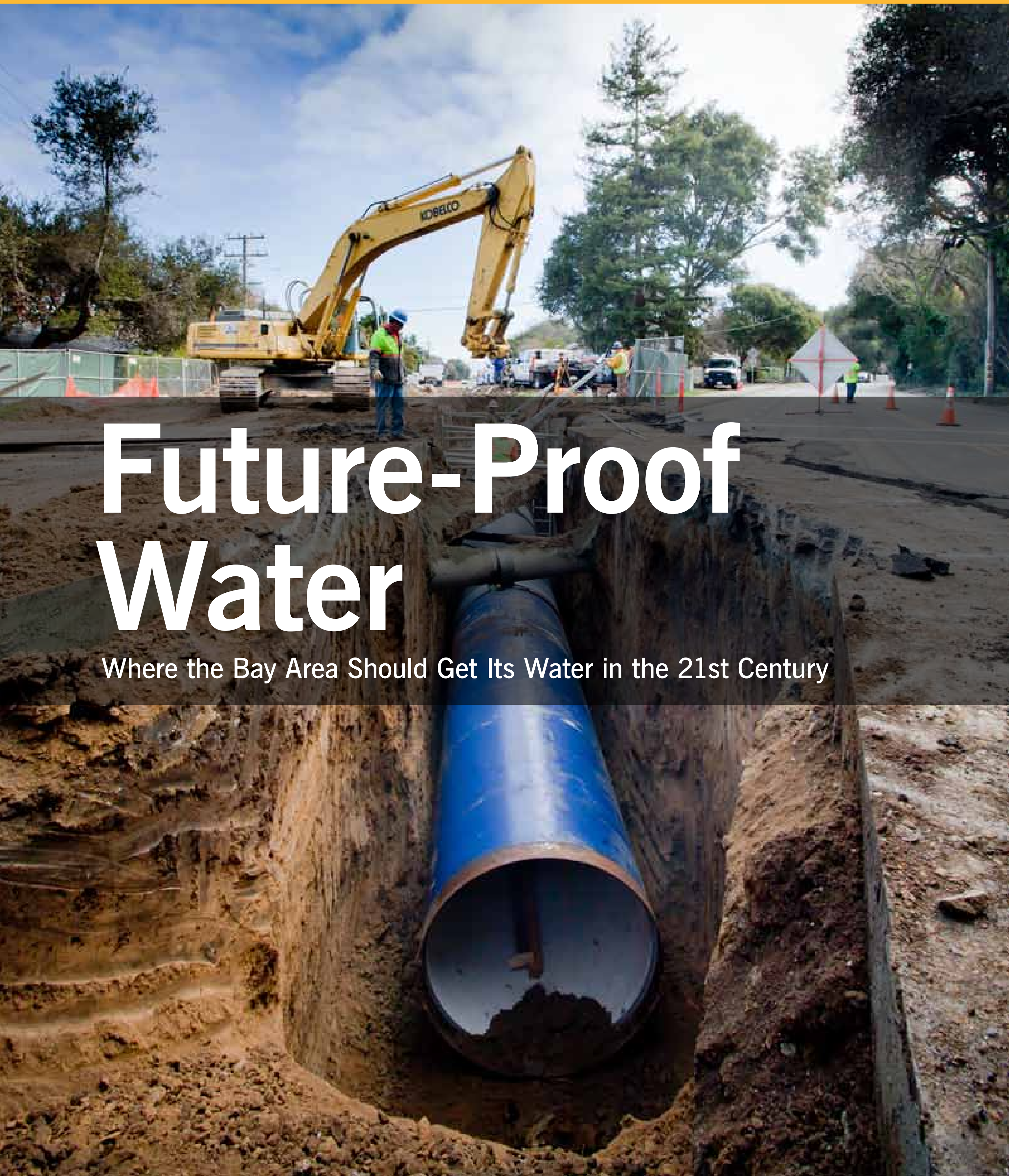
SPUR REPORT 03/2013

Future-Proof Water

Where the Bay Area Should Get Its Water in the 21st Century



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The SPUR Board of Directors reviewed, debated and adopted this report as official policy on January 16, 2013.

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ON THE COVER

The new Bay Division Pipeline No. 5 is part of a seismic upgrade to the Hetch Hetchy regional water system.

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Executive Summary
Future-Proof Water

As water is essential to life, having a safe, reliable supply of water is crucial for the continued growth and prosperity of the Bay Area. Our region of 7 million people will add 2 million more by 2040—growth that will require water. More than two-thirds of the Bay Area's water is imported from outside the region, mostly from the Sierra Nevada and the Sacramento–San Joaquin River Delta. Today these supplies are regularly threatened by drought, earthquakes, water quality impairments and new regulations on availability and usage — risks that will intensify with future climate change.

To understand our future water supply vulnerabilities and to recommend ways to minimize the environmental impact of our growing region, this SPUR report addresses two questions:

1. Does the Bay Area have the water we need to support projected population growth?
2. How should we supply our region's future water needs?

SPUR found that most but not all of the Bay Area's urban water agencies will have sufficient supplies to meet projected region-wide water demand in 2035, which will be 22 percent greater than demand was in 2010. But soon after 2035, the region will not have enough water to meet its needs without curbing use or developing new supplies. During dry years or multiple-year droughts, some parts of the region will experience water shortages even sooner. Beyond 2035, several variables will affect how much water the region will need to serve its growing population, including the impacts of climate change on the availability of supplies and on water storage and the intensity of the region's future growth and development patterns.

It takes many years to study, plan, permit and construct water-supply facilities, so it is not too early to begin planning for water supplies in 2035 and beyond. SPUR evaluated a wide range of measures to reduce the demand for water and to augment the water supply, comparing them based on cost-effectiveness, reliability and environmental impact. Recognizing that water agencies in the Bay Area face unique supply and demand challenges in their service territories and that a one-size-fits-all strategy would be inappropriate, we recommend that the region begin meeting our future needs by conserving water and lowering the demand for new supplies. Then we propose that remaining needs be met through a hierarchy of new supplies that prioritizes reliability and sustainability.

SPUR's recommendations for securing future Bay Area water supplies

1. Develop water supply scenarios for mid-century and beyond that include assumptions about changes in the amount and timing of precipitation.

2. Evaluate the vulnerability of water supply and delivery systems to earthquakes, develop risk-reduction plans and invest in reliability upgrades to meet service goals.

3. Prioritize demand management measures, especially water efficiency and conservation best management practices, as a low-cost, highly reliable and low-environmental-impact strategy for meeting future water needs.

   a. Water agencies should develop and advance retrofit-on-resale ordinances to improve the water efficiency of existing commercial and residential buildings.

   b. Water agencies should study pricing and rate structure reforms, including tiered pricing, to create incentives for conservation at higher volumes of use.

4. Require new development to be highly water-efficient through compact land use planning, green building ordinances and/or by making water-neutrality a condition of approval for new large developments.

5. After demand management measures are fully implemented, prioritize development of new water supplies in the following order:

   a. Conjunctive use, carefully monitored groundwater projects and indirect/direct potable reuse projects

   b. Recycled water, on-site reuse and district-scale systems, and banking and transfers

   c. Desalination and development of new surface water supplies and surface storage

6. Employ water rationing as a temporary emergency measure only.

Explanations of the recommended tools begin on page 23.
Complete recommendations begin on page 32.

Where the Bay Area Should Get Its Water in the 21st Century

For more than a century, water supply and management has been one of the most enduring and complex policy issues in California. Monumental investments in water delivery and infrastructure — largely to move water from north to south and east to west — supported the state's economic expansion and urban growth in the 20th century. Today this water delivery system is aging and ever more at risk from challenges such as climate change, sea level rise, earthquakes, and a public mandate to reduce impacts on ecosystems and endangered species. As key parts of the system are retrofitted[1] or even reconsidered altogether,[2] demand for water is growing rapidly: California's population is expected to increase more than 50 percent by 2050, increasing the competition for available water supplies.

The Bay Area, which relies on imported water from the Sierra Nevada and the Sacramento–San Joaquin River Delta for two-thirds of its water supply, is also growing. Our region, home to more than 7 million people in 2012, is expected to add 2 million more by 2040 — accommodating a quarter of the state's expected growth of 8 million people by that time. This growth will require reliable and safe water. There are many ways to extend our existing water supplies further into the future through efficiency, demand management, conservation, plumbing code changes and other efforts to reduce per capita water use — policies and programs this report will describe in more detail. But existing supplies are at risk even today from drought, earthquakes, water quality impairments and new regulations on availability and usage — risks that are very likely to grow as the climate changes.

This SPUR report aims to answer two questions:

1. Does the Bay Area have the water we need to support projected population growth?

2. How should we supply our region's future water needs?

1 For example, the San Francisco Public Utilities Commission's Water System Improvement Program, a $4.6 billion seismic retrofit of the San Francisco and peninsula water delivery system. Available at: www.sfwater.org/index.aspx?page=114

2 For example, the Bay Delta Conservation Plan (BDCP), a multi-stakeholder and multiyear planning process that resulted in a 2012 governor's proposal to shift the delta diversion point farther north and tunnel Sacramento water to the southern parts of the state. Available at: http://baydeltaconservationplan.com/Home.aspx

Seismic improvements to Calaveras Reservoir's downstream dam are underway to improve the reliability of this water source.

SPUR has a long history of support for water infrastructure and development projects, from supporting 2002 ballot measures that funded the San Francisco Public Utilities Commission's Water System Improvement Program to more recent efforts to recycle water and to legalize on-site water reuse in new large developments.[3] In our 2011 report *Climate Change Hits Home,* we briefly discussed the potential impacts of climate change on water systems.[4] We recommended that Bay Area water supply agencies plan for climate change through at least the end of the century and prioritize alternative water supply opportunities and demand management strategies according to cost, reliability and environmental benefits. We specifically encouraged agencies to evaluate locally available drought-proof strategies such as conservation, water recycling and desalination.

In this report, we describe the region's current water systems and supplies, future availability of those supplies, future water demand and options for meeting that demand. We also recommend which types of water supplies will be our most reliable, most sustainable long-term options.

3 Available at: www.spur.org/publications/library/policymemo/spur-supports-non-potable-water-ordinance

4 *Climate Change Hits Home*, May 2011. Available at: www.spur.org/adaptation

Figure 1: Major Urban Water Agencies in the Bay Area

Eleven water agencies serve 7.1 million people in the metropolitan Bay Area and beyond.

Source: SPUR map with data from: California Spatial Information Library ABAG Projections, 2005; Bay Area Integrated Regional Water Management Plan, November 2006

Bay Area Water Supplies

The Bay Area's water systems are managed by a network of special districts, city and county agencies, and private companies.[5] There are more than 100 water retailers and wholesalers in the region, serving residential, commercial, industrial and agricultural users. Eleven major water agencies manage the water supply for the vast majority of urban users in the Bay Area (see Figure 1). These agencies have diverse supply portfolios, i.e., sources where they get water. These include local groundwater (underground well water), surface water (rivers and lakes), recycled water (treated wastewater for approved uses) and water imported directly from major Sierra rivers and the delta (see Figure 2, page 8).

Water agency supply portfolios tend to depend on local geography, historic water rights and contracts for buying imported water. For example, the San Francisco Public Utilities Commission (SFPUC), which serves 2.6 million people in San Francisco, San Mateo, Alameda and Santa Clara counties, receives 85 percent of its water from the Tuolumne River and 15 percent from local supplies, including Alameda Creek. The Santa Clara Valley Water District, a wholesale supplier in Santa Clara County, supplies about 50 percent of its water from local surface and groundwater and 50 percent from imported water sourced from the State Water Project and Central Valley Project, in addition to supplies delivered to the county by the SFPUC. The Bay Area also has 28 major groundwater basins — underground reserves or aquifers, commonly known as well water — underlying about 30 percent of the region.[6] (See Figure 10, page 29.)

Four major conveyances, or water systems, import two-thirds of the region's water from the delta and the Sierra Nevada (see Figures 2 and 3, pages 8 and 9):

1. The Mokelumne River watershed supplies 90 percent of the water for the East Bay Municipal Utility District (East Bay MUD). The district has water rights to divert up to 325 million gallons a day (mgd) from this river system and owns and operates two major reservoirs, which are managed for water storage, flood control, recreation and fisheries.

2. The Tuolumne River watershed in Yosemite National Park supplies 85 percent of water for the SFPUC, which serves the City and County of San Francisco and 26 wholesale customers in three counties with about 218 mgd through the Hetch Hetchy system.

3. The State Water Project, managed by the California Department of Water Resources (DWR), supplies water from the Feather River watershed that is conveyed through the delta to several Bay Area agencies, including the Alameda County Water District, the Zone 7 Water Agency (serving Livermore–Amador Valley), the Solano County Water Agency and the Santa Clara Valley Water District.

4. The Central Valley Project, managed by the U.S. Bureau of Reclamation, supplies water from the Trinity River, Sacramento River, American River and San Joaquin River watersheds that is also conveyed through the delta. It is a significant supplier for the Santa Clara Valley Water District and Contra Costa Water District and provides a supplemental water supply to East Bay MUD in dry years.

