increments.

12. **Logarithmic form conversion for SFR demand.** Convert estimates of Member Agency-level post-conservation monthly SFR household demands in 2013 (*qu013_cal*) to natural logarithmic form (*l_qu013_cal*). This is presented in the tab "9 cal_sfr_forecasts".

13. **Growth in SFR demand factor covariates.** Calculate the projected changes in demand factor covariates included in the SFR regression model, which are presented in logarithmic form in the tab "1 sfr forecast factors" and are highlighted in orange (e.g. *l_tac15*). The differences between the 2013 values of these covariates and the values in the relevant forecast years are given in the tab "9 cal_sfr forecasts" and are highlighted in orange (e.g. *dl_tac15* = *l_tac15* – *l_tac13*).

14. **SFR demand growth due to growth in SFR demand factor covariates.** Multiply growth in SFR demand factor covariates (e.g *dl_tac15* in tab "9 cal_sfr forecasts") by the corresponding regression coefficients (e.g. *b_l_tac* in tab "1 sfr forecast factors").

These products do not account for future conservation savings; these are addressed in a subsequent step. These products are not reported in their own cells, although their calculation is embedded in the calculations described for the next step.

15. **Generate forecasts of Member Agency-level monthly SFR household demands in natural logarithmic form (*l_qu015_f* through *l_qu0_50_f*).** Add the products from the previous steps to base SFR household demands in natural logarithmic form for 2013. The resulting forecasts of SFR household demands in natural logarithmic form for the years 2015-2050 (in five year increments) are reported in tab "9 cal_sfr forecasts" and are highlighted in light-shaded grey (*l_qu015_f* through *l_qu0_50_f*).

16. **Generate forecasts of Member Agency-level post-conservation monthly SFR household demands in levelized form (*qu015_f* through *qu0_50_f*).** We apply the exponential function to each of *l_qu015_f – l_qu050_f*, and then multiply each by the sigma factor for the SFR sector. This gives a demand measure that does not account for changes in conservation savings between the projection year and the year 2013. To adjust for these future conservation savings, we the take difference between the per unit conservation savings in the relevant projection year and the year 2013. These differences are recorded in the tab "9 cal_sfr forecasts" under *d_cons15* through *d_cons50* and are highlighted in green. The results are *qu015_f – qu050_f*, which are forecasts of Member Agency-level post-conservation monthly SFR household demands in levelized form. These are highlighted in medium-shaded grey.

17. **Forecasts of Member Agency-level post-conservation annual SFR demands for the years 2015-2050 (*qu0_sfr_agency15 – qu0_sfr_agency50*).** Multiply the household demands in the previous step by 12 to convert from monthly to an annual demand and then multiply by the projected number of SFR household units to recover a measure of aggregate SFR demand by year. Convert to AF using the conversion factor of 435.6 ccf/AF. The resulting Member Agency level forecasts are recorded in the tab "9 cal_sfr forecasts" and are highlighted in dark-shaded grey (*qu0_sfr_agency15 – qu0_sfr_agency50*).

18. **Forecasts of Member Agency-level post-conservation annual MFR and CII demands for the years 2015-2050 (*qu0_mfr_agency15 – qu0_mfr_agency50, qu0_cii_agency15 – qu0_cii_agency50*).** Repeat 13-17 for both the MFR sector and CII sectors. Note that the outcome variable in the regression model for the MFR sector is monthly demand per MFR unit (household); the outcome variable in the regression model for the CII sector is annual demand per employee.

19. **Forecasts of Member Agency-level post-conservation annual M&I demands for the years 2015-2050.** Sum sector-specific demands with-in a Member agency and

year (e.g. *qu0_sfr_agency15 + qu0_mfr_agency15 + qu0_cii_agency15*). These deliver M&I demands (less system losses) at the Member Agency-level, which are reported in the tab "table2_demands by agency_af".

20. **Forecasts of MWDSC aggregate post-conservation annual M&I demands less system losses.** Sum Member Agency-specific M&I demands across Member Agencies and within a year. These deliver M&I demands (less system losses) at the MWDSC-level, which are reported in the tab "table1_demands by sector_af".

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Integrated Water Resources Plan Update 2015

Appendix 8

Demand Forecasting

Appendix 8 – Demand Forecasting

Retail water demand forecasting is essential for planning total water requirements in Metropolitan's service area. Retail water demand can be met with conservation, local supplies, or 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 urban water use within the region including residential, commercial, industrial, 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. Metropolitan relies on member agencies' projections of agricultural demands.
- **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.

RETAIL M&I DEMAND FORECAST

In forecasting retail M&I water demand, Metropolitan adopted a new econometric model (the Metropolitan Water District – Econometric Demand Model or MWD-EDM) developed by The Brattle Group (January 2015). 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.

MWD-EDM comprised of three separate regression models described below. Each model is developed using historical water consumption and socio- demographic and economic data specific to the sector:

- Single-Family Residential (SFR) Model - SFR water demand is modeled as a function of price, weather, retailer-level housing and socio-demographic characteristics, and member agency-level fixed effects. The model used water consumption data from 153 retailers with 3,000 accounts or more in Metropolitan's service area. The dataset, ranging from 1994 to 2011, consisting of 1,225 observations and representing 80 percent of all SFR accounts from all 26 Metropolitan member agencies.
- Multifamily Residential (MFR) Model - MFR demand is modeled as a function of price, retailer-level housing and socio-demographic characteristics, and member agency-level fixed effects. Water consumption data collected from 53 water retailers consisting of 469 observations and representing 23 out of 26 Metropolitan member agencies.
- Commercial, Industrial, and Institutional (CII) Model - CII demand is modeled as a function of price, weather, and the share of employment in the manufacturing sector and member agency level fixed effects. Water consumption data collected from 75 water retailers consisting of 709 observations and representing 25 out of 26 Metropolitan member agencies.

The SFR and MFR models forecast average monthly household consumption before conservation while the CII model forecasts average monthly consumption per employee. **Table A.8-1** shows the dependent and the covariates uses in the econometric models for each sector.

Table A.8-1
MWD-EDM Variables

Sector	Dependent Variable	Independent Variable (Covariate)
SFR	Water-Use Per Household	Total Average Cost Total Average Cost x Median Lot Size Annual precipitation Average Max Temperature Median Income Average Household Size Median Lot Size
MFR	Water-Use Per Household	Median Tier Price Median Income Median Lot Size Average Household Size
CII	Water-Use Per Employee	Median Tier Price Cooling Degree Days Average Max Temperature Share of Employment In Manufacturing Median Tier Price x Share of Manufacturing

Total retail M&I demand is the product of projected household/employee and the average monthly consumption. For an in-depth discussion on model specification, see **Appendix 7**.

Price Elasticity

Price elasticity of demand is a measure used in economics to show the responsiveness of the quantity of water demanded to a change in its price. The assumed price increase reduces the water use. This reduction can be assessed in MWD-EDM and is considered a conservation savings due to price or "price-effect." Consumers can respond to price increases by installing water-conserving fixtures and appliances such as high-efficiency toilets. However, many of the fixture-based conservation savings options are already factored into Metropolitan's Conservation Savings Model. As more water efficient fixtures are installed, the impact of changing water using behavior through price or rates is reduced. Consider consumers who respond to rate increases by taking shorter showers. Their behavior adjustment will save less water if they use a water-efficient low-flow showerhead compared to a regular showerhead. This effect is known as demand hardening. In order to avoid double-counting conservation savings and account for demand hardening, the impact of price elasticity is reduced. In MWD-EDM, price elasticity is reduced to 33 percent by 2020 and keeping it constant beyond 2020. Price-effect savings are reduced (and demands increased) as a result of this adjustment. The elasticity is reduced in proportion to increases in conservation savings from the conservation model. Reducing price elasticity to 1/3 of its originally estimated levels is based on professional judgment, assuming that much of the easily obtained water use efficiencies will be achieved by 2020, but allowing for new conservation technologies.

