**SPUR REPORT**
CLIMATE

SPUR
REGIONAL STRATEGY

# Water for a Growing Bay Area

## How the region can grow without increasing water demand

OCTOBER 2021

PACIFIC INSTITUTE

**This report is a component of the SPUR Regional Strategy, a vision for the future of the San Francisco Bay Area**
**spur.org/regionalstrategy**

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Additional appendices giving estimates for Bay Area urban water use scenarios are available at spur.org/bayareawater

## Introduction

# Balancing the Region's Growth and Water Use

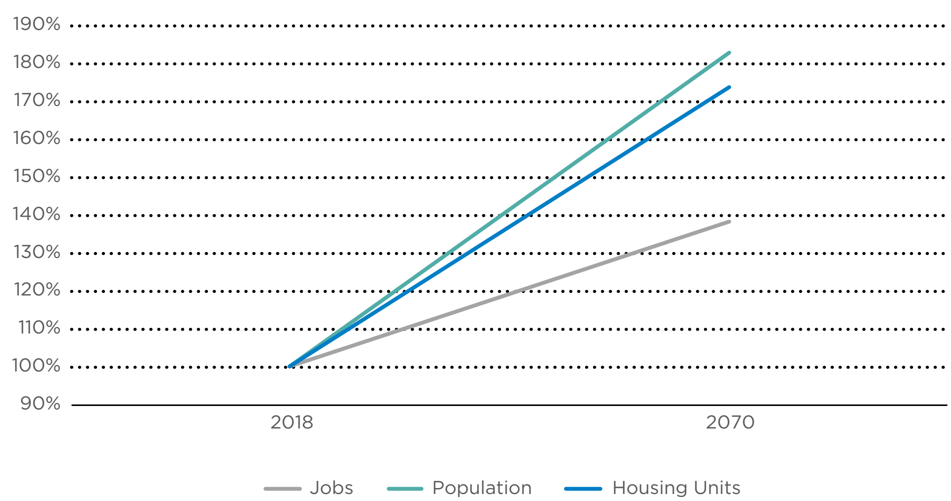
The San Francisco Bay Area is at a crossroads. The region, blessed with a beautiful natural setting, multiple shipping ports and world-class universities, is a driver of global economic growth. But the region's housing supply has not kept up with population growth. Many low-income households, disproportionately made up of people of color, have been forced into overcrowded and substandard housing or displaced from the urban center to new neighborhoods far from their jobs, friends and families. The most vulnerable have lost their homes entirely and are among the region's 35,000 unhoused people.[1]

Over the next half-century, the Bay Area's need to add housing will only grow more intense. The region is projected to add 2 million new jobs by 2070, which would attract as many as 6.8 million people, and needs to build at least 2.2 million new housing units just to prevent housing affordability from worsening.[2,3] This represents 83% more people, 74% more housing units and 38% more jobs over the next 50 years (see Figure 1).

FIGURE 1

**The Bay Area is projected to grow rapidly in jobs, population and housing units over the next 50 years.**
Job increases will attract new people to the Bay Area. To meet the new demand without worsening housing affordability, 2.2 million new homes need to be built.

Source: Szambelan, Sarah Jo, and Sarah Karlinsky, *A Civic Vision for Growth,* Technical Appendix, SPUR, 2021, https://www.spur.org/civicvisionforgrowth




1 All Home, "Regional Action Plan 2021," http://www.allhomeca.org/regionalactionplan/

2 Szambelan, Sarah Jo, and Sarah Karlinsky, *A Civic Vision for Growth,* Technical Appendix, SPUR, 2021, https://www.spur.org/civicvisionforgrowth

3 Karlinsky, Sarah, *What It Will Really Take to Create an Affordable Bay Area,* SPUR, 2020, https://www.spur.org/publications/spur-report/2021-04-19/what-it-will-really-take-create-affordable-bay-area

The San Francisco Bay Area has flourished in part because it has ready access to abundant freshwater. While the Bay Area does not receive much rain, it sits at the mouth of the state's largest watershed, the San Francisco Bay–Delta. Nearly half the rain and snow that California receives fall within the boundaries of the Bay–Delta watershed (see Figure 2).