These major water systems convey the region's everyday water supplies, but water agencies in the region also mitigate the risk of drought with supplemental dry-year supplies. Many participate in water transfer agreements, which may be either short-term, one-time deals typically lasting a year or less or long-term agreements that provide urban water agencies with supplies when they're available or offer an option to buy supplies in dry years. These transfers and long-term agreements are typically made with local irrigation districts or agricultural suppliers.

Some agencies also participate in innovative water management programs to store water in the ground in wet years for use in dry years. For example, some agencies have groundwater basins with available space for storage, enabling them to practice "conjunctive use," a strategy to manage surface water and groundwater supplies together: aquifers are used to store water in wet years and then are drawn down in dry years. Some agencies participate in faraway water banks to serve a similar purpose. For example, the Alameda County Water District, Santa Clara Valley Water District and Zone 7 Water Agency have contract rights to store more than 565,000 acre-feet of water in groundwater banks in Kern County.[7] Because these banks are located south of, or downstream from, the districts'

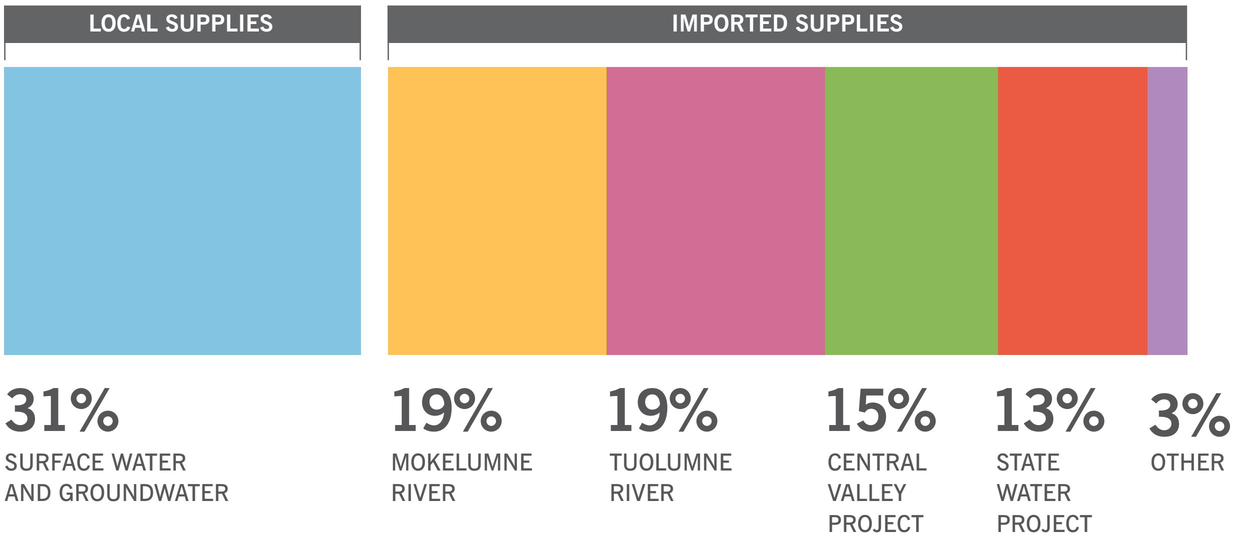
5 Association of Bay Area Governments' Earthquake and Hazards Program, Water System and Disasters: Background Information Compiled for the 2009–2010 Update of the Multi-Jurisdictional Local Hazard Mitigation Plan for the San Francisco Bay Area, December 2009. Available at: http://quake.abag.ca.gov/wp-content/uploads/2010/10/Water-and-Disasters.pdf

6 Bay Area Integrated Regional Water Management Plan, November 2006, p. B-8. Available at: www.bairwmp.org

7 For example, the Semitropic Water Storage District, www.semitropic.com

Figure 2: Sources of Regional Water Supply

The region's water comes from diverse sources, but two-thirds of it is imported from outside the region.



Source: Bay Area Integrated Regional Water Management Plan, November 2006, p. B-27.

normal water delivery facilities, the return of water in dry years is accomplished by exchanging supplies within the State Water Project. In dry years, water is delivered from the Kern groundwater banks to meet State Water Project demands in Southern California, while an equivalent amount of State Water Project supply is diverted farther north directly to the Alameda County Water District, Santa Clara Valley Water District and Zone 7 Water Agency.

The region's major water suppliers have a history of cooperating to achieve shared goals. In 2006, water resource managers in the region worked together on a massive regional planning project, the Bay Area Integrated Regional Water Management Plan,[8] which will be updated again in 2013. This plan is a comprehensive assessment of water resource challenges and opportunities in the region, including water supply, water quality, habitat management and flood control issues. Its completion and update allow the region to access significant state funding for projects and for region-wide goals such as improving the seismic reliability and climate resilience of water resource systems.

In case of emergencies such as severe earthquakes, regional water agencies have also constructed interties, pipe connections that link their systems and can deliver water where it is needed in the event of an outage. For example, the SFPUC's Hetch Hetchy system is intertied with East Bay MUD and the Santa Clara Valley Water District; 25 member agencies of the Bay Area Water Supply and Conservation Agency (BAWSCA)[9] are intertied with each other; and East Bay MUD is intertied with the Contra Costa Water District and with other neighboring agencies. But while these interties are valuable measures to keep water flowing in the event of an emergency, they are not a source of new supplies to meet the region's growing demand.

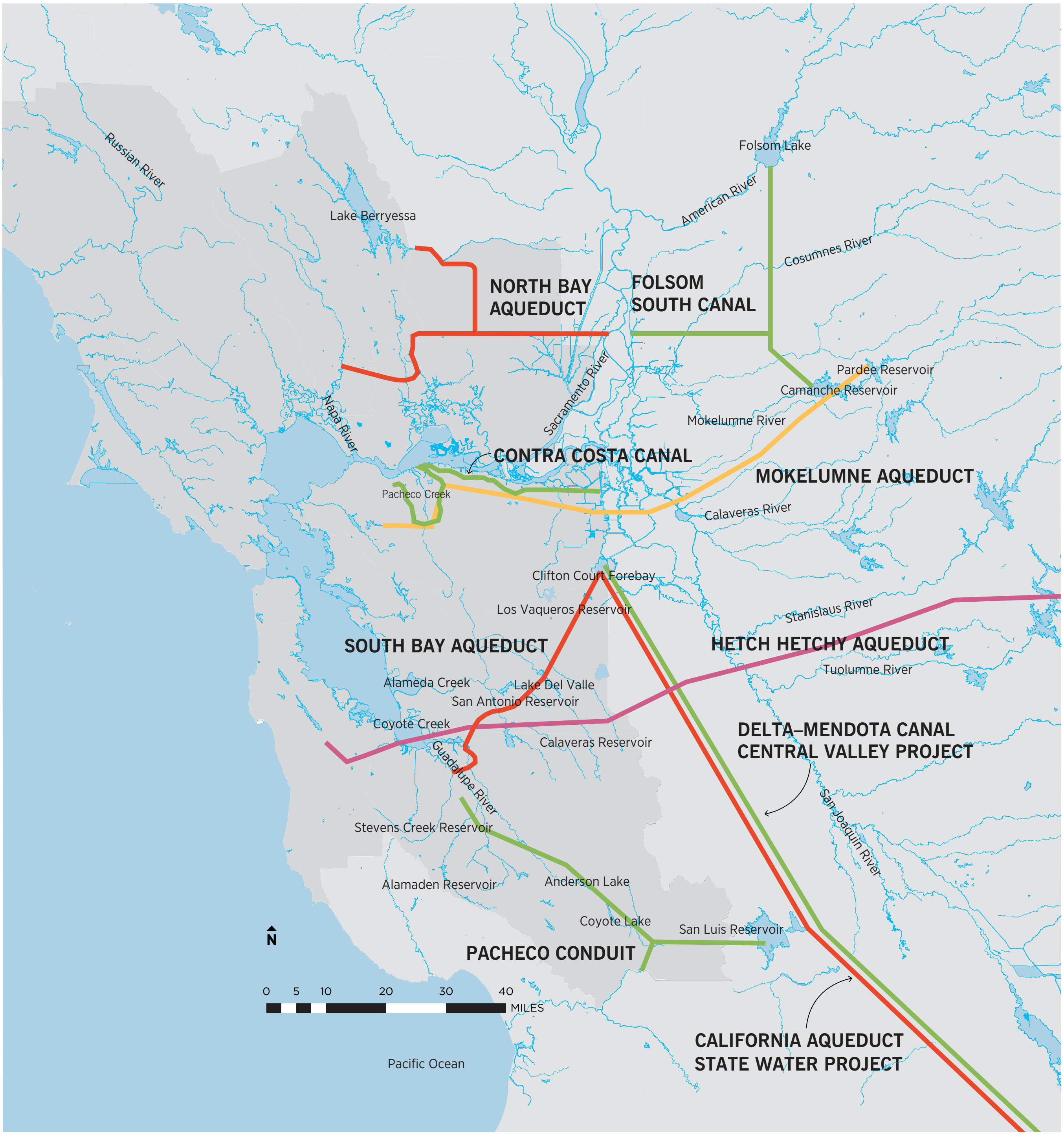
Although critical, interties do not protect the region from earthquake damage to our many miles of pipelines and other water system infrastructure. According to the U.S. Geological Survey, there is a 63 percent chance that a magnitude 6.7 or greater earthquake will occur in the Bay Area in the next 30 years. More than 93 percent of critical water system facilities in the region are vulnerable to severe

8 For more information about the 2006 Integrated Regional Water Management Plan and the 2013 update, visit www.bairwmp.org

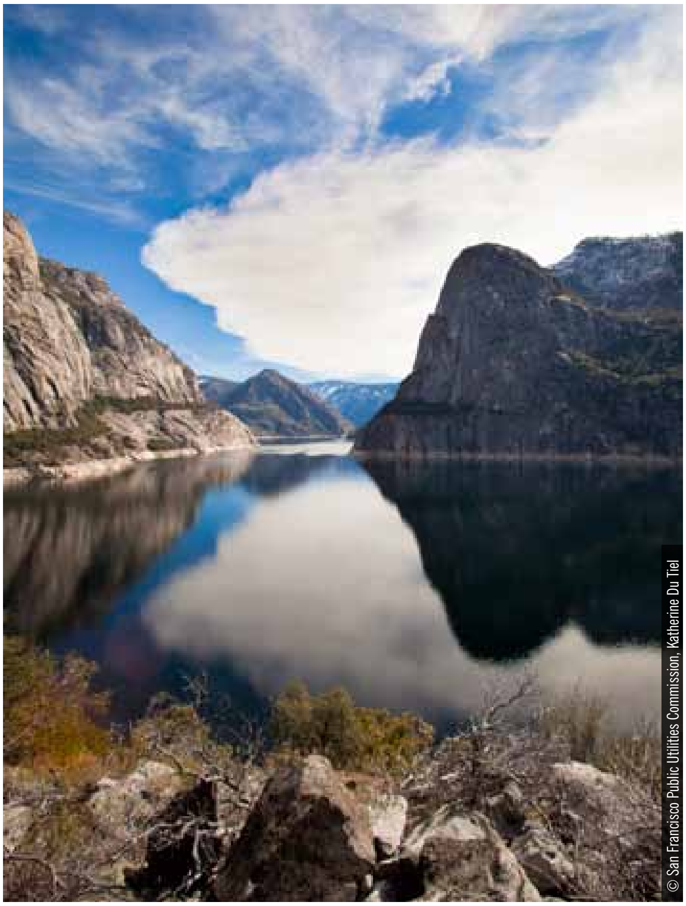
9 BAWSCA is comprised of the 26 wholesale customers of the SFPUC and includes the entirety of the Alameda County Water District.

Figure 3: Major Water-Importing Infrastructure in the Bay Area

The Bay Area is highly dependent on imported water from four primary sources: the State Water Project (shown in red), the Central Valley Project (green), the Tuolumne River watershed (purple) and the Mokelumne River watershed (yellow). The region conveys, pumps and treats water in several interconnected systems. (Local reservoirs, wells and pipelines not shown).



Source: SPUR map with data from: Cal-Atlas, PG&E, Santa Clara Valley Water District, Bay Area Integrated Regional Water Management Plan



The largest reservoir in the SFPUC's regional water system, Hetch Hetchy serves more than 2.5 million people in the Bay Area every day.

ground shaking.[10] If the Hayward Fault in the East Bay ruptures, that could damage the Hetch Hetchy, Mokelumne and South Bay aqueducts and numerous local pipelines; some local dams are also on or near faults.[11] Using data from the 1989 Loma Prieta Earthquake, the Association of Bay Area Governments estimates that 6,000 to 10,000 water pipeline ruptures could occur following a Hayward fault event. Many agencies, such as East Bay MUD, the Contra Costa Water District, the SFPUC and BAWSCA, have funded major improvements to the seismic reliability of their water systems, such as the SFPUC's $4.6 billion Water System Improvement Program.