Fixed Effects

MWD-EDM forecasts retail M&I demand for each of the 26 member agencies. To account for the differences observed between each agency, MWD-EDM uses the fixed effects or the constant term that represents the member agency specific intercepts that account for all time-invariant unobserved factors common to an agency. See **Appendix 7** for member agency fixed effects for the SFR, MFR, and CII sector models.

Demographics

Demographics are recognized by the water industry as drivers of water demand. Metropolitan's retail demand modelling 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 used previously in Metropolitan's 2010 IRP 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 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 producing long-term transportation 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 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.

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. Metropolitan uses the forecast for every county except Imperial, which is outside of Metropolitan's service.

In October 2013, SANDAG released the *Series 13: 2050 Regional Growth Forecast* (Series 13). Series 13 is 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.

Table A.8-2
Population, household, and employment are key drivers for forecasting water demand. Projections of these drivers continue to grow over the next 25 years.

	2020	2025	2030	2035	2040
Population	19,354,000	20,019,000	20,637,000	21,206,000	21,791,000
Households	6,413,000	6,653,000	6,872,000	7,095,000	7,323,000
Employment	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 outbound 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 rate contributed to slower population growth than was anticipated before the recession. However, mortality rates were projected to be lower as well as 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 A.8-3** represents the amount of water need in Metropolitan's service area for consumption and for maintaining and sustaining production of local groundwater and surface reservoirs.

Table A.8-3
Total demand represents the amount of water needed in Metropolitan's service area to meet retail M&I, agricultural, seawater barrier, and replenishment demands.

Demand	2020	2025	2030	2035	2040
Retail M&I[1]	3,669,000	3,732,000	3,801,000	3,870,000	3,925,000
Retail Agricultural	130,000	167,000	163,000	161,000	160,000
Seawater Barrier	72,000	72,000	72,000	72,000	72,000
Replenishment	292,000	295,000	297,000	297,000	297,000
Total Demand	**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 are 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 of them 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.

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 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 and are not a component of the current Conservation Model. Metropolitan's conservation accounting combines pre-1990 savings and 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, which comprises only a small proportion of the region's total households. Second, the current MWELO does not have a uniformly effective enforcement mechanism, leading to questions on whether all new home construction in all parts of the 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, MWELO does not currently affect existing housing stock; therefore savings associated with MWELO compliance are not calculated for existing housing 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 by the California Urban Water Conservation Council (CUWCC). 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 action 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.

More detailed discussion of the Conservation Savings Model can be found in **Appendix 9**.

Total conservation savings in **Table A.8- 4** includes the amount of savings from active conservation savings achieved through Metropolitan's Conservation Credits Program and from member agency-funded programs installed up to fiscal year 2015/16. Active conservation savings are projected to decline over time as water-efficient devices reach the end of their useful lives. In projecting conservation savings, Metropolitan does not assume future active conservation activities beyond fiscal year 2015/16. This assumption is consistent with Metropolitan's approach to forecast existing resources. Code-based and price-effect savings are projected to increase as the region's population continues to grow.

Table A.8-4

Total conservation savings are projected to increase in the next 25 years.

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

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

LOCAL SUPPLY PROJECTIONS

Local supplies represent water produced by the 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.
- **Los Angeles Aqueduct** – A major source of imported water is conveyed from the Owens Valley via the Los Angeles Aqueduct (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** – Seawater desalinated for 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 forecasting the quantities of local supplies its member agencies will 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. **Appendix 5** contains a complete list of local projects provided by the member agencies. This inventory 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.

Table A.8-5
Local supplies contribute to more than half of the water demands in Metropolitan's service area. Total local supplies are projected to increase gradually as the region continues to develop local resources.

Local Supply	2020	2025	2030	2035	2040
Groundwater Production	1,290,000	1,288,000	1,288,000	1,288,000	1,289,000
Surface Production	110,000	110,000	110,000	110,000	110,000
Los Angeles Aqueduct	261,000	264,000	264,000	266,000	268,000
Seawater Desalination[1]	51,000	51,000	51,000	51,000	51,000
Groundwater Recovery[1]	143,000	157,000	163,000	165,000	167,000
Recycling[1]	436,000	466,000	486,000	499,000	509,000
Recycling - M&I	243,000	267,000	285,000	298,000	308,000
Recycling - Replenishment	126,000	129,000	131,000	131,000	131,000
Recycling - Seawater Barrier	67,000	70,000	70,000	70,000	70,000
Other Non-Metropolitan Imports	13,000	13,000	13,000	13,000	13,000
Total Local Supplies	**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.

DETERMINING DEMANDS ON METROPOLITAN

Imported water from Metropolitan serves as a supplement supply to its 26 member agencies. For most 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 needs.

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. The Sales Model 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. For example, each forecast year, say 2020, has 91 possible outcomes, one for each hydrology year during the period 1922 to 2012. 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.

Table A.8-6

Total demand on Metropolitan represents the amount of water needed to meet the remaining needs of the region, after factoring production from local supplies.

Demand On Metropolitan	2020	2025	2030	2035	2040
Consumptive Use	1,689,000	1,750,000	1,791,000	1,840,000	1,879,000
Seawater Barrier	5,000	2,000	2,000	2,000	2,000
Replenishment	166,000	166,000	166,000	166,000	166,000
Total Demand on Metropolitan	**1,859,000**	**1,918,000**	**1,959,000**	**2,008,000**	**2,048,000**

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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Appendix 9

Metropolitan Conservation Savings Model: Methodology and Assumptions

Appendix 9 – Metropolitan Conservation Savings Model: Methodology and Assumptions

INTRODUCTION

Unlike traditional water supplies, which can be directly measured, conservation reduces water demand in ways that are 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 of them 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. These conservation savings estimates are incorporated into Metropolitan's long-term planning such as the Integrated Water Resources Plan (IRP). This Technical Memo provides a high-level description of the Conservation Model.

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 service area saved an estimated 250 TAF per year as the result of this 1980 plumbing code and unrelated water rate increases. Within Metropolitan's planning framework, these savings are referred to as "pre-1990 savings." Pre-1990 savings were estimated for the 1996 IRP and are not a component of the current Conservation Model. Metropolitan's conservation accounting combines pre-1990 savings and estimates of more recently achieved savings.

The Conservation Model accounts for the following sources of conservation:

- Active Conservation – 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 (CUWCC). 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 action from water agencies.

- Price-Effect Conservation – Water saved by retail customers attributable to the effect of changes in the real (inflation-adjusted) price of water. Because water has a positive price elasticity of demand, increases in water price will decrease the quantity demanded.

METROPOLITAN'S CONSERVATION SAVINGS MODEL

The Conservation Model features a comprehensive representation of Metropolitan's active conservation activities and utilizes a combination of fixture/program savings rates based on CUWCC reports and other sources. It measures active and plumbing code conservation from a 1990 base year. Active and code-based conservation savings are calculated in the Conservation Model described here, while price-effect savings is calculated using the MWD-EDM. MWD-EDM is a statistical model used for forecasting retail water demands. Potential savings from public outreach and education programs are not accounted for in the Conservation Model.