FIGURE 2

**The San Francisco Bay–Delta watershed is the largest in the state**

More than half the rain and snow that reaches California falls within the boundaries of the Bay–Delta watershed.

Source: Redrawn from U.S. GAO. San Francisco Bay–Delta Watershed, 2018, https://www.gao.gov/assets/gao-18-473.pdf


The natural ecosystem of the Bay–Delta is feeling the strain of supplying water for much of the state. As a result of massive water diversions from the Sacramento–San Joaquin Delta and its tributaries to cities and farms, the San Francisco Bay–Delta is starved of freshwater. The Bay–Delta Estuary now experiences chronic artificial drought conditions, with annual freshwater input in the past decade resembling that of dry years that would naturally occur less than once every 20 years (see Figure 3).[4] Lack of freshwater has contributed to the decline of native fish populations.[5] And in the Central Valley, once-abundant salmon runs are at risk of extinction, with three types of salmon listed as threatened or endangered under the Endangered Species Act.[6]

4 Swanson, Christina, *State of the Estuary Report 2019 Update*, Technical Appendix: Freshwater Inflow Indicators and Index, 2019, https://www.sfestuary.org/wp-content/uploads/2019/10/SOTER-Combined-Technical-Appendix.pdf

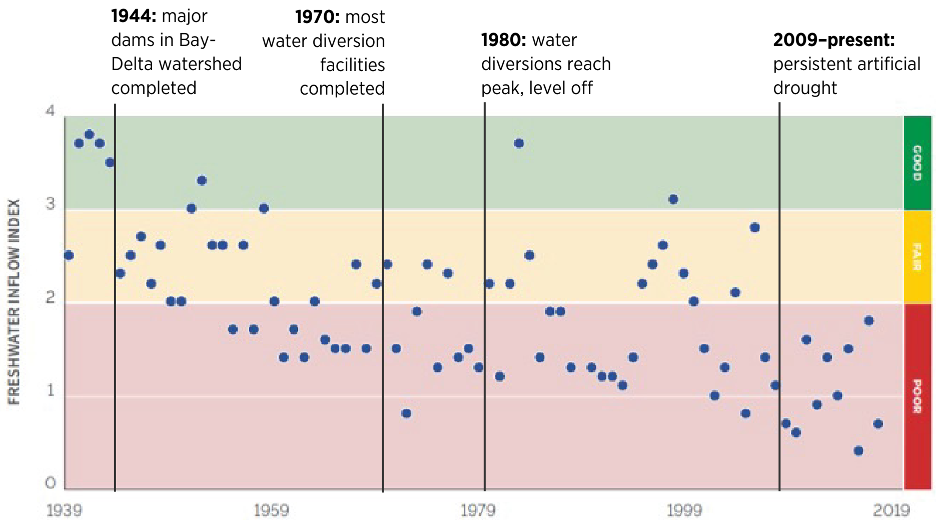
5 San Francisco Estuary Partnership and Delta Stewardship Council, *State of the Estuary Report*, 2019, pg. 17, https://www.sfestuary.org/wp-content/uploads/2019/10/State-of-the-Estuary-Report-2019.pdf

6 Department of Fish and Game, "State and Federally Listed Endangered and Threatened Animals of California," July 2021, https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=109405&inline

FIGURE 3

**The Bay–Delta experiences chronic artificial drought due to freshwater flow diversions for farms and cities.**

Since 2009, the Bay–Delta's freshwater inflow every year resembles what would have arrived in an exceptionally dry year before the diversions began. The Freshwater Flow Index is an index of multiple indicators, showing how the actual water input from rivers to the Bay–Delta has changed relative to what it would be under conditions unaltered by people.