Perhaps the greatest remaining seismic risk to the Bay Area's water supply is the potential levee failure in the delta, which provides water to 25 million people in California. Much of the land in this region is below sea level and protected by more than 1,000 miles of earthen levees, many of which hold water back 365 days a year. If these fail, salt water from the bay will flow into the delta and enter the drinking water system; if these levees catastrophically fail and the delta is flooded as the result of an earthquake (and there is a 55 percent probability that this will happen in the next 25 years), exporting fresh water from this system could be interrupted for a year and a half.[12] Water districts that wholly rely on delta supplies, such as the Contra Costa Water District, are especially vulnerable to such an event. If they haven't already, Bay Area water suppliers should assess their system vulnerabilities to earthquakes, and conduct retrofits of critical lifeline infrastructure to minimize damages from future disasters.

10 ABAG, supra note 5.

11 Ibid.

12 Ibid.

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1. The Rinconada Water Treatment Plant treats 80 million gallons of delta water a day for west Santa Clara Valley.
2. Anderson Reservoir is the largest reservoir in the Santa Clara Valley Water District's system.
3. The 5-mile-long, 100-foot-deep Bay Tunnel allows water pipelines to cross underneath San Francisco Bay, surfacing in Menlo Park (shown here).
4. The Hetch Hetchy intertie links the SFPUC water system with the Santa Clara Valley Water District, among others, to provide backup water supplies in case of emergency.
5. Lower Crystal Springs Dam on the peninsula is undergoing seismic upgrades as part of the SFPUC's Water System Improvement Program.

The Bay Area's Future Water Demand

The Bay Area's 11 major urban water suppliers served 7.1 million people in their service areas in 2010. By 2035, that population is projected to grow by 25 percent to almost 9 million people (see Figure 4). Projected population growth across the region will not occur evenly; some water districts will see a faster rate of growth than others. This means that demand for and pressure on existing water supplies will be more intense in some parts of the region than others. Projected employment growth in the region through 2035 is also significant — about 1.1 million jobs, about a third of which can be accommodated in existing development.[13] Most of the job growth will occur in relatively water-intensive fields among commercial/institutional users: knowledge, health and education, and leisure and hospitality.[14] Together, the residential and commercial/institutional sectors are the two largest customer types served by urban water agencies in California, with residential use accounting for two-thirds of all urban water use.[15]

How does this growth translate into water demand projections? California water agencies with more than 3,000 connections (i.e., separately metered customers) are required to prepare an urban water management plan every five years, describing existing supplies, planned supplies, projected demands and drought contingency plans at least 20 years into the future.[16] To forecast future demand, a simple approach is to multiply current per capita water use by projected population growth in an agency's service area. For the past 30 years in California, this relationship between population and water demand has been closely correlated.[17] But most agencies actually have a much more complicated water demand model, factoring in projected land use changes in their service territories plus three important trends:

1. The Water Conservation Act of 2009 (SB X7-7) set a state goal to reduce urban per capita water use 20 percent by 2020. All urban retail water agencies must establish a baseline per capita water use level and develop reduction targets, which may be a straight 20 percent reduction or one of three other methods approved by the California Department of Water Resources (DWR). Agricultural suppliers are not required to meet reduction targets but instead must implement efficient water management practices. Agencies must comply with SB X7-7 in order to continue to be eligible for state water grants or loans. Implementing this law should decrease per capita demand through 2020, in some cases well below what agencies have expected in the past.

2. As of 2009, California's building code, Title 24 (or CALGreen), mandates that new construction demonstrate a 20 percent savings from baseline water use through the installation of high-efficiency fixtures like toilets, faucets and showerheads. CALGreen also requires outdoor water use to conform to local water-efficient landscape ordinances (which cities are required to have) and for irrigated landscape design to reduce water use by 50 percent from initial plant establishment.[18] Many water agencies assume a certain percentage of future projected water "savings" will result from the gradual implementation of these plumbing code changes and new appliance standards in new construction, sometimes referred to as "passive conservation." In the Bay Area, urban water agencies generally factor this passive conservation into future demand estimates, so reported demand projections already include these savings. Passive conservation has saved significant quantities of water throughout California since 1992, when higher-efficiency fixtures were first required in the plumbing code.

3. Most urban water agencies actively implement conservation and efficiency programs to reduce per capita consumption on top of plumbing code savings. These programs, or "active conservation," include dozens of best practices in water conservation, such as education programs, water audits and surveys, free low-flow fixtures, rebates, and developing local retrofit and landscape ordinances. Water agencies usually factor or report savings from these programs into their future demand forecasts, but they may report demand numbers both with and without expected conservation.[19]

13 ABAG and Metropolitan Transportation Commission, Plan Bay Area: Jobs-Housing Connection Scenario, Draft, March 9, 2012.

14 Although some agencies' 2010 urban water management plans include job growth projections, not all do, so we cannot report this data by agency.

15 Christian-Smith, Juliet, Matthew Heberger, and Lucy Allen, Urban Water Demand in California to 2100: Incorporating Climate Change, Pacific Institute, August 2012, p. 14. Available at: www.pacinst.org/reports/urban_water_demand_2100/full_report.pdf

16 AB 797, the Urban Water Management Planning Act, was adopted in 1983.

17 Christian-Smith et al., supra note 15, pp. 15–16.

18 California Building Standards Commission, 2008 California Green Building Standards Code, California Code of Regulations, Title 24, Part 11, effective August 2009, p. 31. Available at: www.documents.dgs.ca.gov/bsc/2009/part11_2008_calgreen_code.pdf

19 For example, the SFPUC reports two demand numbers, one factoring in conservation, and one not. East Bay MUD subtracts all expected conservation and expected future recycled water supplies to report one number: the planning level of demand.

Figure 4: How Much, and Where, Will the Bay Area Grow?

While some service areas are projected to grow in population by less than 10 percent in the next 25 years, three agencies — the Santa Clara Valley Water District, East Bay MUD and Zone 7 Water Agency — serve populations that are projected to grow more than 30 percent by 2035.

	2010	2015	2020	2025	2030	2035	TOTAL CHANGE	PERCENT CHANGE
SAN FRANCISCO	856,095	875,856	895,617	915,377	935,138	954,899	98,804	12%
BAWSCA AGENCIES	859,399	894,250	921,853	950,858	982,306	1,014,212	154,813	18%
SANTA CLARA COUNTY	1,822,000	1,945,300	2,063,100	2,185,800	2,310,800	2,431,400	609,400	33%
ALAMEDA COUNTY WATER DISTRICT	327,000	347,000	364,000	378,000	395,000	411,000	84,000	26%
ZONE 7	220,000	244,000	274,000	285,000	290,000	291,000	71,000	32%
EAST BAY MUD	1,300,000	1,474,000	1,538,000	1,607,000	1,677,000	1,751,000	451,000	35%
CONTRA COSTA COUNTY	495,230	542,650	564,410	586,290	610,270	635,140	139,910	28%
SOLANO COUNTY	413,300	421,500	432,000	443,000	454,000	465,000*	51,700	13%
CITY OF NAPA	86,743	89,243	90,743	91,743	92,643	93,552*	6,809	8%
SONOMA COUNTY	602,270	649,969	672,666	694,116	715,442	735,063	132,793	22%
MARIN MUNICIPAL WATER DISTRICT	190,600	195,200	198,200	201,100	204,000	206,500	15,900	8%
REGION-WIDE	**7,172,637**	**7,678,968**	**8,014,589**	**8,338,284**	**8,666,599**	**8,988,766**	**1,816,129**	**25%**

Population projections by water service area, 2010–2035

* Indicates numbers that were not provided through 2035 in urban water management plans; calculated by SPUR based on five-year trend for the service area. Portions of Santa Clara County that receive SFPUC supplies are included only in the Santa Clara County numbers, and portions of Marin County served by the Sonoma County Water Agency are included only in the Sonoma County numbers.

Source: 2010 urban water management plans of all 11 agencies, in which population projections are typically derived from ABAG's projections and/or the California Department of Finance; BAWSCA Annual Survey, FY 2009–10.

SPUR's analysis of all 11 agencies' urban water management plans shows that across the Bay Area, water demand in normal years (not accounting for the impact of climate change) will grow by 263 mgd, from 1181 mgd to 1444 mgd between 2010 and 2035 (see Figure 5). While the change in aggregate demand is an increase of 22 percent, agencies vary widely in their projections, from a 2 to 3 percent increase in San Francisco and Marin to double-digit increases on the peninsula, in Santa Clara County and in the East Bay. In 2010, most water agencies experienced lower than average demand, largely attributable to the national economic recession. As a result, the increase in demand over the 25-year period, calculated based on 2010 urban water management plans, may exaggerate the rate of increase that the region will actually experience.

For the Bay Area as a whole, the projected growth in water demand is slightly less than the projected population growth over the 2010–2035 period, indicating that the region will become slightly more water-efficient over time. Water efficiency is generally measured by per capita demand (gallons per capita per day, or gpcd), which is the total amount of water used in a service territory divided by the total population. Water agencies typically also report residential per capita demand as a subset of total per capita demand. This is a better metric for apples-to-apples comparisons across service territories, but it does not provide a complete measure of water use because it does not account for commercial, agricultural and industrial uses. Parts of the region are already more water-efficient than others. This is due to a number of factors, including climate, population density, land use, commercial and industrial use, and the presence of agriculture. It is difficult to discern whether a service territory's per capita demand is the result of programs and policies aimed at improving water efficiency, or if its water use is more determined by geographic circumstances such as climate and land use. For these reasons, this SPUR report focuses on total water demand and use — rather than per capita demand or residential per capita demand — because it is what will determine where the Bay Area looks for future water and how much it must find.

In general, Bay Area urban water users are relatively efficient compared to users in other areas in California. San Francisco's per capita use is below 100 gallons per capita per day. In 2010, peninsula and Alameda County water use averaged 137 gpcd, and Santa Clara Valley Water District use averaged 163 gpcd. By contrast, some water districts in warmer and lower-density parts of California, such as the Central Valley, use 200 to 300 gpcd.[20] In the Bay Area hydrologic region[21], the least densely populated and most agricultural areas — Solano County, Contra Costa County and Zone 7 — are the least efficient on a per capita basis, exceeding 200 gpcd, much like Central Valley providers.

The form of future growth, and the land use changes that accompany it, could significantly affect demand. If we accommodate the 2 million people moving to the Bay Area between now and 2035 in more compact, urban areas and multi-family dwellings, we could reduce water use from a business-as-usual scenario.[22] This savings would largely come from using water more efficiently and from cutting the need to water landscaping and lawns, which are more common in large-lot, dispersed suburban development. It has been well-documented that large lots are a major contributor to both residential and commercial water use, largely due to landscaping. Nationwide, lawn care alone accounts for an average of 50 percent of household water use.[23] More compact development also allows for shorter transmission systems, reducing leak losses and lessening energy needs for pumping and pressurization. Infill development in already-dense areas leverages ratepayers' investment in existing water delivery infrastructure, while sprawl development increases capital and maintenance costs for all users. In short, smart growth can reduce both the cost of water provided to ratepayers and the quantity of water they need.[24]

Water utilities have little control over land use and the growth patterns of their service territories. California's Senate Bills 610 and 221 (both passed in 2001) require water supply assurances for new development, but they do not include water budgeting or require efficiency measures. SB 610 requires every large development project to have a water supply assessment, and SB 221 requires cities and counties to make the availability of a sufficient water supply a condition for approving new residential subdivisions. Most urban water management plans, as 20-year master plans, satisfy agencies' compliance with SB 610 and SB 221.[25] But the responsibility for minimizing future water demand through better land use planning and compact development lies with planning agencies and regional growth management agencies. These agencies and elected officials, who approve new large projects, could do more to consider water issues and to require that new development meet

20 DWR, California Water Plan, Update 2009, San Francisco Bay Hydrologic Region, Bulletin 160-09, p. SF-14. Available at: www.waterplan.water.ca.gov/docs/cwpu2009/0310final/v3_sanfrancisco_cwp2009.pdf

21 The Bay Area hydrologic region is a subset of the nine-county Bay Area that includes all the watersheds that drain to the bay. It is a slightly smaller region both geographically and population-wise than the entire service territory of the 11 major water agencies that we evaluate in this report.

22 Some of this denser development is already taken into account in urban water management plans' long-term water demand estimates throughout the region, which commonly base future population estimates on ABAG demographic projections (which include local General Plans, zoning changes, and other land use factors).

23 U.S. Environmental Protection Agency (EPA), Growing Toward More Efficient Water Use: Linking Development, Infrastructure, and Drinking Water Policies, 2006. Available at: www.epa.gov/dced/pdf/growing_water_use_efficiency.pdf

24 U.S. EPA, supra note 23, p. 7.

25 DWR, Guidebook for Implementation of Senate Bill 610 and Senate Bill 221 of 2001. Available at: www.water.ca.gov/pubs/use/sb_610_sb_221_guidebook/guidebook.pdf

Figure 5: How Much Will Our Water Needs Grow in the Next 20 Years?

Demand for water will grow more quickly in some parts of the region than in others. As a whole, the Bay Area will demand 22 percent more water in 2035 than it did in 2010.