Methodology

Distinguishing between active, code-based and price-effect conservation can be complex when, for example, active programs for fixtures are concurrent with conservation-related plumbing codes. The Conservation Model combines active, code-based, and price-effect conservation savings using methods that avoid double-counting. The Conservation Model consists of two interrelated models:

1. Active Conservation Model (Active Model) and
2. Code-Based Conservation (Code-base Model).

Currently, there are 74 devices and programs represented in the Active Model. These devices are aggregated into residential, landscape, and commercial, industrial, and institutional sectors. Eight of the fixtures are tied to Code-based models. The model generates individual estimates for each of Metropolitan's 26 member agencies. Results are post-processed to the following use categories:

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

Active Conservation

The Active Model estimates savings from conservation programs administered by Metropolitan and its member agencies since 1990. The savings are calculated by combining counts of active program activity – numbers of devices and/or program implementations – with device-related savings factors. The factors include:

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

Active Conservation Assumptions

Device savings estimates are determined by key assumptions described above. These assumptions are shown in appendices A and B. Devices may be represented more than once due to different implementation methods or savings factors. Assumptions are periodically reviewed to ensure they represent the best savings estimates available. In some cases, the sources behind the assumptions are noted.

Active Savings Calculation

Device savings are limited by decay rates, or a corresponding device life, but not both at the same time. For example, a residential high-efficiency toilet (HET) saves about 38 gallons per day over a lifetime of 20 years with no assumed decay rate. For a complete list of current and past device and program savings factors, see Appendices A and B. Annual savings are expressed in acre-feet (AF).

$$S_i = \frac{d_i * a_i * 365}{325{,}851 \text{ Gallons per AF}}$$

- S_i is the annual savings in acre-feet (AF) for device i.
- d_i is the number of device i installed under an active conservation program.
- a_i is the gallons per day savings from a baseline. Baselines are specific to each device and represent the typical amount of water usage for a conventional device prior to more efficient alternatives being made available, either through plumbing code enforcement or market innovations. For example, a HET with a 1.28 gallons-per-flush (GPF) has a savings factor of 38 gallons per day compared to the 3.5 GPF toilets available before the 1992 plumbing codes.
- 365 is the number of days assumed in one year for the purpose of simplifying the calculation.
- 325,851 is the number of gallons in one acre-foot of water.

Lifetime savings is the sum of annual savings over the life expectancy of the device.

$$L_i = \sum_{t_i=1}^{n} S_i$$

- L_i is the lifetime savings of device i.
- n is the number of years a device is expected to produce savings before it fails. This varies depending on the type of device.

- t is the year when device i is producing savings.
- S_i is the annual savings in acre-feet (AF) for device i.

Code-Based Model

Plumbing code conservation is the impact of plumbing codes and other ordinances on water demand. Metropolitan's Code-Based Model represents plumbing code conservation with demographically-driven stock models. The stock models are device- or fixture- specific and are based on the same demographic data used in Metropolitan's retail demand projection. Each stock model tracks the stocks and flows of conserving and non-conserving water devices, allowing it to estimate the impacts of plumbing codes on device saturation and overall savings. The Code-Based Model accounts for the following:

- Fixtures from new construction,
- Natural replacement, and
- Code-based devices originated from devices installed through active conservation programs.

New Construction

Water fixtures installed due to new construction are assumed to be in compliance with the plumbing codes in effect when the new construction occurs. For instance, the model would assume a house built in 1997 would meet the efficiency standards set by California's 1992 plumbing code. Therefore, new construction is assumed to result in measurable savings from a non-efficient baseline. The Code-Based Model uses 1990 as the baseline. Estimates and projections of the number of fixtures added through new housing units and offices is based on growth in housing units or employment. The following equation calculates the number of fixtures installed each year from new residential construction.

$$N_{nc} = \left(h_{y+1} - h_y\right) * \ b_h * \ c_p$$

- N_{nc} is the number of fixtures installed from new construction.
- h_y is the number of households for year y. This is used to measure housing growth from new construction from year to year.
- b_h is the number of fixtures per household based on averages developed from single-family and multi-family housing units (e.g., 2 toilets per household).
- c_p is the plumbing code compliance rate. The compliance rate increases over time as the conventional fixtures are phased out and replaced in the market.

Natural Replacement

Natural replacement accounts for the savings that accrue when fixtures are replaced with more efficient models due to remodeling, failure or other non-program reasons. The Code-Based Model represents this effect with a "natural replacement rate" that is expressed as a percentage of existing fixtures that are replaced in a given year. Natural replacement rates vary by device and are linked to the expected life of the device. Devices with short lifespans will be replaced more frequently and thus have higher natural replacement rates. A simple percentage is used to account for this natural turn-over in non-conserving fixtures because it is difficult to back-calculate the age of the fixtures in pre-1990 construction. Metropolitan's model assumes that two percent of all non-efficient toilets in the residential sector are retrofitted due to natural replacement in any given year. The new toilets are assumed to meet the efficiency standards in effect at the time of the retrofit. For instance, a residence that retrofitted a broken toilet in 1997 is assumed to have replaced it with a 1.6 GPF toilet required by the 1992 plumbing code. The following formula represents this mathematically.

$$N_{nr} = (d_{nc} - d_c) * r_{nr} * c_{nr}$$

- N_{nr} is the number of fixtures installed from natural replacement.
- d_{nc} is the number of non-conserving or conventional fixtures.
- d_c is the number of conserving or water-efficient fixtures that are installed through conservation programs administered by water agencies.
- r_{nr} is the natural replacement rate of fixtures that are replaced with more efficient models due to remodeling or failure. For example, the CUWCC and other agencies use a four percent natural replacement rate for toilets. Metropolitan uses a lower rate of two percent to account for possible double-counting of ultra-low flush toilet rebates during the 1990s due to free-ridership.
- c_{nr} is the compliance rate for natural replacement. During the early phase-in period of plumbing code, it is presumed that consumers still have a choice between conserving fixtures that conform to the new plumbing code or the conventional fixtures. The compliance rate increases over time as the conventional fixtures are phased out and replaced in the market.

Customers who receive or take advantage of active conservation incentives to fund device retrofits they would have performed anyway (due to failure, remodeling or for other reasons) are known as "free-riders." While the model has the ability to account for free-ridership, this feature is not used by Metropolitan.

Fixtures Up for Renewal

As water-conserving fixtures reach their useful lives and become defective or inefficient, they may be replaced with water conserving fixtures due to plumbing codes. The water savings from the device is then considered "renewed" in the Conservation Model, and the renewed savings is tracked. For example, a fixture that was installed through an active conservation program provides water savings that otherwise would not have been realized without plumbing codes. However, subsequent adoption of efficient plumbing codes means that when the fixture reaches the end of its life, it will be replaced by the same or more water-efficient model. Fixtures up for renewal are calculated as follows:

$$N_{ur} = d_a + d_c$$

- N_{ur} is the number of fixtures up for renewal as they reach their useful lives.
- d_a is the number fixtures installed through conservation programs that have reached their useful lives and are being replaced by the same water-efficient models or better.
- d_c is the number of fixtures that were replaced due to plumbing codes that have reached their useful lives and are being replaced by the same water-efficient models or better.