Source: Freshwater Flow Index from San Francisco Estuary Partnership and Delta Stewardship Council, *State of the Estuary Report*, 2019, https://www.sfestuary.org/our-estuary/soter/ Historic events added by SPUR.

The impact of diversions from the Bay–Delta and its tributaries is felt not just by fish and wildlife but also by the people who rely on those ecosystems. The Winnemem Wintu Tribe has long fought to allocate more water to rivers during drought to preserve salmon populations.[7] This fight is about more than the economic value of the fish: The Winnemem Wintu believe that since their origins, the tribe and the salmon have pledged to care for one another.[8] The current system of storage and diversion projects also flooded most of their ancestral tribal lands, and more are under threat from proposals to raise the height of Shasta Dam.[9]

Diversions of freshwater also contribute to the proliferation of harmful algal blooms (HABs) in the Delta, which prevent many communities from enjoying their waterways. The problem is most concentrated in and around Stockton, which has a high share of low-income households and people of color. HABs flourish in slow-moving, warm, nutrient-filled water and produce substances that are poisonous to eat, drink and breathe. Persistent HABs mean that people who live in the Delta cannot play or fish in their waterways for much of the year.[10] The two main drivers of HABs are decreased freshwater flow and rising temperatures, associated with water diversions and climate change.[11]

The Bay–Delta ecosystem has already been stretched to its limits to provide freshwater for human use, and climate change is predicted to make precipitation less consistent than it was in the past. Dry years will become drier and wet years wetter, with fewer in-between years.[12] The increasing variability

7 Winnemem Wintu Tribe, "80 Years Is Long Enough to Wait — Shasta Dam and the Winnemem Wintu Tribe," July 28, 2021, http://www.winnememwintu.us/news-and-media/

8 KCET, "When Salmon Speak: The Winnemem Wintu and Winter-Run Chinook," October 27, 2016, https://www.kcet.org/shows/tending-the-wild/when-salmon-speak-the-winnemem-wintu-and-the-winter-run-chinook

9 Dallman, Suzanne, Mary Ngo, Paul Laris and Deborah Thien, "Political Ecology of Emotion and Sacred Space: The Winnemem Wintu Struggles with California Water Policy," *Emotion, Space and Society* 6, 2013, pgs. 33–43.

10 State Water Board, "California Voluntary Guidance for Response to HABs in Recreational Inland Waters," https://mywaterquality.ca.gov/habs/resources/habs_response.html

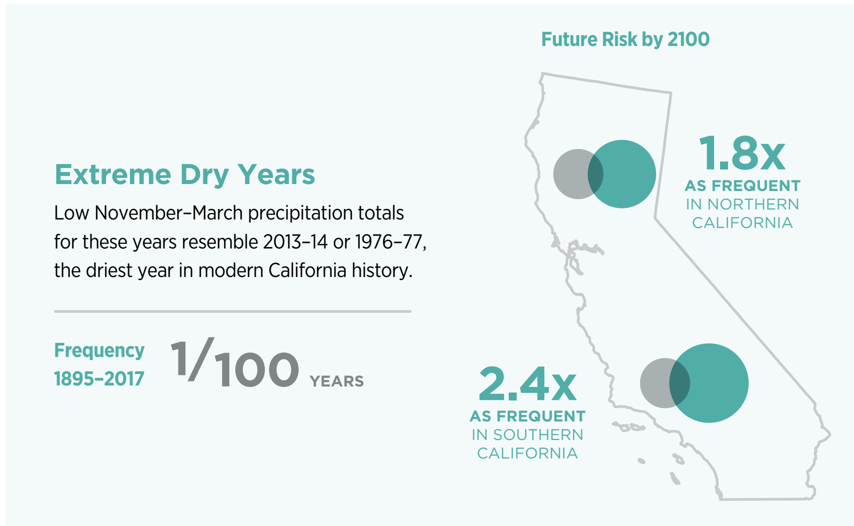
11 Lehman, P.W., T. Kurobe and S.J. Teh, "Impact of Extreme Wet and Dry Years on the Persistence of *Microcystis* Harmful Algal Blooms in San Francisco Estuary," *Quaternary International*, January 2020, https://doi.org/10.1016/j.quaint.2019.12.003