	2010	2015	2020	2025	2030	2035	TOTAL CHANGE	PERCENT CHANGE
SAN FRANCISCO	71.4	73.6	71.7	71.2	72.1	73.7	2.3	3%
BAWSCA AGENCIES	100.0	122.3	128.3	132.8	137.8	142.9	43.0	43%
SANTA CLARA COUNTY	297.2	335.5	343.6	353.9	365.5	377.6	80.4	27%
ALAMEDA COUNTY WATER DISTRICT	42.4	45.5	47.3	48.9	50.9	51.8	9.5	22%
ZONE 7	59.1	57.7	59.9	64.6	67.4	N/A	8.3	14%
EAST BAY MUD	216.0	223.0	221.0	224.0	229.0	229.0	13.0	6%
CONTRA COSTA COUNTY	145.1	158.1	171.0	181.6	192.4	199.2	54.1	37%
SOLANO COUNTY	174.4	188.0	194.4	196.8	199.2	N/A	24.8	14%
CITY OF NAPA	12.0	13.3	12.8	12.7	12.8	13.0	1.0	8%
SONOMA COUNTY	46.5	63.6	65.1	67.6	70.2	73.0	26.5	57%
MARIN MUNICIPAL WATER DISTRICT	17.4	18.0	17.7	17.6	17.7	17.8	0.4	2%
REGION-WIDE	**1181.4**	**1298.5**	**1332.7**	**1371.7**	**1415.1**	**1444.5**	**263.1**	**22%**

Water demand for the Bay Area (in millions of gallons per day)

Source: 2010 urban water management plans of all 11 agencies. Portions of Santa Clara County that receive SFPUC supplies are included only in the Santa Clara County numbers, and portions of Marin County served by the Sonoma County Water Agency are included only in the Sonoma County numbers. Zone 7 and Solano County did not report numbers for 2035.

Dense infill development can reduce our water demand because it requires less water for landscaping than low-density sprawl. Drought-tolerant landscaping and other greenbuilding practices can add to the water-efficiency of new development.

or exceed efficiency standards. Such a goal could be accomplished by mandating “water neutrality” for new large developments — i.e., requiring new projects to have a neutral or positive impact on the region’s water supply — or by creating a green building program with stricter requirements than CALGreen.

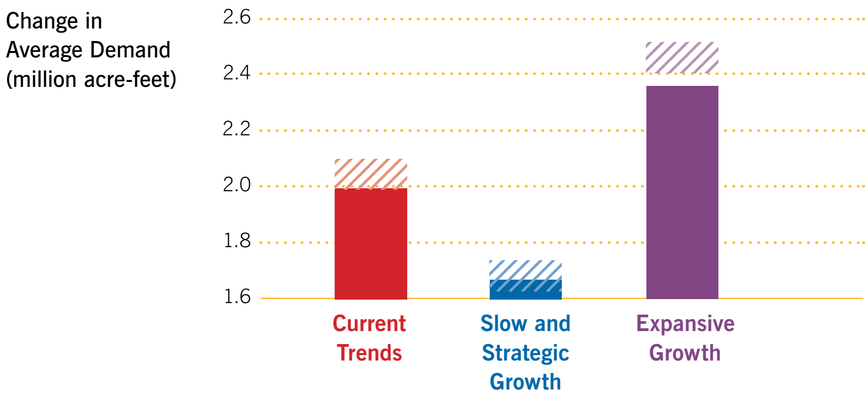
Scenarios for Long-Term Water Demand

For the 2009 California Water Plan, the DWR evaluated water demand projections for the Bay Area hydrologic region through 2050 based on three future growth scenarios (see Figure 6). Scenario 1, “Current Trends,” assumes current trends of urban growth and development, with longer commutes, decreases in irrigated cropland and relatively uncoordinated regulations. Scenario 2, “Slow and Strategic Growth,” reflects more efficient planning resulting in less resource-intensive growth, slower population growth in the state, compact urban development and greater water and energy conservation. Scenario 3, “Expansive Growth,” reflects an increase in resource use, faster population growth, more low-density housing, greater expansion of urban areas and significant decreases in irrigated cropland for conversion to urban development. The DWR also modeled these three scenarios both with and without potential climate change impacts.

The DWR found that growth and climate change will increase demand in all three scenarios by mid-century but will be most pronounced under “Expansive Growth.” This model clearly indicates that if the region does not grow in a strategic and compact way, emphasizing water efficiency and conservation, we will need to find significant sources of new supply to meet our needs in the future — even in normal water years, let alone during a drought.

Figure 6: How Much Will Our Water Needs Grow by Mid-Century?

For the 2009 California Water Plan, the DWR modeled three future growth scenarios, and the variability of climate change under each. Of these, the "Slow and Strategic Growth" scenario shows only a small increase in water demand by mid-century; other scenarios involve significant increases in demand. The bars show an increase above a baseline of the historical period 1998–2005 with the additional variability of climate change shown as cross-hatching..



Changes to urban water demand under three growth scenarios for the Bay Area, 2043–2050

Source: DWR, California Water Plan, Update 2009, San Francisco Bay Hydrologic Region, Bulletin 160-09, p. SF-39.

Looking even further into the future, SPUR used a model developed by the Pacific Institute to examine the effect of certain parameters on the region's water use up to the year 2100 (see Figure 7).[26] The model allows users to estimate urban water use based on a variety of factors, such as population, climate change, household type and conservation measures. We selected three test variables to determine their effect on future urban water use in the San Francisco Bay Area hydrologic region:

Climate change

We evaluated water use under three climate change scenarios. The baseline — representing the status quo or no climate change — predicts future water use using historical climate data (an average of the climate between 1960 and 1999). It is important to note that this is just a baseline and not a real possibility: SPUR has written extensively about the certainty and future trajectories of climate change.[27] To explore two real scenarios, we evaluated two alternative pathways of future world development created by the United Nations' Intergovernmental Panel on Climate Change, which represents the global scientific consensus. One of the UN's future scenarios, A2, forecasts uneven economic growth and continued income disparities but is otherwise much like the DWR's "Expansive Growth" scenario. The other, B1, is much like the DWR's "Slow and Strategic Growth" scenario and represents a world more focused on sustainable development in the future, with a corresponding reduction in greenhouse gas emissions.

Conservation savings

At some point, our conservation practices may be so thorough that we will reach a plateau and will stop saving additional water year over year. The model allowed us to simulate various timelines for such an event. The model's baseline value of 2020 is based on SB X7-7 legislation, but we also ran scenarios in which conservation savings continue their current pace until 2030 and 2050. The model's conservation assumptions do not include the potential effect of higher water prices on users' motivation to conserve water, nor do they model savings from water-saving technologies that have not been invented yet.

Housing density

We used the percentage of new housing constructed as multi-family or attached townhome-type dwellings, rather than detached single-family homes, as a proxy for urban density and compact development. Our baseline scenario assumes 44 percent multi-family housing, based on an Urban Land Institute (ULI) study using data from the Metropolitan Transportation Commission and Association of Bay Area Governments; this percentage reflects the actual share of multi-family housing as of 2010.[28] We also modeled two other scenarios. The first one estimates total water use for a housing distribution of 64 percent multi-family, which will be the region's distribution in 2035 if all housing built after 2020 is built at a ratio of 80 percent multi-family to 20 percent single-family detached, as ULI expects.[29] The second scenario considers total water use if 80 percent of all housing in the region were multi-family or attached townhomes. This last scenario is not realistically achievable due to the share of existing housing that is detached single-family. We chose to model it to explore the idea that increasing multi-family housing could make a significant difference in water demand.

All other parameters were kept at their default values based on the extensive literature review conducted by the Pacific Institute.

The model was sensitive to scenario changes for all three variables: climate change, conservation success and housing density/urbanization. While either climate change scenario will increase regional demand by about 3 to 8 percent above the baseline (which itself reflects about a 36 percent increase in demand by 2100), a small percentage shift toward more multi-family housing could result in a small but measurable decrease in water demand.

Moving the projected end date of water conservation savings from 2020 to 2030 or 2050 has a very large effect on future urban water demand in the Bay Area — a phenomenon that holds true throughout California.[30] If conservation efforts and programs reach diminishing returns at some point in the future, when all inefficient fixtures have been swapped out, total and per capita consumption will begin to steadily increase — largely due to projected growth in demand in the commercial, industrial and institutional sectors and due to projected warmer temperatures, which will ramp up the demand for landscape uses.

Under every single scenario, we will need more water for the Bay Area than we use today. If we are very successful at sustaining conservation through mid-century and climate change is fairly benign — which is extremely unlikely — we may need as little as 4 percent more water for the region than we did in 2000. But if

26 For a full description of the parameters and associated default values, the model and an accompanying report (Christian-Smith et al., supra note 15) may be downloaded at www.pacinst.org/reports/urban_water_demand_2100

27 See www.spur.org/climate-adaptation for our collection of research reports and policy memos about both climate change mitigation and adaptation.

28 Nelson, Arthur C., 2011. The New California Dream: How Demographic and Economic Trends May Shape the Housing Market. Washington, DC: Urban Land Institute, pp. 44–45. Available at: http://law.gsu.edu/resources/news/Nelson_ULI_The_New_California_Dream.pdf

29 The 80 percent/20 percent split is estimated in the Nelson/ULI study (supra note 28), based on ABAG and MTC data, for the increment of housing growth between 2010 and 2035.

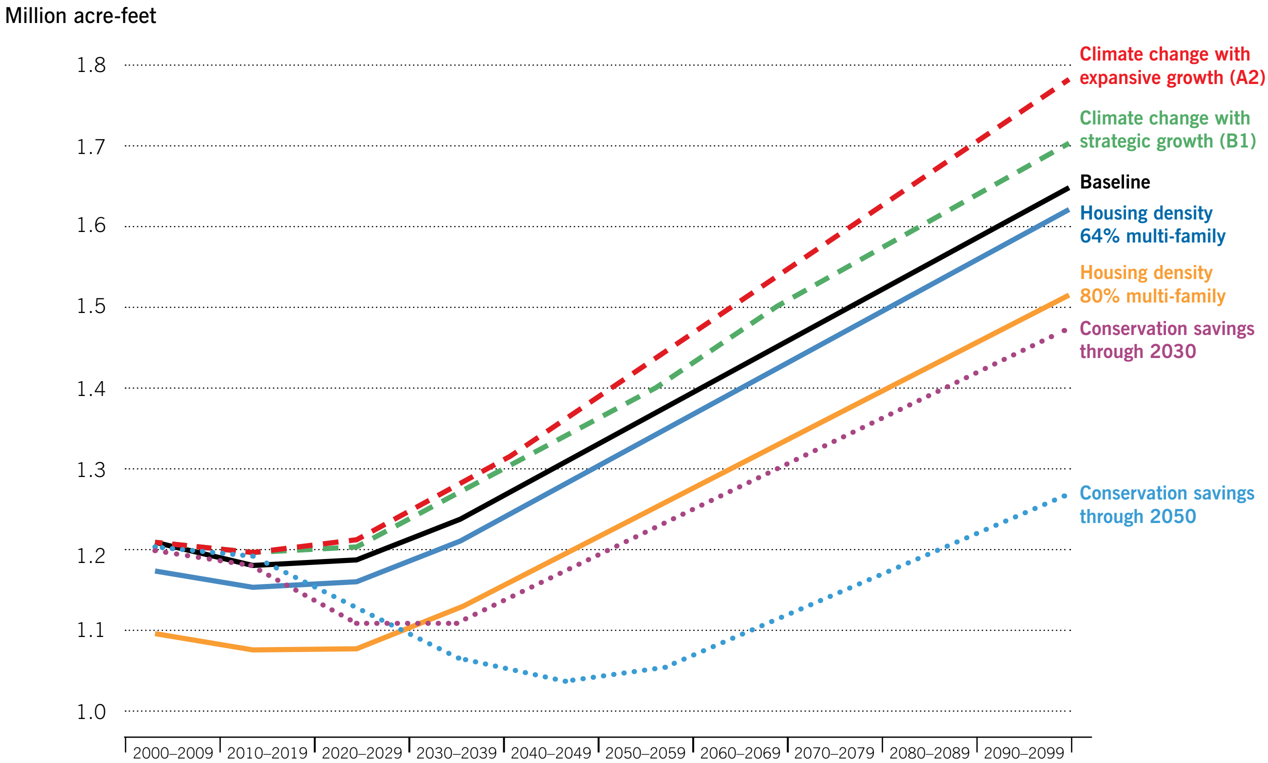
30 Christian-Smith et al., supra note 15, pp. 48–49.

we sustain conservation gains only through 2020 (as required by SB X7-7) and climate change is severe, we may demand 47 percent more water by the end of the century than we used at the beginning. This is equivalent to more than half a million acre-feet a year, or 508 mgd — a significant amount of water for the Bay Area.

The results of our model and of the DWR's clearly indicate that the water needs of the future are not certain and that demand may vary significantly depending on numerous controllable and uncontrollable factors. In the following section, we discuss some of the challenges regional water agencies will face as they try to ensure that supplies meet near-term future demand, at least.

Figure 7: How Much Will Our Water Needs Grow by Century's End?

Under every scenario, the Bay Area will need more water by 2100 than it uses today. Unless we are extraordinarily successful at water conservation and efficiency and can extend the current pace of savings through 2050, water demand could increase by as much as 47 percent by 2100. Note: Our model does not show the potential combined effects of these factors on water use.



Effect of climate change, conservation and housing density on total Bay Area urban water demand, 2000–2099

Source: SPUR analysis using a model published by the Pacific Institute.