Stock Models

The number of efficient fixtures for each stock model is the sum of fixtures from active programs (N_{ap}), new construction, natural replacement, and fixtures up for renewal.

$$N = N_{ap} + N_{nc} + N_{nr} + N_{ur}$$

The following fixtures and devices are assigned stock models based on existing plumbing codes:

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

The Stock Models generate annual estimates of devices and fixtures that are fed into the Active Model's water savings calculations and tracked separately. The Stock Models also account for the impacts of active programs on the overall device saturation rate. As a result, increased levels of active conservation lead to lower levels of plumbing code conservation. This helps avoid double-counting conservation savings in the model.

Plumbing Code Assumptions

Plumbing code savings are determined by the device-specific assumptions used in the stock models. The stock models are driven by projections of housing and employment described earlier in this memo, so they are consistent with the demand projections. Initial device counts and growth in the number of devices are determined by the demographics combined with the assumptions described below:

- Devices per Household or Per Employee: This factor represents the average number of devices per household or per employee and is multiplied by the demographic projections to develop estimates of total number of devices or "stock." Devices per household and employee can vary by agency and change over time.

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

Table A.9-1
Plumbing Code Assumptions

Stock Model	Device per Household/ Employee	Compliance Rate	Natural Replacement Rate	Plumbing Code Year
Res. Toilets	2	99%	2%	1992
Res. Shower Heads	1.8	95%	10%	1992
Res. Aerators	3.5	90%	33%	1992
Res. Washing Machine	0.74	100%	6.7%	2007
CII Toilets	0.27*	100%	2%	1992
CII Urinals	0.06	100%	4%	1992
CII Pre-Rinse Spray Heads	0.0055*	95%	16.7%	2006
CII Washing Machine	0.0073*	100%	5%	2007

* Varies overtime and by agency (based on CUWCC BMP savings factors)

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

PRICE SAVINGS ASSUMPTIONS

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

UN-METERED WATER USE SAVINGS

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

Table A.9-2
Current Program/Device Factors

Current Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
CII								
Agricultural Conservation		af	89.2742	0.100	365	10		Board Ltr 8-7, May 2010; Lifetime savings inputted into WINS, incentive is $195/af up to 50% of all equip
Connectionless Food Steamer		ea	223.290	0.250	365	10		Bd Ltr 8-8, dated Dec. 13, 2005 - 81,500 gal/yr for 10 years
Cooling Tower Cond Meter		ea	803.500	0.641	260	5		Bd Ltr. 7-7 Aug 1997. Assumes office building, open 5 days per week - 3.2 AF lifetime savings
Dry Vacuum Pump		½ hp	120.000	0.092	260	7		Bd. Ltr. 8-4, July 2007 - 30,000 gpy per .5 HP & 7 yr life
HET - Melded Rate	From avg of 3.5 - 5 & 1.6 gpf	ea	21.880	0.025	365	20		
Ice Machine		ea	137.500	0.154	365	10		
In-Stem Flow Regulator		ea	2.678	0.003	365	5		Board Ltr 8-4, May 2012
Laminar Flow Restrictor		ea	20.979	0.024	365	5		Board Ltr 8-4, May 2012
PH Cooling Tower Controller		ea	2,435.856	1.943	260	5		Bd Ltr 8-8, Dec 2005. Assumes office bldng, 5 days/week. 844,430 gpy * 75% (to adjust for behavior)
Plumbing Flow Control		ea	7.499	0.008	365	10		
Pre-Rinse Spray Head	1.6 gpf	ea	136.610	0.153	365	5		Bd. Ltr. 7-7, August 1997 - Savings from CUWCC study; 50,000 gpy savings & 5 yr life
Rotating Nozzles		ea	3.570	0.004	365	5		Bd. Ltr. 7-5, dated August 2006 - 6,600 gal life savings per nozzle & 5 yr life

Current Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
Soil Moisture Sensor		ea	11.520	0.013	365	10		
Steam Sterilizer		ea	1,160.740	1.300	365	15		Bd. Ltr. 7-5, August 15, 2006 - 1.3 afy & 15 yr life
Turf Removal		Sq ft	0.121	0.000	365	10		Bd. Ltr. 8-2, November 18, 2008; 44 gal/yr per sq. ft.
WBIC by Station		#stations	11.520	0.013	365	10		
Weather-Based Controller		ea	290.000	0.325	365	10		Bd Ltr 8-8, dated Sep 14, 2004
Zero Water Urinal	From avg of 3.0 - 1.5 gpf to .25 gpf	ea	109.590	0.123	365	20		Bd Ltr 8-8, dated Dec 13, 2005 - 40,000 gpy & 20 yr life
Landscape								
Audits		acre	8,931.507	0.550	365	2		Bd. Ltr. 7-5, August 2006
Large Rotors - HE Nozzles		ea	16.000	0.018	365	10		Bd. Ltr. 8-4, July 2007 - .18 AF life savings & 10 yr life
Moisture Sensor (Station)		#stations	11.520	0.013	365	10		
Synthetic Turf		sf	0.125	0.000	365	10		Bd. Ltr. 8-4, July 2007 - 6 AFY savings on athletic fields & 10 yr life
Water Use Accountability		acre	14.910	0.008	365	1		Bd. Ltr. 8-8, September 2004; 0.1 per year divided by 12 to account for monthly billing. 5-yr program with 1-yr life to capture annual activities over the course of the program.
Weather-Based Controllers		acre	290.000	0.325	365	10		Bd Ltr 8-8, dated Sep 14, 2004
Residential								

Current Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
H-E Clothes Washer (WF 4)	From WF 13	ea	29.320	0.033	365	14		
HET - Melded Rate	From average of 3.5 – 5 & 1.6 gpf to 1.28 gpf	ea	21.880	0.025	365	20		
Irrigation Evaluation with Timers		ea	25.900	0.029	365	4	0.6	Bd. Ltr. 7-4, March 1996; CUWCC guidelines give 25.9 gpd for turf audit + 60% decay.
Irrigation Evaluation without Timers		ea	12.200	0.014	365	4	0.6	Bd. Ltr. 7-4, March 1996; CUWCC guidelines give 12.2 gpd for turf audits without timers + 60% decay.
Multi-Family Premium HET (Melded Rate)	From HET – Melded Rate to 4 liters	ea	33.390	0.037	365	20		
Rain Barrel		ea	1.700	0.002	365	5		
Rotating Nozzles		ea	3.570	0.004	365	5		Bd. Ltr. 7-5, dated August 2006 - 6,600 gal life savings per nozzle & 5 yr life
Showerheads	From 2.5 gpm	ea	5.500	0.006	365	5	0	Bd. Ltr. 7-4, March 1996; CUWCC gives 20-30% decay rate for showerheads.
Soil Moisture Sensor		ea	36.990	0.041	365	10		
Surveys, Single Family		ea	21.000	0.024	365	5	0.3	Bd. Ltr. 7-4, March 1996; CUWCC gives 21 gpd for untargeted intensive home surveys.
Turf Removal		Sq ft	0.121	0.000	365	10		Bd. Ltr. 8-2, November 18, 2008; 44 gal/yr per sq. ft.
WBIC Large Site (Station)		# of statio ns	11.520	0.013	365	10		

Current Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
Weather-Based Controller		ea	36.986	0.041	365	10		Bd Ltr. 8-5, dated Aug. 20, 2002 - 13,500 gpy savings & 10 yr life