12 Swain, Daniel L., Baird Langenbrunner, J. David Neelin and Alex Hall, "Increasing Precipitation Volatility in Twenty-First-Century California," *Nature Climate Change* 8 (5), 2018,

of precipitation against a backdrop of rising temperatures means that more water evaporates before it can make its way to the aqueducts and reservoirs that supply coastal cities. Consequently, dry periods are predicted to become longer and more severe than they have been in the past (see Figure 4).[13]

FIGURE 4
**California's climate will grow more variable by the end of the century.**
In Northern California, climate models predict that extremely dry years will be 1.8 times as frequent, and extreme wet years 2.5 times as frequent.

Source: Redrawn from UCLA Institute of the Environment and Sustainability and UCLA Center for Climate Science, "California Is Headed for a Future of Precipitation Extremes," April 23, 2018, https://www.ioes.ucla.edu/article/study-forecasts-a-severe-climate-future-for-california/

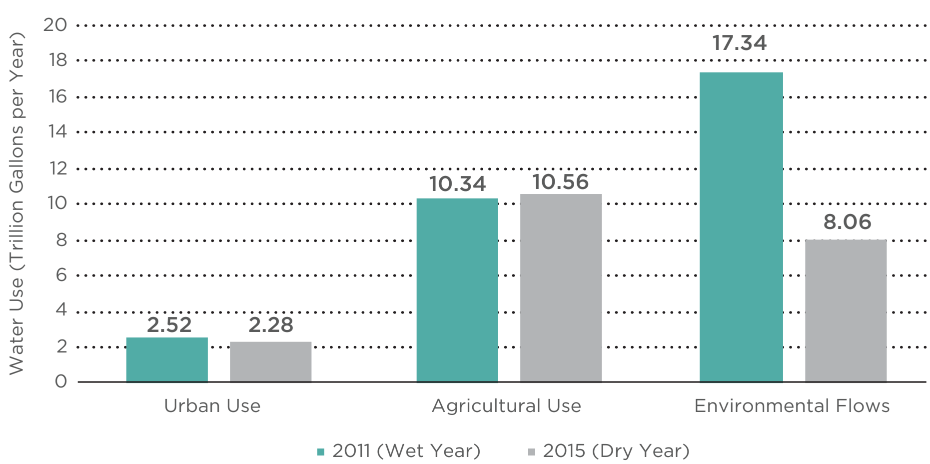



## How California Uses Water

California uses water for a variety of purposes. Of human uses, 80% of water is used for agriculture and 20% for urban purposes such as supplying people's homes, watering landscapes and providing water for businesses (see Figure 5). Despite urban water conservation mandates and curtailments to agricultural water deliveries, human water use is remarkably consistent from wet years to dry years, in part because agriculture makes up for shortfalls in surface water allocations by pumping groundwater in dry years. What varies radically from wet to dry years is not human water use but the amount of water that is left in rivers, wetlands and the Delta.

FIGURE 5
**Statewide, 80% of human water use is dedicated to agriculture and 20% to urban purposes.**
The amount of water that remains in the environment varies widely from wet to dry years.