Meeting Water Demand in the Near Term

Meeting future water demand with adequate supplies is one of the most important planning functions of water utilities. Most water agencies are actively working to secure sufficient water supplies for projected demand within about a 30-year planning horizon. Unsurprisingly, SPUR's analysis of urban water suppliers in the Bay Area shows that in a normal water year most agencies will be able to meet projected demand with existing or planned supplies until 2035 (see Figure 8).

However, during multiple dry years in a row, there is not enough supply to meet demand, even now. By 2035, if no measures are taken to reduce demand and no new supplies are planned, the difference between supply and demand in a multiple-year drought will be 307 mgd — about 21 percent short of total demand. For some agencies, this gap will be more severe than for others. The City and County of San Francisco's projected demand is well below expected supply levels, even in a multiple-year drought, but the city is alone in this distinction. The 10 other water agencies in the region will not be able to meet projected 2035 demand for either a single dry year or a multiple-year drought.[31] BAWSCA, representing the SFPUC's 26 wholesale customers, won't be able to meet projected demand for even a normal water year by 2035. The Santa Clara Valley Water District, East Bay MUD, Contra Costa Water District, Sonoma County Water Agency and Marin Municipal Water District project an almost equal balance of supply and demand in 2035 for a normal water year.

Having sufficient water supplies on hand to meet 100 percent of normal-year demand in a multiple-year drought is not the normal business practice of water agencies. In fact, this level of service could lead to overbuilding water infrastructure at great expense to ratepayers. The level of acceptable shortage in a dry year is a policy choice made by water utilities, their governing boards and elected overseers. Based on the chosen level, each of these utilities procures supplies, participates in short-term transfers and develops drought management and rationing plans. Although the region as a whole will fall 21 percent short of demand in a multiple-year drought by 2035, some agencies will face more severe gaps between supply and demand — estimates range from 8 percent to 51 percent. Shortages beyond 10 to 15 percent may have disproportionately high economic impacts[32] and may not be manageable through voluntary measures. Prolonged shortages much greater than these levels could cause economic loss, compromise public health, and lead to poor social outcomes.

Many agencies estimate potential future drought based on historic drought records, such as the severe single-year drought of 1976–77 or the dry period of 1987–92. But these records may be inappropriate analogues for future drought under climate change conditions. Although agencies filing urban water management plans were not required to discuss climate change impacts on their water supply and demand in 2010 reports, many did, and all will be required to do so in their next five-year reports.

Although the exact timing and magnitude of future climate change impacts are uncertain, consensus is growing around their general trajectory, as we described in SPUR's 2011 report *Climate Change Hits Home*.[33] As the climate changes, the Sierra snowpack that provides natural water storage for freshwater supply — essential for many Bay Area water agencies — is likely to melt earlier and more rapidly (see Figure 9, page 22). Longer and drier droughts are predicted before the end of the century, leading to more frequent and more severe water shortages and exacerbating conflict over an already stretched resource. Across the state, more precipitation will fall as rain instead of snow, leading to water storage challenges for a system that has been designed to capture slow and steady snowmelt. Higher air temperatures will increase water uptake by plants, increase evaporation and decrease soil moisture; as a result, less water will flow into reservoirs. Higher temperatures will also increase water demand across all sectors, and higher water temperatures could impair water quality.

Decreased precipitation and increased evaporation mean that groundwater basins will not be replenished at the same rate as they are today. Coastal freshwater supplies may be more vulnerable to saltwater intrusion from sea level rise. Saltwater intrusion into coastal aquifers would make some of the freshwater unusable without more intensive treatment. A combination of increased storm intensity and sea level rise into the delta could

31 Some water agencies reported single-dry-year scenarios that represented a more severe level of drought or water shortage than their multiple-dry-year scenarios, including Zone 7, the City of Napa, the Sonoma County Water Agency and the Marin Municipal Water District. For SPUR's analysis, we used agencies' reported numbers and accepted their own drought demand calculation methodologies; we did not group single-dry-year and multiple-dry-year supply estimates according to our own categorizations of drought severity. This may result in underestimating the worst-possible multiple-year drought scenario across the region.

32 SFPUC, Economic Impact Analysis: Water Supply Reduction, November 23, 2005, pp. 3–4.

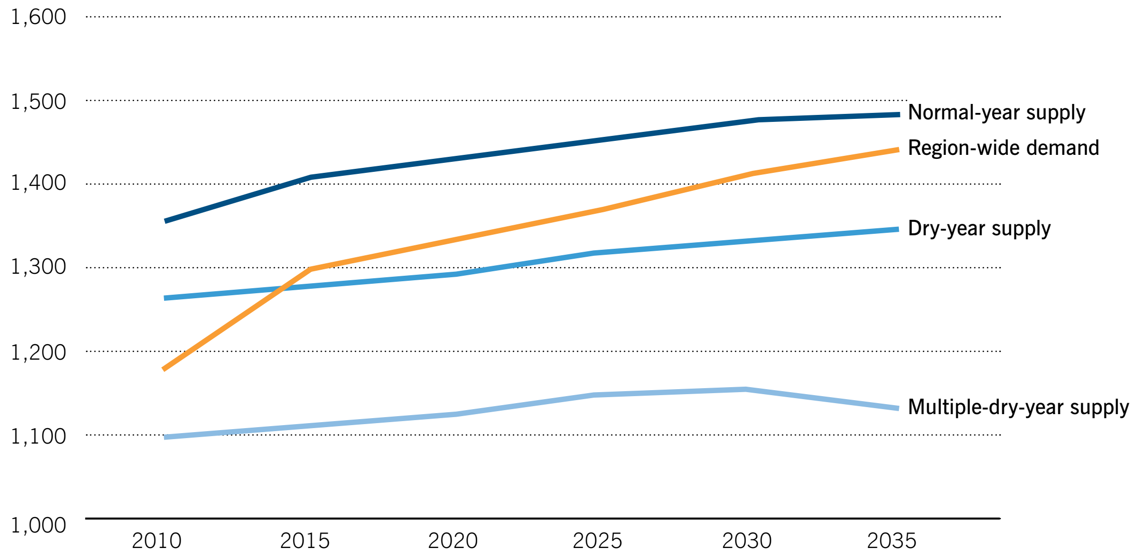
33 SPUR, *Climate Change Hits Home*, May 2011. Available at: www.spur.org/adaptation

increase the risk for flood-caused levee failures, which could destroy low-lying areas and contaminate freshwater supplies stored and conveyed in the delta.

Some water utilities serving the Bay Area, including East Bay MUD and the SFPUC, have undertaken water supply modeling to understand shifts in the quantity and timing of runoff that may occur due to climate change.[34] East Bay MUD and the SFPUC have found that because of the high altitude and capacity of their storage reservoirs, along with other factors, climate change may not significantly affect water deliveries through about 2020 to 2030. San Francisco's Hetch Hetchy watershed is somewhat protected by its high elevation, where the magnitude of predicted changes in snowpack and melt through 2030 is within the range of existing runoff patterns.[35] However, in projecting these and future changes, the utilities are in the process of factoring in net changes in precipitation, the impact of which may be much more significant by mid-century and beyond. For example, the SFPUC has evaluated changes to runoff into its largest reservoir, Hetch Hetchy, for various climate change scenarios in 2040, 2070 and 2100. By 2100, depending on temperature trends and precipitation (either increases or decreases), median annual runoff may increase 2 percent or decrease as much as 29 percent. But in a critically dry year, in a scenario of high temperature increases and precipitation

Figure 8: Regional Water Supply vs. Demand

Looking at our short-term needs, during normal water years, there will be a surfeit of water in the Bay Area compared to the level of demand in 2010. However, the size of the surplus will be much smaller by 2035 due to increases in demand. Even today, there would not be enough water to meet demand should a multiple-year drought occur.



Region-wide normal-year supply, dry-year supplies and projected demand, 2010–2035

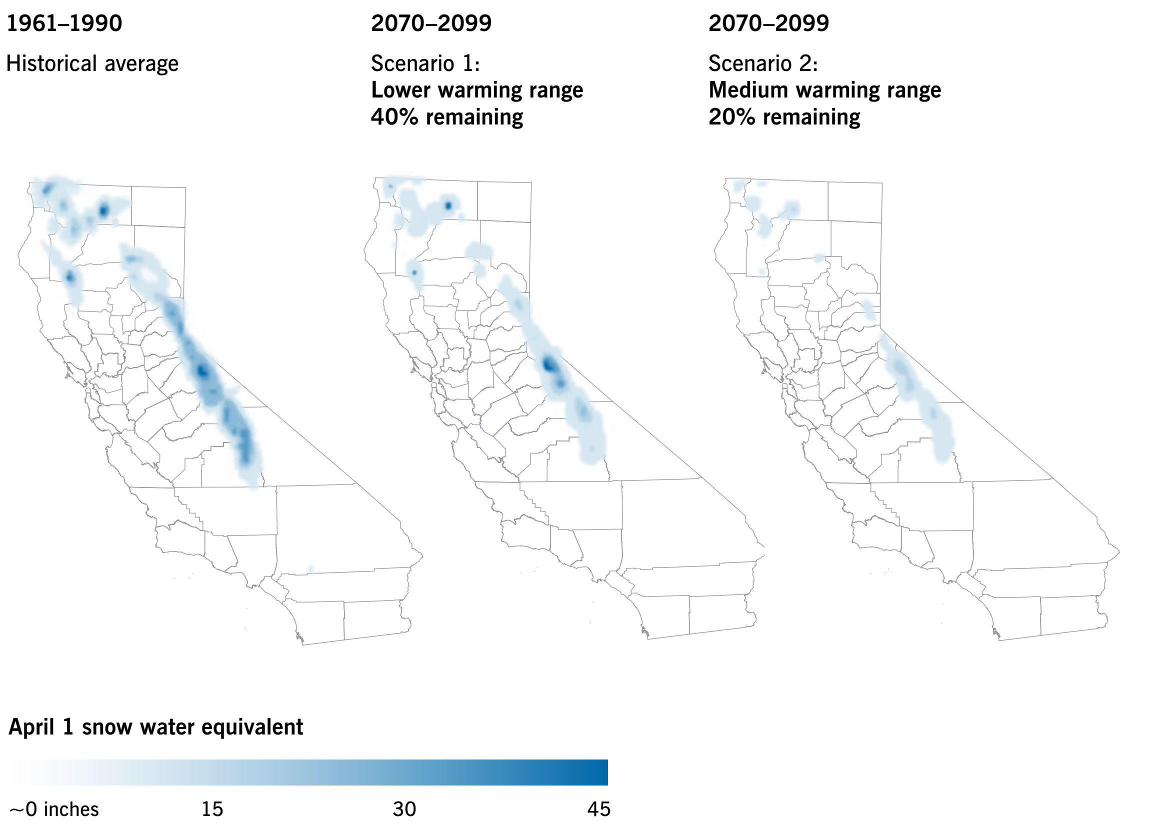
Source: SPUR analysis of 2010 urban water management plans of all 11 agencies.

34 Ibid., p. 22

35 San Francisco Planning Department, "Programmatic EIR for the SFPUC Water System Improvement Program," Case No. 2005.0159E, Master Responses to Comments, Section 14.11: Master Responses on Climate Change, 2008. Available at: www.sf-planning.org/Modules/ShowDocument.aspx?documentid=8016

Figure 9: Projected Decreases in California's Snowpack

The Sierra Nevada snowpack provides water to the majority of Californians. By the end of this century, as little as 20 percent of this snowpack may exist under hotter, drier conditions caused by climate change.



Source: Cayan, Dan et al., 2006, in 2009 California Climate Adaptation Strategy, p. 80. Available at: www.energy.ca.gov/2009publications/CNRA-1000-2009-027/CNRA-1000-2009-027-F.PDF

decreases, future runoff may be 47 percent below the median annual runoff in 2010.[36]

While the idea of a water shortage in future dry years seems alarming, it is not yet a crisis. Water agencies generally do not keep extra water supplies on hand today in case of a severe or prolonged drought 30 years from now. Nor do they develop supplies to meet 100 percent of demand in a dry year because that could lead to overbuilding infrastructure. But planning tools like urban water management plans, the long-term water supply plans built upon them[37] and, more recently, climate models can help agencies understand when and how severe future shortfalls may be. This will allow them to plan for new supplies and/or develop measures to reduce demand in the meantime. This SPUR report seeks to help with the process of prioritizing where these future supplies — or savings — should come from.

36 David Behar, SFPUC, "Societal Dimensions": What Does THAT Mean?!, February 2012. Available at: www.cesm.ucar.edu/working_groups/Societal/Presentations/12/behar.pdf

37 This includes East Bay MUD's Water Supply Management Plan and the Santa Clara Valley Water District's Water Supply and Infrastructure Master Plan.

Tools for Meeting Water Needs

Water agencies can meet projected future demand either by lowering demand or increasing supply — or both. In this section, we describe a variety of tools of each type, their advantages and disadvantages, their average costs and some examples from the Bay Area, where possible. In the following section, we provide an analysis of these options and propose priorities for future supplies for the region.