Table A.9-3
Past Program/Device Factors

Past Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
CII								
Analyst Survey I		ea	2,947.397	3.300	365	1	0	Based on data from 900 surveys conducted by MWD
Analyst Survey II		ea	2,947.397	3.300	365	1	0	Based on data from 900 surveys conducted by MWD
Engineer Survey		ea	6,609.315	7.400	365	1	0	Based on data from 900 surveys conducted by Metropolitan
Flush Valve Kit		ea	31.346	0.035	365	5	0	Bd. Ltr. 7-7, August 1997
HE Urinal – Upgrade	From 1.0 to .5 gpf	ea	13.700	0.015	365	20		Bd. Ltr 7-5, August 2006 - 100,000 gal life savings & 20 yr life
HET – Upgrade	From 1.6 to 1.28 gpf	ea	7.000	0.008	365	20		Bd Ltr 8-8, dated Dec. 13, 2005 - 7 gpd savings & 20 yr life
High-Efficiency Toilet	From avg of 3.5 – 5 to 1.6 gpf	ea	38.000	0.043	365	20		Bd Ltr 8-8, dated Dec. 13, 2005 - 38 gpd savings & 20 yr life
High-Efficiency Urinal	From avg of 3.0 - 1.5 gpf to .5 gpf	ea	54.794	0.061	365	20		Bd Ltr 8-8, dated Dec. 13, 2005 - 20,000 gpy savings & 20 yr life
High-Efficiency Washers		ea	96.000	0.108	365	10	0	Bd. Ltr. 7-7, August 1997 - 16 gal per load * 6 loads/day * 365 days
Industrial Process Improve		af	178.575	0.100	365	10	0	Bd. Ltr. 7-7, August 1997 & Bd. Ltr. 8-10, June 2004; adjusted to pay on water saved for 10 yrs

Past Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
Recycled Water Hook-Up		acre	892.876	1.000	365	25		Bd. Ltr. 8-9, August 21, 2007 - $500/af for first year use
ULF Toilets - Dual Flush	From avg of 3.5 – 5 to 1.28 gpf	ea	40.044	0.045	365	20	0	Bd. Ltr. 8-5, August 2002 - 2,250 gpy additional savings over ULFT & 20 yr life
ULF Toilets - Flush Valve	From avg of 3.5 – 5 to 1.6 gpf	ea	33.854	0.038	365	20	0	Bd. Ltr. 7-7, August 1997
ULF Toilets - Tank Type	From avg of 3.5 – 5 to 1.6 gpf	ea	33.854	0.038	365	20	0	Bd. Ltr. 7-7, August 1997
ULF Urinals	From avg of 3.0 - 1.5 gpf to 1.0	ea	38.390	0.043	365	20	0	Bd. Ltr. 7-7, August 1997
Water Broom		ea	191.838	0.153	260	5	0	Bd. Ltr. 8-5, August 2002 - 50,000 gpy, 5 yr life & 5 days/wk
Water Management Study		ea	90,402.308	72.100	260	1	0	Based on data from 900 surveys conducted by Metropolitan
X-Ray Processor		ea	2,858.082	3.200	365	5	0	Bd. Ltr. 8-5, August 2002 - 3.2 AFY savings, 5 yr life, & hospital open 7 days a week.
Zero Water Urinal - Upgrade	From 1.0 to .25 gpf	ea	27.400	0.031	365	20		Bd. Ltr. 7-5, August 2006 - 200,000 gal life saving & 20 yr life
Landscape								
California-Friendly Landscape		Sq ft	0.088	0.000	365	10		Savings factors provided by Carlos Michelon
Central Controllers		acre	290.000	0.325	365	10	0	Based on water savings achieved from weather

Past Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
								based controllers
ET Controllers		ea	36.986	0.041	365	10	0	Bd. Ltr. 8-5, August 2002 - 13,500 gpy & 10 yr life
Residential								
Aerators	From 2.5 gpm	ea	1.500	0.002	365	2	0	Bd. Ltr. 7-4, March 1996; CUWCC guidelines, p. 2-20.
Flappers Replaced w/Survey		ea	8.000	0.009	365	5	0	Bd. Ltr. 7-4, March 1996
H-E Clothes Washer (WF 5)	From WF 13	ea	27.945	0.031	365	14		Bd. Ltr. 8-7, March 13, 2007 - 10,200 gpy
H-E Clothes Washer (WF 6)	From WF 13	ea	24.658	0.028	365	14		Bd Ltr 9-10, dated Nov 9, 2004 - 9,000 gpy
HET – Upgrade	1.6 to 1.28 gpf	ea	7.000	0.008	365	20		Bd Ltr 8-8, dated Dec. 13, 2005 - 7 gpd savings & 20 yr life
High-Efficiency Toilet	From avg of 3.5 – 5 to 1.28 gpf	ea	38.000	0.043	365	20		Bd Ltr 8-8, dated Dec. 13, 2005 - 38 gpd savings & 20 yr life
High-Efficiency Washers		ea	13.973	0.016	365	14	0	Bd. Ltr. 8-8, January 26, 1999 - ~100 gal/week
Multi-Family Surveys		ea	8.800	0.010	365	4	0.3	Assume same as SF indoor survey - 12.2
Showerheads - Distributed		ea	5.500	0.006	365	5	0	Bd. Ltr. 7-4, March 1996; Daily savings reduced to account for .55 installation probability.
Surveys, Single Family-Old		ea	21.000	0.024	365	5	0.3	Bd. Ltr. 7-4, March 1996
Toilet Displacement		ea	4.000	0.004	365	5	0.6	Bd. Ltr. 7-4, March 1996; CUWCC gives 60% decay rate.

Past Program/Device	Flow Rate	Unit	Gallons per Day	Acre-feet per Year	Days per Year	Device Life (Yrs)	Device Decay (%/Yr)	Source or Justification
ULF Toilets - Distribution	From avg of 3.5 – 5 to 1.6 gpf	ea	31.280	0.035	365	20	0	Bd. Ltr. 9-9, March 1992 - Weighted regional avg; 60% SF (34 gpd), 40% MF (27 gpd)
ULF Toilets - Rebate	From avg of 3.5 – 5 to 1.6 gpf	ea	31.100	0.035	365	20	0	Bd. Ltr. 9-9, March 1992; Weighted regional avg; 60% SF (34 gpd), 40% MF (27 gpd)
ULFT - Dual Flush Upgrade	1.6 to 1.28 gpf	ea	6.164	0.007	365	20		Bd Ltr. 8-5, dated Aug. 20, 2002 - 2,250 gpy savings & 20 yr life
ULFT Toilets - Dual Flush	From avg of 3.5 – 5 to 1.28 gpf	ea	37.264	0.042	365	20		Bd Ltr. 8-5, dated Aug. 20, 2002 - 2,250 gpy additional savings over ULFT & 20 yr life
WBIC for Large Residential		acre	290.185	0.325	365	10		Bd. Ltr. 8-8, December 2005

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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Appendix 10

Imported Supply Forecasts

Appendix 10 – Imported Supply Forecasts

STATE WATER PROJECT FORECAST

Forecasts of State Water Project (SWP) supplies are based on modeling studies produced by the California Department of Resources (DWR). DWR publishes updated forecasts of SWP deliveries in its biennial SWP Delivery Capability Report. The most recent update to the Delivery Capability Report can be found here: http://baydeltaoffice.water.ca.gov/swpreliability/. The 2015 Delivery Capability Report provides estimates of the current (2015) and future (2035) SWP delivery capability for each SWP contractor under a range of hydrologic conditions. These estimates incorporate regulatory requirements in accordance with USFWS and NMFS biological opinions. In addition, these estimates of future capability also reflect potential impacts of climate change and sea level rise.