Source: California Department of Water Resources (DWR), "Water Plan Update Water Balance Data," 2018, https://data.cnra.ca.gov/dataset/water-plan-water-balance-data



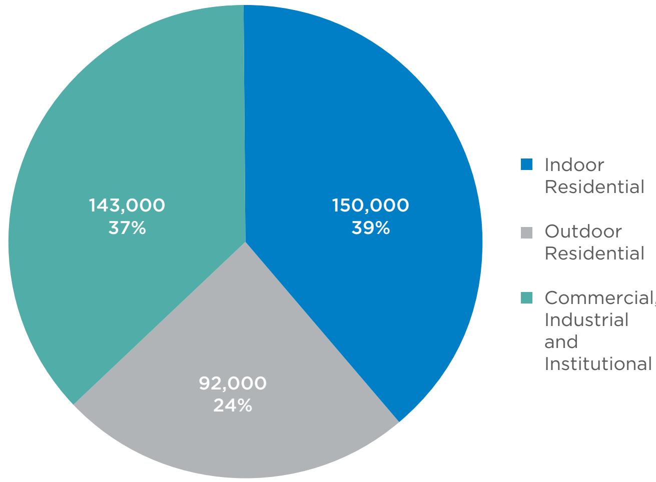

pgs. 427–33; and David Ackerly, Andrew Jones and Bruce Riordan, *California's Fourth Climate Change Assessment: San Francisco Bay Area Region Report*, 2018, https://barc.ca.gov/sites/default/files/documents/2020-12/20190116-sanfranciscobayarea.pdf

13 Ackerly et al.; see footnote 12.

Unlike the rest of the state, in the Bay Area about 90% of water use goes to supplying homes and businesses, including watering landscaping.[14] Indoor residential use is the largest share, at 39%, followed by 37% for businesses and institutions and 24% for residential outdoor irrigation (see Figure 6).[15]

FIGURE 6
**Indoor residential use is the largest segment of water use in the Bay Area, followed by water use by businesses, then residential outdoor irrigation.**
Average estimated water use 2010–15, nine-county Bay Area, in millions of gallons per year
**The three major types of water use in the Bay Area are indoor residential; outdoor residential; and commercial, industrial and institutional. This chart does not include water for energy production, which constitutes less than 1% of Bay Area urban water use.**

Source: California Department of Water Resources, "Water Plan Update Water Balance Data," 2018, https://data.cnra.ca.gov/dataset/water-plan-water-balance-data




## Why Save Water That Can Be Reused?

When analyzing water use, it's important to understand the distinction between water that is used and consumed (making it unavailable for future use) versus water that is used and returned to the system, where it is available for reuse. For example, when a homeowner or a farmer applies water to a lawn or field, some of that water may evaporate or discharge into a salty bay or ocean, becoming unavailable for immediate reuse. Another portion, however, may percolate into a fresh aquifer or run off into an irrigation channel and be available for other people to use. Another portion may run off into rivers or wetlands and benefit natural ecosystems. Applied water use is the amount of water used for any purpose, including water that will be available for reuse as well as water that is consumed. A subset of applied water use is consumptive water use, the amount of water not available for immediate reuse.[16]

Many policy researchers focus on reducing consumptive use, arguing that non-consumptive uses are less important because they do not reduce total water supplies.[17] But there are important benefits in reducing applied water use, even if some of that water could be reused. Non-consumptive uses of water often cause changes to local ecosystems, use energy and result in a deterioration of water quality. In this report, we look at reducing urban applied water use and refer to it simply as "use" from here on.

14 DWR, California Water Plan SB Interface LITEv9.1 Excel Tool, 2018.

15 The DWR's water balance data also include water for groundwater recharge (for future use) and conveyance losses as additional classes of urban water use. These classes were excluded from the above figure because the focus of our assessment is on the direct use of water to support residential, commercial, industrial and institutional development.