SPUR recommends three priority criteria for evaluating and sourcing new supplies:

RELIABILITY (OR DROUGHT-PROOFNESS) measures the risk of a supply source being interrupted or reduced by changing weather patterns or other natural hazards. Reliability in water supplies may be thought of in four dimensions: normal-year supply reliability, drought supply reliability, the vulnerability of supply to emergency outages and regulatory vulnerability, where changes in regulations affect water supplies.[38] The former two dimensions may be measured quantitatively, and the latter two more qualitatively. Quantitatively assessing the reliability of all potential new water supplies for the Bay Area is beyond the scope of this report, but we do assess general reliability for the types of supplies and demand-reduction measures described.

RELIABILITY RATINGS

Reliable in most situations

Reliable in some situations

Not reliable over the long term

COST-EFFECTIVENESS compares costs per unit of produced water from different sources. Our evaluation measures cost-effectiveness from the perspective of water agencies and their ratepayers, not from the perspective of private investors, developers or building owners. It is a quantitative measure that we report with ballpark figures from the Bay Area if possible, and from other parts of California if not. It is important to keep in mind that each water agency's cost is unique, so cost-effectiveness is a relative figure that must be evaluated in the context of a single agency's portfolio. The cost-effectiveness of conservation measures, for example, may be very different depending on what measures are used and how long an agency has been investing in conservation; for some, the low-hanging fruit has already been exhausted and marginal savings are increasingly more expensive.

COST-EFFECTIVENESS RATINGS

Typically cost effective

Cost-effectiveness varies by project

ENVIRONMENTAL IMPACT measures the sustainability and natural resource impacts of water supply development. Principally, it is measured in three ways: use of energy and production of greenhouse gas emissions, impact on surface water and groundwater quantity and quality, and impact on ecosystems and habitat such as rivers, wetlands and endangered species habitat.[39]

ENVIRONMENTAL IMPACT RATINGS

Low impact

Moderate impact

One or more significant impacts

38 BAWSCA, Long-Term Reliable Water Supply Strategy, Phase 1 Scoping Report, May 27, 2010, Section 5, p. 6. Available at: http://bawsca.org/docs/BAWSCA_Strategy_Final_Report_2010_05_27.pdf

39 Ibid., p. 8.

Tools for Demand Management

Conservation and efficiency

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

These tools focus on reducing water waste through incentives, rules and education. They cover a broad set of demand management tools and have grown increasingly important to urban water agencies in California over the last 20 years. Most water agencies view conservation as an investment in reliability and even consider conservation savings as a source of future water supply in their long-term portfolios.[40] Although conservation and efficiency are distinct — the former focusing on reducing water use, the latter on reducing waste — in practice, programs and laws designed to save water are bundled together because they have the same outcome.

All of the Bay Area's major wholesale and retail urban water suppliers are members of the California Urban Water Conservation Council, a statewide organization of hundreds of water utilities that have all signed a memorandum of understanding pledging to implement best management practices in conservation. The memorandum of understanding requires regular reporting on utility operations, education programs and programs for residential, commercial/industrial/institutional and landscape water users. Agencies also report on their conservation programs and on their implementation of best management practices in their urban water management plans. Conservation programs typically count water savings from the implementation of both active and passive conservation activities. Best management practices in water utility conservation include: having a designated conservation coordinator, enacting ordinances to prevent water waste, conducting system-wide water audits to identify and correct losses, metering all water connections, providing rebates and incentive programs to encourage the installation of water-efficient fixtures and conducting public education programs and campaigns, including outreach at schools.

Although conservation and efficiency are generally cost-effective ways to augment an agency's water supplies, they are not free. Between 1990 and 2010, the biggest urban water agencies in California invested about $1 billion in conservation and saved more than 13 million acre-feet of water,[41] resulting in an average cost of about $76 per acre-foot of water saved. Bay Area water utilities, which have been making deep investments in conservation for decades, have already achieved the easiest gains, so conservation programs are increasingly more expensive per unit of water saved. The SFPUC's cost of conservation programs averages $860 per acre-foot of water, representing a range of program costs from $58 per acre-foot for washing machine rebates to $6,141 per acre-foot for audits of complex commercial customers like universities.

40 California Urban Water Agencies, California Urban Water Agencies' Water Supply Reliability Report, August 2012. Available at: www.cuwa.org/pubs/CUWA_WaterSupplyReliability.pdf

41 SPUR analysis of data reported by CUWA, August 2012, supra note 40.

Metering

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

Metering of all water connections enables agencies to measure individual customers' water use and to price water by volume so that water bills reflect levels of consumption. Although meter installation has been required for all new construction in California since 1992, many cities, such as Sacramento, are still in the process of installing meters to comply with a state law requiring all customer connections to be metered by 2025. Increasingly, water utilities such as the SFPUC and East Bay MUD are replacing existing meters with "smart" water meters, which can measure use more precisely by the time of day and report this information with an electronic signal. This information, if made accessible to customers and utilities, can help detect leaks and inform customers how much water they are using in real time.

Pricing

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

Pricing water use provides a powerful economic incentive for conservation. Although demand for water is relatively inelastic, it is not unresponsive to price. On average, a 10 percent increase in the marginal price of water can reduce urban residential demand in the U.S. by 3 to 4 percent.[42] For price signals to work as an incentive for conservation, meters and volume-based billing practices are necessary. Price-based approaches tend to be less expensive for

42 Olmstead, Sheila M. and Robert N. Stavins, Managing Water Demand: Price vs. Non-Price Conservation Programs, July 2007, Pioneer Institute White Paper, No. 39. Available at: www.hks.harvard.edu/fs/rstavins/Monographs_&_Reports/Pioneer_Olmstead_Stavins_Water.pdf

a utility to implement than other types of conservation programs because they don't require monitoring, enforcement or voluntary compliance. Such measures also allow residents and businesses to choose to reduce water use however they prefer, rather than being urged or required to limit particular types of uses, such as outdoor watering, or to install certain technologies. To create an incentive for conservation, it's best to implement a multiple-tiered rate structure in which higher volumes of use command higher per-unit prices. But in reality, raising prices on water — particularly among low-income populations or high-volume industrial users — is politically sensitive, so techniques that are not based on price tend to be more popular approaches to demand management.[43]

Water budget–based rates

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

This is a way to benchmark individual water use and charge customers more per unit for water that exceeds their budgeted amounts. Rate structures based on water budgets also reward customers for using less than their water budget allows for. Budgets may be based on a customer's historical use, indoor/outdoor water allocation, number of units and/or number of bedrooms. Water budgets may also vary seasonally based on expected outdoor water use. However, budgets are complex to administer because they require individual use models to be developed and updated for every customer.

Green building programs

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

These programs can create incentives in new construction or major retrofits to achieve water savings beyond code requirements. As of 2009, California's building code, CALGreen, requires 20 percent more savings than baseline modeled water use. But local ordinances can require more; San Francisco's Green Building Ordinance requires a 30 percent reduction. Green building programs may reduce future demand, but they have a narrower scope than other demand management tools because they only apply to the small portion of the built environment that is new. In San Francisco, this amounts to 1 to 2 percent of total square footage in the city each year.[44]

43 Ibid., p. 6

44 See www.spur.org/files/SPUR_Greening_Apartment_Buildings.pdf

Compact development

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

This is a future-oriented demand management tool. The idea that sprawl inefficiently uses water is not new, but water savings is rarely described as a benefit of denser, infill development. Low-density development uses more water than high-density development largely because of increased outdoor water use for lawns and landscaping.[45] According to the Pacific Institute model SPUR used to predict long-term regional water demand, if a greater share of the region's new households live in multi-family units (rather than single-family units), it could reduce total regional water use, relative to the mix of housing types available today, through 2100. If the share of multi-family housing units can increase from 44 percent (the mix in 2010) to 64 percent (what the mix will be in 2100 if all new housing is built at a ratio of 80 percent multi-family to 20 percent single-family, which is expected), the region would save 2 percent more water than if the current housing mix were continued until 2100. This quantity, about 27 mgd, is a free benefit of urbanization (which entails building fewer water-intensive landscaped areas). The more the region invests in compact development and reducing outdoor water use, the more water-efficient it will be in the future.

Retrofit-on-resale ordinances

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

Such ordinances require that all water fixtures in a building meet certain plumbing code requirements before a deed is transferred in a sale. In San Francisco, retrofit-on-resale legislation passed in 2009; it applies to all residential sales and requires retrofits of commercial buildings, even in the absence of a sale, by 2017. This law is expected to accelerate passive water savings, arriving by 2018 at a target that would otherwise not have been reached until 2030. Retrofit-on-resale is in place in several other big cities in California, including San Diego and Los Angeles, but it has not achieved widespread popularity in the Bay Area.

45 Western Resource Advocates, Smart Water: A Comparative Study of Urban Water Use Efficiency Across the Southwest, 2003. Available at: www.westernresourceadvocates.org/water/smartwater.php

Water-neutral development

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

This tool requires developers to not only make new developments water-efficient but to fund retrofits elsewhere in the service territory. This demand offset results in a "zero water footprint," meaning that the development saves as much water as it uses through both on-site and off-site investments in water efficiency. East Bay MUD, faced with long-term supply constraints, is currently pioneering this tool. The agency has already partnered with four major developers in its service territory to implement site-specific offset fees toward the goal of water neutrality.[46]

Reducing system losses

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS

Leaks are a normal part of managing and conveying water. With thousands of miles of pipes in the ground in an average city, some newer than others, system losses are expected to occur. A leak detection audit of 47 California water utilities found an average loss of 10 percent of total delivered water supplies. Ten percent is also the benchmark standard for unaccounted-for water as recommended by the American Water Works Association. Utilities in the Bay Area report different rates of loss. The SFPUC reports about 9 percent loss due to meter errors and unbilled consumption, including for firefighting. East Bay MUD reports an 11 percent loss in its distribution system in 2010–2011. Although certain unmetered uses, such as main flushing and firefighting, are beneficial and expected, others (including illegal connections, breaks and other leak losses within the distribution system) can be found and fixed. Upgrading older infrastructure and keeping water distribution systems in a state of good repair are good practices to save water.

46 See www.ebmud.com/sites/default/files/pdfs/FY13%20Schedule%20N%20-%20Water%20Demand%20Mitigation%20Fees%20(effective%208_13_12)_0.pdf

Rationing

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
low normal-year reliability, high drought-year reliability but only temporarily		potentially significant community and economic impacts

Rationing is an emergency measure that sharply limits water use. It may be used during a short-term supply disruption, such as a major earthquake, or during a period of prolonged shortage caused by a multiple-year drought. Rationing is typically implemented after all voluntary measures to reduce demand have been in place for a while and deeper cuts are needed. During a drought, Bay Area utilities have been able to reduce demand temporarily by 10 to 15 percent. In deeper droughts, such as the drought of 1987–92, agencies have had to implement mandatory limitations based on customer class. This involves creating a water budget to develop allotments based on typical use, then implementing fines for excess use, restricting flow or even shutting off water. Not all water suppliers have the authority to impose rationing; it is most feasible for municipal retail water agencies.

Rationing can have severe economic impacts. As water availability decreases, more and more businesses reach a tipping point that requires them to decrease their business activities.[47] A 2002 study for the SFPUC on the impacts of rationing in its service territory found direct economic losses ranging from $500 million to almost $6.7 billion annually for modeled rationing increments of 10 to 30 percent.[48] Indirect impacts, or ripple effects of these losses, were nearly as large as direct impacts. The most severe levels of rationing (20 to 30 percent) had disproportionately greater effects on economic activity, ranging from almost $5 billion to more than $11 billion in annual economic loss through both direct and indirect impacts.

47 SFPUC, supra note 32, p. 4.

48 Ibid., pp. 3–4.

Tools for Developing New Supplies

Banking and transfers

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
high drought reliability, low emergency reliability	greenhouse gas emissions/ energy use from pumping; additional surface storage may have ecological impacts	

These tools enable multiple buyers and sellers to legally exchange various types of surface water, groundwater and storage entitlements.[49] Most water banks in California were established after 1990. Water banks help to create water reliability in dry seasons and dry years. They can form contracts with both suppliers and users, act as an intermediary, set a market price and hold auctions, and generally help direct water to its most valued uses. Several water agencies in the Bay Area, especially those dependent on delta supplies, participate in water banking, including Zone 7, the Contra Costa Water District and the Alameda County Water District.

Water transfers may involve more direct leasing or purchase contracts between suppliers and users and are a growing tool to meet urban demand in California. Transfers provide reliability and a voluntary mechanism to trade entitlements. Many of the East Bay agencies (such as Zone 7, the Contra Costa Water District and the Solano County Water Agency) have long-term agricultural-to-urban water transfers in place, many of which involve options to buy from nearby irrigation districts during drought years. The Santa Clara Valley Water District and the SFPUC have participated in or pursued short-term option agreements during dry years.

In one type of innovative transfer arrangement being pioneered in the San Diego region, the urban water utility partners with agricultural users to invest in agricultural water efficiency improvements. These water savings are then transferred to the utility without any loss of service to agricultural users or additional negative environmental impacts.