Metropolitan used a number of modeling studies from the 2015 Delivery Capability Report including the (DCR) Base Scenario, Early Long-Term (ELT), Existing Conveyance High Outflow (ECHO), and Existing Conveyance Low Outflow (ECLO) scenarios. In addition to these scenarios, Alternative 4a study associated with the RDEIR/SDEIS on the Bay Delta Conservation Plan/California WaterFix. The following table (**Table A.10-1**) provides a summary of the key assumptions for each scenario.

Table A.10-1
Summary of State Water Project Supply Scenario Assumptions

Scenario	Level of Development	Climate Change Impacts	Conveyance Facilities	Regulatory Restrictions
DCR Base	2015	No	Existing	Current
Early Long-Term	2035	Yes	Existing	Current
Existing Conveyance Low Outflow	2035	Yes	Existing	Current South Delta
Existing Conveyance High Outflow	2035	Yes	Existing	Current South Delta Fall X2 Spring Outflow
Alternative 4a	2035	Yes	California WaterFix	Current South Delta Fall X2

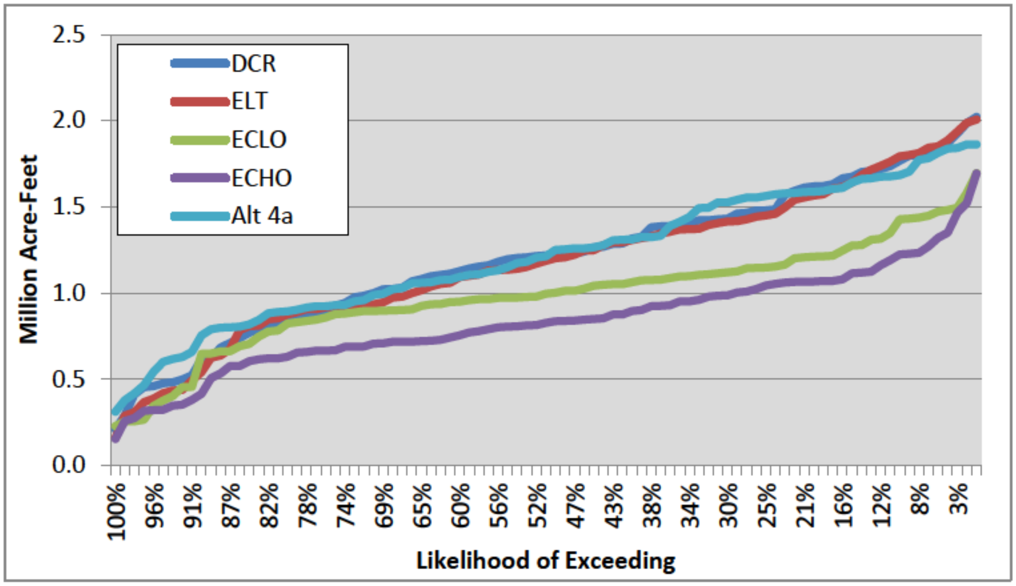
Each of the modeling studies described in this appendix are produced by DWRs CalSim-II model. CalSim-II is used to simulate SWP and Central Valley Project operations under a range of historical hydrologic conditions from 1922-2003. The forecasts of SWP supplies used in the water balance analyses for this report needed to cover a longer hydrology sequence to match with forecasts of CRA supplies. The CalSim II modeling studies were extended beyond 2003 to 2012 using regression analysis. **Table A.10-2** summarizes the total SWP supplies available to Metropolitan under each scenario, with the extended hydrology range.

Table A.10-2
Summary of State Water Project Table A and Article 21 Deliveries (Acre-Feet)

SWP Supply Scenario	Minimum	Average	Maximum
DCR Base	209,000	1,202,000	2,022,000
Early Long-Term	160,000	1,177,000	2,008,000
Existing Conveyance Low Outflow	229,000	984,000	1,695,000
Existing Conveyance High Outflow	154,000	837,000	1,695,000
Alternative 4a	314,000	1,213,000	1,863,000

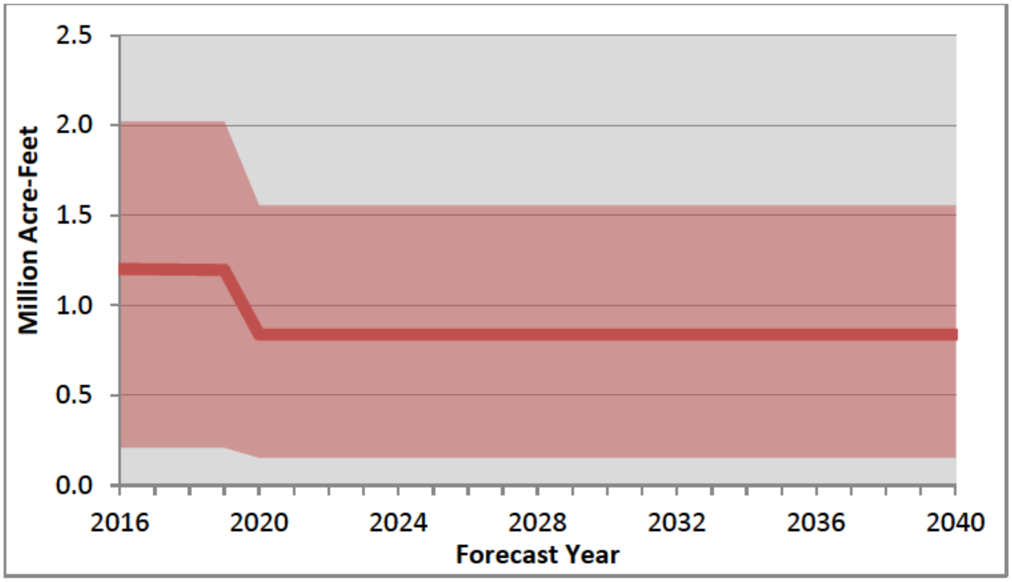
The following chart, **Figure A.10-1**, shows the full range of SWP supplies available to Metropolitan for each of the supply scenarios described above. For each scenario, the 91 hydrology outcomes from 1922-2012 are ranked in order from lowest to highest. This display provides a visual comparison between the different scenarios, as well as additional information about the supply profile for each scenario. For example, the bottom purple line shows the profile for the Existing Conveyance High Outflow scenario. From this chart you can see the minimum and maximum values for this scenario, which correspond to **Table A.10-2** above. In addition the values on the X-axis provide information as to the likelihood of being at or above a certain level of supplies. For example, looking again at the Existing Conveyance High Outflow scenario, this chart shows a 75 percent chance of being at or above 670,000 acre feet of total SWP supplies.

Figure A.10-1
SWP Supply Scenarios Total Table A and Article 21 Supplies



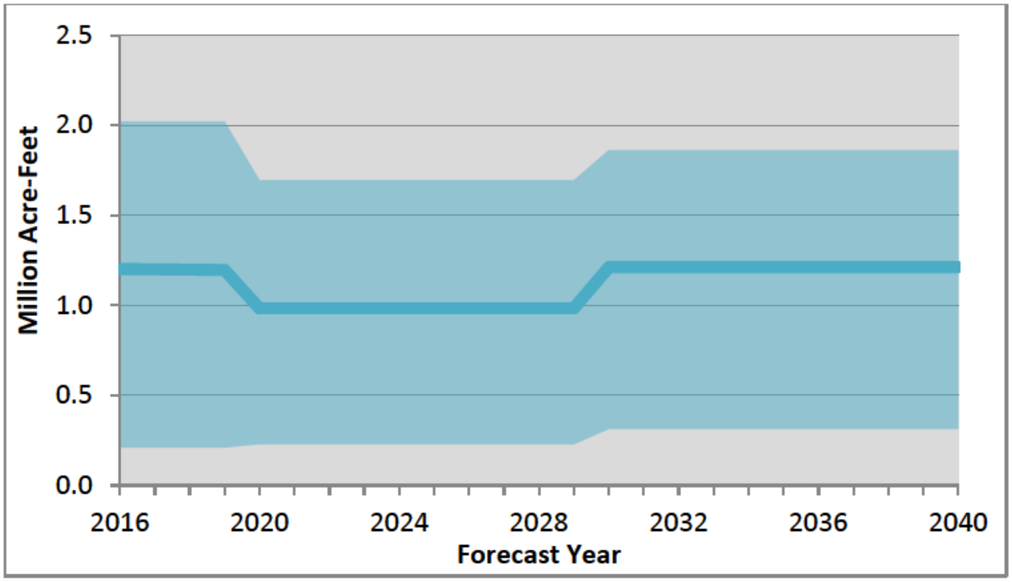
The following charts, **Figure A.10-2** and **Figure A.10-3**, illustrate how different supply scenarios are combined to produce forecasts of SWP supplies over time. For example, the following figure shows the forecasted SWP supplies under the "Do Nothing" case. The "Do Nothing" case begins in 2016 with the DCR Base Case scenario. From the DCR Base Case scenario, SWP supplies decrease slightly over time heading towards the Early Long-Term scenario. In 2020, the forecast drops to the Existing Conveyance High Outflow scenario, and stays at that level until the end of the forecast period. This reflects the assumption that without significant actions and investments to protect SWP supplies against new regulations and flow restrictions, 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. The solid line shows the average SWP supplies and the shaded area the minimum and maximum range for the "Do Nothing" case; these values correspond to the numbers shown in **Table A.10-2**.

Figure A.10-2
Forecasted Average and Range of Supplies from the State Water Project from 2016 to 2040 under the "Do Nothing" Case



Similar to **Figure A.10-2**, **Figure A.10-3** shows the SWP supply forecast for the "IRP Approach" case. Under the "IRP Approach" case, the SWP supply forecast starts with the same assumptions as the "Do Nothing" case; with the DCR Base Case decreasing slightly over time towards the Early Long-Term. In 2020, the SWP supply forecast drops to the Existing Conveyance Low Outflow scenario and stays at that level until 2030. In 2030 the supply forecast increases to the Alternative 4a scenario as the California WaterFix is completed. The Alternative 4a forecast is maintained through the end of the forecast period. Again, the solid line shows the average SWP supplies and the shaded area the minimum and maximum range for the "IRP Approach" case; these values correspond to the numbers shown in **Table A.10-2**.

Figure A.10-3
Forecasted Average and Range of Supplies from the State Water Project from 2016 to 2040 with IRP Target Development



COLORADO RIVER AQUEDUCT FORECAST

Forecasts of base supplies from the Colorado River are generated by the United States Bureau of Reclamation (USBR).

The Colorado River Simulation System Model (CRSS Model) is a modeling package developed, maintained and used by USBR to simulate future operations and deliveries of the Colorado River reservoir system. The CRSS Model originated in the early 1970's as a FORTRAN program; the current version of the CRSS Model is built using RiverWare, a river basin modeling tool developed at the University of Colorado, Boulder by the Center for Advanced Decision Support for Water and Environmental Systems.

The CRSS Model covers the geographic range of the Colorado River drainage basin from the headwaters in Wyoming to the United States-Mexico border. The system is represented in the CRSS Model by 12 major reservoirs, 29 hydrologic inflow points, and over 150 aggregate users (each representing one or more diversion sites).

Inputs to the CRSS Model include: initial reservoir conditions, hydrology and diversion and depletion requests.

Outputs from the CRSS Model include reservoir variables such as storage, elevation, and release, actual diversion and depletions, and system operational indicators for conditions such as surplus and shortage.

The model version used in the 2015 IRP Update is USBR's January 2015 Official CRSS with some modifications made by Metropolitan staff to incorporate assumptions for this effort that differ from a standard run. Some of the key assumptions are:

- Simulate the time period January 2015 through December 2050 on a monthly time-step
- Initialize the model using actual end-of-2014 reservoir conditions
- Extend current surplus and shortage guidelines beyond 2026
- Remove land fallowing and Intentionally Created Surplus (ICS) from this model (IRPSIM determines land fallowing and ICS allocations)
- Use hydrology for years 1922 through 2012 to be consistent with other modeling efforts that are part of this study (data set is 1906-2012)

The model was successfully executed and generated 91 possible outcomes under an index sequential application of the hydrology data set. Output from the CRSS was provided as input to IRPSIM for such variables as annual Metropolitan depletions and surplus volumes; annual system status (shortage, surplus, or normal); and end-of-year storage and elevation in Lake Mead.

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

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Appendix 11

IRPSIM

Appendix 11 – IRPSIM

IRPSIM is Metropolitan's primary tool for evaluating the region's future water supply reliability. The IRPSIM model integrates projections of demands, conservation, imported supplies, and storage to determine future reliability under a range of resource management strategies. Metropolitan originally developed IRPSIM to evaluate the different resource options proposed during the 1996 IRP development process.

In order to perform a resource evaluation, IRPSIM requires input from several of Metropolitan's planning models, as well as inputs derived from DWR and USBR planning models.

MWD-EDM Model: Generates retail demand forecasts using an econometric-based model. For additional information on the MWD-EDM Model reference **Appendix 8** of this report;

Conservation Savings Model: Estimates retail level conservation savings based on conservation devices and programs. Reference **Appendix 9** of this report for additional information on Metropolitan's conservation model;

Local Supply Project Surveys: Provides a forecast of future local supplies based on input received from surveys of the member agencies. **Appendix 5** provides a list of existing and future projects that were provided by the member agencies;

Metropolitan Sales Model: Applies climate effects to the weather-normal forecasts of retail demands and local supplies. The sales model also incorporates forecasts of retail demand, conservation savings, and local supplies to determine demands for Metropolitan supplies;

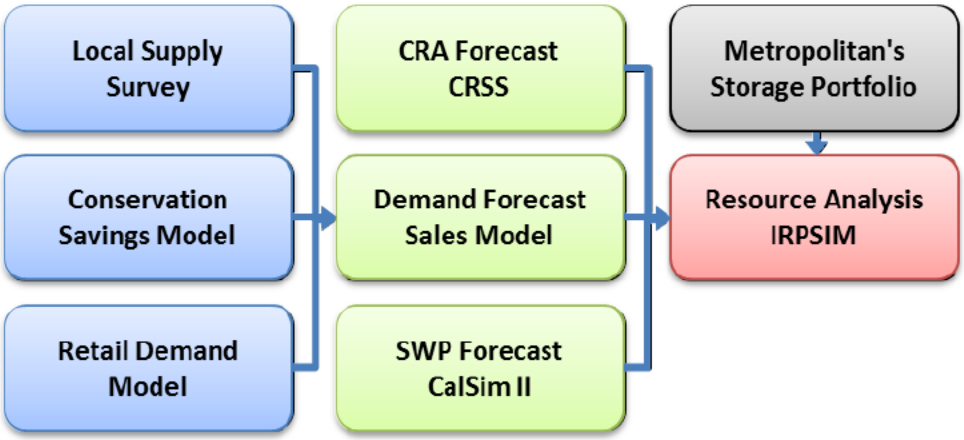
CALSIM II: DWR model forecast of SWP supplies; see **Appendix 10** on imported supply forecasting

CRSS: USBR model forecast of Colorado River supplies; see **Appendix 10** on imported supply forecasting and

Storage Portfolio: Metropolitan's storage portfolio is modeled in IRPSIM, each storage program is represented in detail within the model. Storage programs are described in further detail in **Appendix 3** and **Appendix 4** of this report.