49 Washington Department of Ecology and WestWater Research, Analysis of Water Banks in the Western States, July 2004, Publication No. 04-11-011, https://fortress.wa.gov/ecy/publications/publications/0411011.pdf

Conjunctive use

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
reliable but only available in service territories with groundwater basins	greenhouse gas emissions/ energy from pumping; fewer ecological impacts if groundwater basins are carefully monitored for sustainable yield	

Conjunctive use is the planned management of surface and groundwater resources together, to maximize reliability and availability of supplies within a region or service territory. Conjunctive use stores water in a groundwater basin that is intentionally recharged with other supplies when they are available, such as imported water, local runoff or recycled water. In dry years, higher pumping rates can occur without unsustainably mining groundwater, decreasing surface-lake levels or having other adverse environmental impacts. Conjunctive use not only bolsters supplies in dry years, it may also protect a groundwater basin from over-pumping, saltwater intrusion and land-surface subsidence.

Water agencies around the region actively employ conjunctive use, including the Santa Clara Valley Water District, the Alameda County Water District and Zone 7, and the SFPUC and Solano County service territories are piloting the practice. Conjunctive use is being used in the Westside basin aquifer underlying parts of San Francisco, Daly City, South San Francisco and San Bruno to store extra Hetch Hetchy water to replenish the aquifer. The Santa Clara Valley Water District manages extensive recharging facilities, including more than 70 off-stream recharge ponds. The agency estimates that 65 percent of groundwater pumped in Santa Clara County originates from artificially replenished water.

Not all Bay Area water agencies can take advantage of conjunctive use. Available space in an existing groundwater basin is a necessary condition for conjunctive use and groundwater storage. But basins are natural and cannot be built, and they do not exist in many parts of the region (see Figure 10, page 29).

Recycling

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
has limited potable uses	greenhouse gas emissions and energy use	

Recycling treats wastewater so it can be used for landscape, industrial, agricultural, environmental and other non-potable uses. Recycled water is highly regulated by Title 22 of the state Code of Regulations, which dictates its treatment and uses. All of the major urban water suppliers in the Bay Area have a recycled water program, some older than others. The region's total annual production volume of recycled water from wastewater is approximately 60,000 acre-feet/year (54 mgd), a volume that could double by 2020.[50] Recycled water is a very reliable supply of water because it is produced from wastewater, the volume of which does not fluctuate dramatically during a drought. This reliability has a direct value. A "drought-proof" Bay Area supply of 60,000 acre-feet of recycled water is worth at least 100,000 acre-feet of entitlements to imported water, which could be hard to come by in a drought.[51]

Currently, recycled water only serves non-potable uses in the Bay Area, such as industrial processes and landscape irrigation. As a result, it is not as valuable during a drought as potable supplies that have been approved for all uses. However, it can offset demand for potable water, in effect reserving available potable water for other purposes. Recycled water can therefore serve both to reduce demand and augment supplies.

Non-potable recycled water requires energy to produce, but only about one-eighth the energy demanded by seawater desalination, less than half the energy needed to import State Water Project water and half to three-fourths the energy required to pump groundwater. The average unit cost of producing recycled water from Bay Area projects is $1,000 to $1,200 per acre-foot.[52] However, costs vary widely and can significantly exceed these figures, depending on the project's location, size and level of treatment. Because recycled water must be conveyed separately, in pipes that are specially marked, it is more expensive per unit for projects that must construct new and longer pipelines.

50 Bay Area Clean Water Agencies, Importance of Recycled Water to the San Francisco Bay Area, May 2007. Available at: www.barwc.org/files/LinkClick.pdf

51 Ibid., p. iii.

52 Ibid., p. v.

New groundwater

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
reliable but only available for service territories with groundwater basins	greenhouse gas emissions/ energy use from pumping; fewer ecological impacts if groundwater basin is carefully monitored for sustainable yield	

The Bay Area has 28 groundwater basins underlying approximately 30 percent of the region (see Figure 10). Of these, the Santa Clara Valley Basin, the Napa–Sonoma Valley Basin, the Petaluma Valley Basin and the Livermore Valley Basin are the most widely tapped for water.[53] Groundwater quality in the region is generally good, but in areas close to the bay, aquifers are subject to saltwater intrusion — a condition that could worsen with increased extraction. Groundwater basin monitoring is important to ensure effective management of the water supply, particularly during long-term droughts. Groundwater extraction is considered a relatively sustainable source of water supplies when extraction rates do not exceed recharge rates and when extraction itself does not contribute to worsening water quality in the basin.

The SFPUC is developing a new, small groundwater supply project (up to 4 mgd) in the Westside Basin aquifer in San Francisco, to be blended with water from the regional Hetch Hetchy system. Groundwater wells were once a significant supply of water for San Francisco, but the city has only used a small amount of groundwater — mostly for irrigation at Golden Gate Park — since the construction of the Hetch Hetchy system. In 2010, East Bay MUD tested and established a new groundwater storage project in the South East Bay Plain Groundwater Basin to facilitate the injection of extra water supplies during wet years and the extraction of up to 2 mgd over a six-month period in dry years. However, the basin's native groundwater is not a significant source of supply for East Bay MUD.

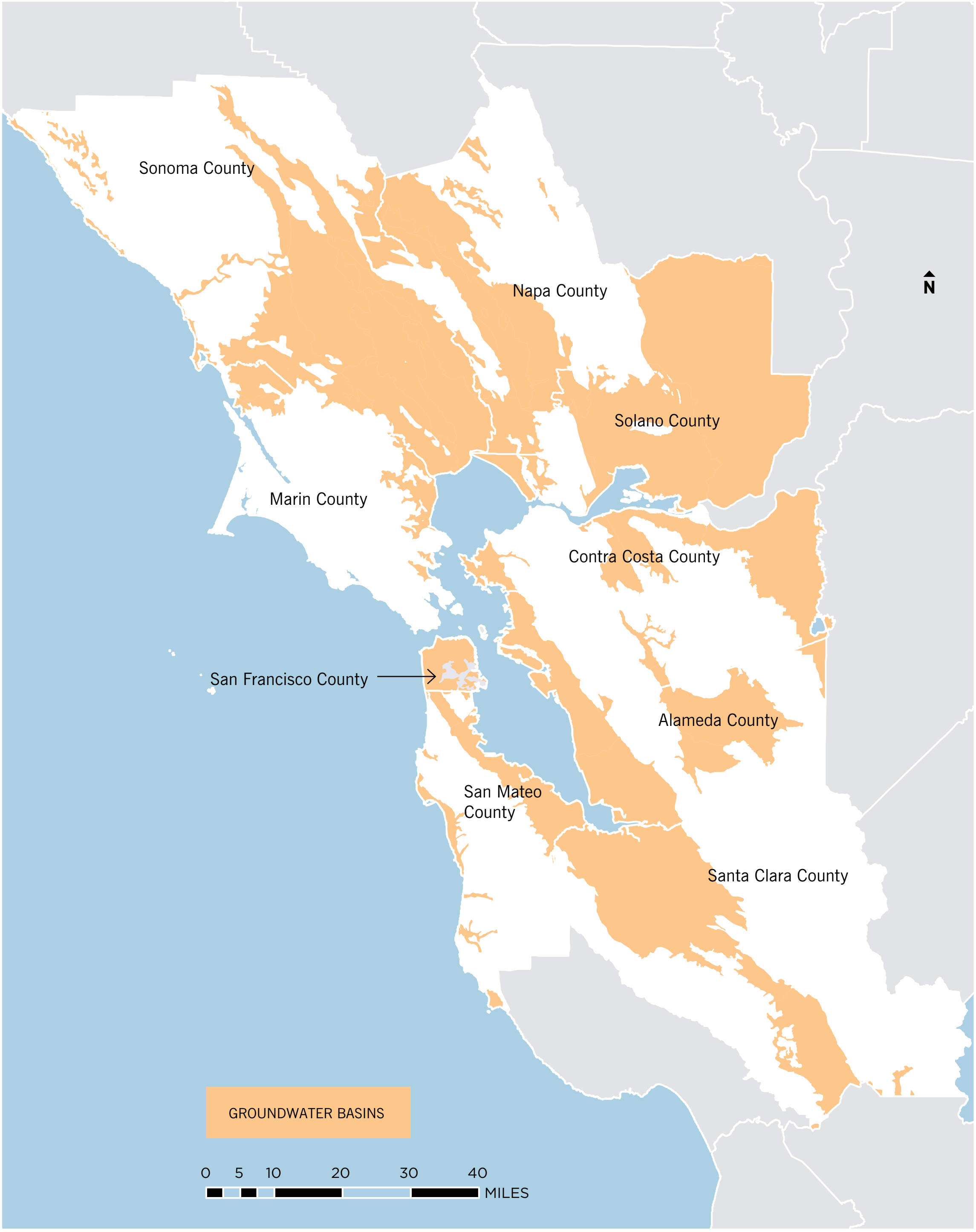
In general, new groundwater development outside of conjunctive use projects is only expected to make up about 10 percent of new supplies for urban water agencies across California between 1990 and 2030.[54]

53 Bay Area Integrated Regional Water Management Plan, supra note 6.

54 California Urban Water Agencies, supra note 40.

Figure 10: The Bay Area's Groundwater Basins

The Bay Area has 28 groundwater basins underlying approximately 30 percent of the region. Groundwater quality in the region is generally good, and extraction is considered a relatively sustainable source of water supplies. But since basins do not exist in many parts of the region, they are not a viable tool for all Bay Area water agencies.



Source: SPUR map with data from: Cal-Atlas, Bay Area Integrated Regional Water Management Plan

Desalination

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
seawater is unlimited	greenhouse gas emissions and energy use; uncertain marine and coastal zone impacts	lower cost for brackish water desalination

Desalination commonly refers to the production of potable water from brackish water or seawater. It has long been considered the holy grail of water supply because it has the potential to transform the planet's largest water source, the ocean, into water for human uses.[55] It has become particularly popular as a water supply idea for the dry, coastal regions where much of California's — and much of the planet's — population is growing. As recently as 2006, more than 20 proposals for large desalination facilities along California's coast had been developed.[56] But as of 2012, only one small project has been permitted and built, and a second was just approved: a 50-mgd facility in Carlsbad scheduled to be complete in 2016.[57] Desalination is perhaps more controversial than many other water supplies because it is energy-intensive, nearly always involves the construction and operation of a major industrial facility in the ecologically sensitive coastal zone and produces a salty waste brine that may have adverse marine environmental impacts.

Three desalination facilities have been built, proposed or piloted in the Bay Area. The Alameda County Water District constructed a brackish groundwater desalination facility in 2003 and recently expanded it to produce 12.5 mgd. The Marin Municipal Water District began studying desalination as a dry-year supply in 1990 and even built a pilot desalination plant in 2005. After certifying the environmental impact report for a full-scale 5-mgd facility (with expansion capacity to 15 mgd), the agency put this option on hold in 2010 because of a major drop in demand for water in its service territory. Finally, the Bay Area Regional Desalination Project, initiated in 2003, is a partnership among the five largest water agencies in the region: the Contra Costa Water District, East Bay MUD, the SFPUC, Zone 7 and the Santa Clara Valley Water District.[58] After a pilot plant was tested in 2008–2009, the partners are currently conducting a site-specific technical analysis for a 20-mgd plant at Mallard Slough near the delta in Contra Costa County. The proposed project would operate continuously and could store water in nearby Los Vaqueros Reservoir when the plant produces more water than needed.

Depending on the source water quality, the cost to produce desalinated water is highly variable (the saltier the source, the higher the cost), but estimates from proposed facilities in California range from $1,900 to more than $3,000 per acre-foot.[59] Costs are not expected to decline dramatically in the near term and could even rise if energy prices increase.

55 Cooley, Heather, Peter H. Gleick and Gary Wolff, Desalination, With a Grain of Salt: A California Perspective, Pacific Institute, June 2006. Available at: www.pacinst.org/reports/desalination/desalination_report.pdf

56 Ibid., p. 2.

57 Cooley, Heather and Newsha Ajami, Key Issues for Desalination in California: Cost and Financing, Pacific Institute, November 2012. Available at: www.pacinst.org/reports/desalination_2013/financing_final_report.pdf

58 See www.regionaldesal.com/about.html

New surface water and storage

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
high normal-year reliability, low drought reliability	ecological impacts of diversions and inundation	

There is very little new surface water for Bay Area water utilities to develop, but building new surface storage and increasing the size of existing reservoirs is an area of active exploration and planning. Enlarging existing surface water storage can improve reliability and flexibility in system operations, maximizing the benefits of imported water. Water agencies such as the Santa Clara Valley Water District and the SFPUC are actively working to repair or replace old dams that currently support local storage reservoirs but need improvements to meet today's seismic standards.

New storage facilities enable water agencies to capture more of the benefits of transfers, wet years and new supplies like desalinated water. For example, in 2012 the Contra Costa Water District raised the height of its dam on Los Vaqueros Reservoir by 34 feet, increasing the reservoir's capacity from 100,000 acre-feet to 160,000 acre-feet. The main purpose of the reservoir expansion was to improve water quality for customers by storing more wet-year delta water for blending with lower-quality water in dry years. But the additional capacity could also enable Los Vaqueros to store desalinated water produced by the regional desalination project once that facility is developed.

Expanded storage facilities could also help manage climate change impacts by providing additional storage for heavy rains and capturing more of the precipitation that may fall in the Sierras as rain rather than snow. However, expanded surface storage could also have adverse ecological impacts as more acres of dry land and natural habitat are inundated.