The following figure, **Figure A.11-1**, illustrates the relationships between IRPSIM and the various planning models described above.

Figure A.11-1
Diagram of Metropolitan Planning Models and Forecasts



MASS BALANCE MODELING

IRPSIM is what is known as a mass balance simulation model; in each forecast year, IRPSIM evaluates supplies and demands and then uses Metropolitan's resource portfolio to balance any differences between the two. If a surplus exists between supplies and demands, water is stored in Metropolitan storage accounts until all of the capacity is used, storage is full, or supplies and demands are balanced. Any remaining surplus supplies are considered unused or "wasted" and are not available for use in subsequent years of the forecast. Conversely, if a shortage exists, IRPSIM will draw from Metropolitan's storage and transfer programs until all of the capacity is used, storage is empty, or supplies and demands are balanced. If in any year the gap between supplies and demands is too large to be balanced by Metropolitan's resource portfolio, shortages are used to balance the model. In practice, shortages would result in implementation of Metropolitan's Water Supply Allocation Plan.

INDEXED SEQUENTIAL METHODOLOGY

IRPSIM uses a modeling methodology known as indexed sequential monte-carlo simulation. Under this methodology IRPSIM evaluates projections of Metropolitan's demands, imported supplies, and storage portfolio based on an assumed pattern of future climate. Demands, local supplies, and imported supplies all vary depending upon the associated hydrologic conditions. Rather than try to predict future weather patterns, IRPSIM cycles through 91 years of historical hydrology from 1922 to 2012. In this manner, the indexed sequential methodology generates 91 different reliability outcomes for each forecast year, based on the range of impacts seen in the historical hydrology. Using the indexed sequential methodology, Metropolitan can evaluate the probability of being in shortage or surplus for each forecast year given the range in historical hydrology. This method of sequential analysis is also effective in capturing the operation of storage resources that are drawn upon and refilled over the forecast horizon.

As an example, if the weather over the next 20 years (2016-2035) was expected to be the same as the last 20 years (1996-2015), IRPSIM would adjust the projected 2016 demands and supplies using the historical 1996 hydrology, and adjust the projected 2017 demands and supplies using the historical 1997 hydrology, and so on. This method preserves the sequence of hydrologic history, as well as the independence of hydrologic variations in demands and the individual supply sources. The following figure illustrates how IRPSIM cycles through the historical hydrology impacts to generate 91 different trials or "traces" over the 2016 to 2040 forecast horizon.

IRPSIM OUTPUT & ANALYSIS

Based on the modeling methodologies described above, IRPSIM generates large amounts of output data. Each simulation produces 91 hydrology outcomes for each the nearly 8,000 variables modeled in IRPSIM, under each of the 2016 to 2040 forecast years. In order to narrow this output down into something meaningful, analyses usually focus on a selection of key variables, these key output variables generally fall into the following categories: demands, conservation, local supplies, quantity of surplus or shortage, yields from Metropolitan supply programs, use of transfers, storage programs, and storage balances.

Figure A.11-2
Illustration of the Indexed Sequential Methodology Used in IRPSIM

Year	2016	2017	2018	2019	2020	→	2040
Trace 1	1922	1923	1924	1925	1926	→	1956
Trace 2	1923	1924	1925	1926	1927	→	1957
Trace 3	1924	1925	1926	1927	1928	→	1958
Trace 4	1925	1926	1927	1928	1929	→	1959
Trace 5	1926	1927	1928	1929	1930	→	1960
↓	↓	↓	↓	↓	↓	→	↓
Trace 91	2012	1922	1923	1924	1925	→	1955

The first approach is to evaluate IRPSIM output for individual years; referencing **Figure A.11-2** above, a single year is evaluated by reading down a column. This approach provides the range in values and the likelihood of occurrence for any variable in a single forecast year based on the 91 historical hydrologies. The reliability curves shown in **Sections 3** and **4** of the 2015 IRP Update report are examples of this type of analysis. The second approach is to evaluate IRPSIM output by individual hydrology traces; looking at **Figure A.11-2** above, an individual trace is evaluated by reading across a single row. This approach provides an accounting of how demands, local supplies, and Metropolitan's resource portfolio perform in the future over a single time series of climate.

WATER TOMORROW

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

Integrated Water Resources Plan Update 2015

Appendix 12

Cost Data

Appendix 12 – Cost Data

To gain a general sense of scale of future resource development costs, data was compiled in coordination with Metropolitan member agencies. The following describes the methodology and assumptions for estimating the range of resource development unit costs.

METHODOLOGY

The unit cost ($/acre-foot) calculation used is:

$$\frac{Ammortized\ annual\ Capital\ Cost\ (\$) + Annual\ Operating\ Cost\ (\$)}{Annual\ beneficially\ used\ water\ production\ (acre-feet)}$$

Future projects were analyzed to provide a reasonable range of sample future project costs for each resource type. The data set is based on identified future projects through the IRP project inventory list, stormwater database (developed through the Southern California Water Committee Stormwater Task Force), project reports, and member agency feedback. The analysis includes projects with the status of feasibility, advanced planning, or full design and online before 2025. Outliers were not included in this analysis. Stormwater projects with less than 50 acre-feet of annual yield and recycled water projects with less than 300 acre-feet of annual yield were also not included in this analysis due to an observed resulting deviation from the expected range of values (cost breakpoint of larger unit costs for smaller projects).

ASSUMPTIONS

For an "apples to apples" comparison, components of the unit cost calculation were standardized. These adjustments included the following for potential in-region resources:

- Annual supply production
  - Utilized the anticipated yield beyond the start-up period
  - A utilization factor of 85 to 90 percent (or a factor provided directly from the project proponent) was assumed to account for planned and unplanned outages or other issues
  - No escalation or discount rates applied (not a relative unit cost)
- Financial assumptions
  - Annual capital costs
    - Amortized at 5 percent over 30 years
    - Includes distribution facilities
    - Includes contingencies
    - Utilized existing information or a cost model based on recent, similar projects

        - The California CPI was used to bring the cost estimates made in prior years to 2015 dollars
        - No escalation or discount rates applied
    - Operations and Maintenance (O&M) costs
        - Includes the cost to treat and deliver the water (e.g., assumed groundwater pumping costs of $200/acre-foot if other data was not available)
        - Power costs (seawater desalination): Electricity costs ranged from $0.095 per kWh to $0.150 per kWh
        - Calculated at 3 percent of the capital costs if data was not available (recycled water projects)
        - Annual escalation not included

Actual unit costs for any given future project may vary according to specific project parameters and future conditions. This analysis simply provides a general picture of costs to help advance future discussions.

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