59 Cooley, supra note 57, p. 5.

Direct and indirect potable reuse

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
	greenhouse gas emissions/ energy use from pumping	

These tools are ways to treat and reuse highly purified wastewater. They produce water that is drinkable and can offset demands that would otherwise have to be met by traditional water sources. Indirect potable reuse happens when purified water is injected or recharged into groundwater basins or added to surface storage facilities, where it is left to sit for a period of time — at least two months under draft California regulations. There it is mixed and diluted with other water sources prior to entering a drinking-water system and being treated according to potable standards. Storing the water in an environmental buffer — either in a groundwater basin or surface water reservoir where natural treatment processes may occur — for a period of time before anyone consumes it can provide a safety net because delivery can be stopped in the event of a treatment failure.[60] In a direct potable reuse scheme, highly purified wastewater is added directly into the water conveyance system that serves drinking-water treatment plants, forgoing the storage time. Direct potable reuse is not currently allowed in California, though the state is required to complete a feasibility study for permitting it by the end of 2016.

Both indirect potable reuse and direct potable reuse can suffer from a public image problem because of the "ick" factor — consumers might shy away from what was once wastewater — though this is less and less the case. In fact, unplanned indirect potable reuse occurs every day for the millions of Californians who rely on supplies from the delta, where drinking water intakes are downstream from numerous wastewater treatment plants — a situation that is common around the United States. The largest indirect potable reuse project in California is currently run by the Orange County Water District. Built in 2008, this system produces 70 mgd of water whose quality is superior to Orange County's native groundwater. In this system, purified wastewater injection both replenishes an overdrawn aquifer and prevents seawater intrusion, protecting the quality of supplies the aquifer stores. Indirect potable reuse may be cost-competitive with other sources of water in California. The capital and operating costs of treatment at the Orange County facility were $747 per acre-foot in 2009–2010,[61] and preliminary estimates for a facility in Santa Clara County range from $1,000 to $1,600 per acre-foot.

60 Rodriguez, Clemencia et al., "Indirect Potable Reuse: A Sustainable Water Supply Alternative," International Journal of Environmental Research and Public Health, v. 6 (3), March 2009. Available at: www.ncbi.nlm.nih.gov/pmc/articles/PMC2672392

61 Schroeder, Edward et al., Direct Potable Reuse: Benefits for Public Water Supplies, Agriculture, the Environment, and Energy Conservation, National Water Research Institute, January 2012. Available at: www.nwri-usa.org/documents/NWRIWhitePaperDPRBenefitsJan2012.pdf

The lack of an environmental buffer in direct potable reuse projects requires additional safety barriers such as real-time monitoring of water quality or use of an engineered buffer such as an enclosed reservoir or storage tanks.[62] As of 2012, a 2-mgd direct potable reuse facility has been permitted in Texas; other small facilities exist in Namibia and Singapore. The cost of direct potable reuse may be lower than indirect potable reuse, as there are no environmental buffers to maintain and water treatment could be confined to one facility instead of two.

On-site reuse and district-scale systems

RELIABILITY	ENVIRONMENTAL IMPACT	COST-EFFECTIVENESS
potable supply backups must be available	may increase energy demand	

On-site water reuse systems can save between 20 and 75 percent of potable water demand in mixed-use and commercial buildings. Water generated on-site — including drainage from sinks, tubs, laundry machines and foundations — is captured, treated and reused for non-potable applications such as toilet flushing and irrigation. In 2012, the SFPUC established a permitting process and incentive program for installing on-site reuse systems in new large commercial buildings. In 2012, the agency also implemented on-site reuse in its new headquarters building. The on-site reuse facility or "living machine" captures all of the building's wastewater and satisfies 100 percent of its non-potable water demand.

District-scale systems capture these same types of wastewater and reuse them for non-potable uses across property boundaries. District-scale systems could also include larger-scale rainwater capture, storage and recycling, possibly for public uses.

Neither district water systems nor on-site treatment systems are common in urban areas in California because on-site wastewater treatment technologies are relatively new, with unclear regulatory and permitting processes in most jurisdictions. However, district-scale water recycling, storage and treatment systems represent a future opportunity to reduce storm-water flows and augment supplies in dense urban areas and in large, campus-type developments. District-scale systems could even be used to comply with water demand management strategies such as water budgets or water-neutral development requirements.

62 Magel, Abram, *Safe, Plentiful Drinking Water for California: An Examination of the Potential for Potable Reuse*, unpublished SFPUC white paper, August 2012.

SPUR Recommendations

The California Aqueduct and Delta-Mendota Canal convey water through the delta to supply millions of water users in California.

As shown previously in this report, most of the Bay Area has the supplies either planned or on hand to meet normal-year water demand in 2035. This demand totals 1,444 mgd, which is 263 mgd greater than demand was in 2010, representing a region-wide increase of 22 percent. Without new supplies or measures that reduce demand, some places — like the BAWSCA service territory — could experience water shortages, especially during prolonged droughts, even sooner than 2035. Beyond 2035, the region's future growth and development coupled with a warmer, drier climate could result in a very dramatic mismatch between supply and demand. To meet the region's certain-to-increase demand over the next 90 years, the Bay Area will need to manage demands for water and develop new water supplies.

Which tools should we use to get there? Comparing our potential sources of future water supply, we can observe the following:

- Demand management tools — including efficiency, conservation, pricing and water budgets — tend to offer the best advantages: high reliability, low cost and low environmental impact.

- The four supply augmentation tools with high reliability and medium to low environmental impact are conjunctive use, groundwater, and indirect and direct potable reuse. These tools begin with a relatively drought-proof source of water and either treat or store it for beneficial reuse.

- Supply augmentation tools with moderate reliability and some potential environmental impacts — depending on how they are implemented — include banking and transfers, on-site reuse and district-scale systems, and water recycling.

- Desalination and new surface storage tend to improve reliability, but depending on how they are implemented, they may have higher environmental impacts, either in terms of energy use or habitat.

- Although it can be useful to extend existing supplies on an emergency basis, rationing is not a tool that improves water reliability.

We recognize that water agencies in the Bay Area face unique supply and demand challenges in their service territories. Some see more commercial use than others, some serve agricultural users, some contain larger landscapes to irrigate and some have more reliable historic water rights than others. Because of this diversity, we don't recommend a one-size-fits-all water supply strategy for everyone. Several of the water supply tools described in this report may only be appropriate in some contexts, may only produce small amounts of new supplies or supplies with limited uses, or may have varied impacts on ratepayers.

The region will add almost 2 million people by 2035, and existing water supplies will barely meet the region's needs at that time unless they are augmented in a significant way. It takes many years to study, plan, permit and construct water supply facilities, so it is not too early to begin planning for water supplies in 2035 and beyond. SPUR recommends that the Bay Area's major urban water suppliers, their customers, land use planning agencies, elected leaders and integrated regional water management and planning efforts take the following steps.

1. Develop water supply scenarios for mid-century and beyond that include assumptions about changes in the amount and timing of precipitation.

Although urban water management plans only require a 30-year outlook, water agencies should look further into the future in light of climate change and the uncertain pace of the region's growth. As little as 20 percent of the Sierra snowpack, which provides most of California's urban water, may be available by the end of this century. Modeling conducted by the SFPUC for its customers in four Bay Area counties suggests that by the end of the century, under drought conditions, much higher temperatures and less precipitation overall, flows from Hetch Hetchy may be about half of what they are today. Water agencies must consider potential impacts of climate change both in terms of reductions in supply — and more competition for new supplies — and increases in demand. Agencies should plan at least 50 years ahead and should evaluate the vulnerability of their service territories and supplies to a range of future climate scenarios.

63 SPUR, *Lifelines: Upgrading Infrastructure to Enhance San Francisco's Earthquake Resilience*, 2009. Available at: www.spur.org/files/spur-reports/SPUR_Lifelines.pdf

2. Evaluate the vulnerability of the water supply and delivery systems to earthquakes, develop risk-reduction plans and invest in reliability upgrades to meet service goals.

In SPUR's report on earthquakes and lifeline infrastructure, we recommended target levels of service for water supply following an earthquake.[63] SPUR recommended that water service be 100 percent restored for critical earthquake response functions, such as firefighting, within four hours of an event. We recommended that 90 percent of a system's customers have water service restored within three days, and 95 percent of customers have water service restored within 30 days. Water utilities should use these metrics, or adopt similar ones, to evaluate system vulnerabilities and to plan reinvestments in their critical lifeline infrastructure, if they haven't already. Because two-thirds of the region's water supply is imported from outside the region and major aqueducts to the region cross several earthquake faults, resilient pipelines and reliable water service are critical to the health and welfare of our growing population.

3. Prioritize demand management measures, especially water efficiency and conservation best management practices, as a low-cost, highly reliable and low-environmental-impact strategy for meeting future water needs.

a. Water agencies should develop and advance retrofit-on-resale ordinances to improve the water efficiency of existing commercial and residential buildings.

b. Water agencies should study pricing and rate structure reforms, including tiered pricing, to create incentives for conservation at higher volumes of use.

4. Require new development to be highly water-efficient through compact land use planning, green building ordinances and/or by making water-neutrality a condition of approval for new large developments.

Land use planning agencies and elected officials who approve new large development projects should support compact, multi-family urban infill development, as prioritized in the region's Senate Bill 375 Sustainable Communities Strategy. The more the region invests in compact development and reducing outdoor water use, the more water-efficient it will be in the future. Efficient land use planning can minimize future water demand caused by population growth.

Green building programs can require new construction or major retrofits to achieve water efficiency standards above and beyond state building code requirements. For example, San Francisco's

Green Building Ordinance requires 30 percent more water savings than baseline water use, whereas CALGreen, the state code, only requires 20 percent.

Water neutrality requires developers to fund offsets or retrofits within the service territory of a new development to meet that new development's demand, resulting in a "zero water footprint" for the new project.

5. After demand management measures are fully implemented, prioritize development of new water supplies in the following order:

a. **Conjunctive use, carefully monitored groundwater projects and indirect/direct potable reuse projects.** These types of projects tend to be highly reliable with a medium to low environmental impact. Indirect and direct potable reuse are superior choices to traditional recycled water because they produce water of a high enough quality for all possible end uses and do not require construction of a separate distribution system. These supplies will tend to be more important down the line; direct potable reuse is currently under review and not permitted in California. Groundwater, particularly when replenished with surface supplies through conjunctive use, is generally a more sustainable type of water supply if it is carefully monitored and managed to ensure that replenishment rates meet or exceed extraction rates. In some basins, groundwater extraction could impair water quality due to saltwater intrusion or cause land subsidence, but careful monitoring and groundwater basin management can prevent such occurrences.

b. **Recycled water, on-site reuse and district-scale systems, and banking and transfers.** These relatively drought-proof supplies provide reliability, but they have varying environmental impacts, such as increasing energy use. Recycled water, a drought-proof supply that has limited end uses due to its non-potable nature, can offset potable water demand, saving the highest-quality supplies for potable uses. But because it's not drinkable, it is of more limited value in a drought; potable reuse projects offer greater bang for the buck. Water agencies and public health agencies should establish clear processes for permitting on-site reuse and district-scale systems, which may be best suited for new large buildings and new large developments. Banking and transfers can help the Bay Area import large quantities of water during dry years.

c. **Desalination and development of new surface water supplies and surface storage.** These supplies can have a lower sustainability profile. Desalination is generally more expensive on a per-unit basis than other types of projects using a similar treatment process, such as potable reuse projects and recycled water. New surface water may not even be available in a multi-year drought, and additional diversions from river systems may have adverse ecological impacts. New surface storage may be a necessary strategy for adapting to future climate change, but groundwater storage (where possible) is more sustainable, and increasing dam heights or impounding reservoirs will flood acres of natural habitat.

6. Employ water rationing as a temporary emergency measure only.

Rationing only produces water savings on a temporary basis in an emergency and may have significant negative economic impacts.

Conclusion

Due to good planning, strong investment and ongoing reinvestment in infrastructure, as well as secured water rights and contracts, in normal water years most parts of the Bay Area have the water supplies necessary to accommodate growth and meet demand through 2035. However, in dry years and particularly in multiple-year droughts, some parts of the region cannot meet water demand with current supplies. Over the long term, as the region continues to grow and as climate change affects the reliability of available supplies, demand is likely to exceed existing supplies soon after 2035.

The Bay Area can meet its future water needs in two ways: reducing demand and increasing supplies. Water agencies have a host of tools to choose from in each of these categories, some more cost-effective, more reliable and/or more sustainable than others. There is no one-size-fits-all strategy that will work for every agency in the region. But since it takes many years to study, plan, permit and construct water supply facilities, it is not too early to begin planning for water supplies in 2035 and beyond.

The Bay Area has a strong set of institutions in its urban water agencies and regional associations of dischargers and suppliers. It also has effective water planning processes through its five-year urban water management plans and the Integrated Regional Water Management Plan. But plans and projects are only as strong as the public's support allows. SPUR believes that our region must do more to build support for water efficiency, water neutrality, integrated water management and water reuse as our best strategies for reliable, long-term urban water supply and environmental sustainability. This report is one contribution among many that will serve to build such a public consensus for the future.

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