16 DWR, "California Water Plan Update 2018: Supporting Documentation for Water Portfolios," 2019, https://data.cnra.ca.gov/dataset/water-plan-water-balance-data/resource/e9b77304-1f4e-4452-99ee-0c61840d4018

17 Johnson, Renée, and Betsy A. Cody, *California Agricultural Production and Irrigated Water Use*, 2015, pg. 28, https://sgp.fas.org/crs/misc/R44093.pdf

# Why Focus on Urban Rather Than Agricultural Water Use?

A common question from city dwellers is, why should we conserve water when agriculture uses four times as much water as cities? Some version of this question comes up repeatedly in sustainability discussions. California oil and gas producers question why they should further reduce their pollution when California already imposes stricter regulations than many other states and countries.[18] Building developers ask why new buildings need to abide by strict energy efficiency standards that don't apply to existing buildings. Follow these arguments to their natural conclusion, and the end result is that nobody ends up shouldering responsibility for their share of environmental impacts.

SPUR and Pacific Institute believe that every sector that uses water is responsible for using water wisely. The framers of the California Constitution held this view in 1879, when they wrote that "the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent of which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented." Woven into the legal fabric of California is the belief that all use should be reasonable and beneficial. By extension, that means that people should pursue, within reason, efforts to use water more efficiently.

For urban water users who feel they should not bear all the burden for increasing efficiency, it's important to realize that the amount of water used by agriculture is expected to decline sharply in the coming decades. Agriculture in California has been able to backfill much of the shortfall in surface water allocations during dry years by pumping groundwater at a rate that far exceeds the rate of aquifer recharge. This has contributed to a long-term decline in groundwater reserves, which eventually will force groundwater users to sharply curtail their use. To prevent a "race to the bottom," the state enacted the Sustainable Groundwater Management Act in 2014 to require that all groundwater basins reach a balance between pumping and recharge no later than 2042.[19] Ending excess pumping of groundwater in the San Joaquin Valley is likely to cause farmers to fallow some 750,000 acres of farmland, leading to crop revenue losses of $2 billion per year.[20] Urban water users are hardly alone in being asked to reduce their water use to address shortfalls in water supply.

The urban and agricultural water sectors alike have capacity to reduce both their applied and consumptive water use. In our scenario modeling, we estimate that the Bay Area's applied water use in 2070 could be 40% lower if the region pursued efficiency measures and compact land growth instead of a business-as-usual approach to growth with little increase in efficiency. Estimates indicate that California agriculture could save 17% to 22% of applied water use. The estimate of potential reductions in agricultural consumptive water use vary far more widely, from 2% to 13%.[21] One study,

18 Willon, Phil, "California Oil Production Limits Stall in Legislature, Leaving the Issue to Newsom," *Los Angeles Times,* August 13, 2020, https://www.latimes.com/california/story/2020-08-13/setbacks-legislation-california-oil-gas-production-environmental-protections-newsom

19 DWR, "Groundwater: Understanding and Managing This Vital Resource," https://storymaps.arcgis.com/stories/ff075c25b77e4b1d95ce86a82bf0fe96

20 Hanak, Ellen, et al., *Water and the Future of the San Joaquin Valley: Overview*, Public Policy Institute of California, February 2019, pg. 16, https://www.ppic.org/wp-content/uploads/water-and-the-future-of-the-san-joaquin-valley-overview.pdf

21 Pacific Institute, and Natural Resources Defense Council, "Agricultural Water Conservation and Efficiency Potential in California," June 2014, https://www.nrdc.org/sites/default/files/ca-water-supply-solutions-ag-efficiency-IB.pdf; and Christian-Smith, Juliet, Heather Cooley and Peter H. Gleick, "Potential Water Savings Associated with Agricultural Water Efficiency Improvements: A Case Study of California, USA," *Water Policy* 14 (2), 2014, pgs. 194–213, https://doi.org/10.2166/wp.2011.017

notable because it was produced by an irrigation district, found that updated infrastructure could save 11% to 18% of water that is currently lost from the system.[22]

## The Importance of Conservation and Efficiency

Conservation and efficiency are generally the least expensive and most environmentally friendly ways to bring water demand in line with supply.[23] Conservation is the act of reducing water use (e.g., taking shorter showers), and efficiency is accomplishing the same goals with less water (e.g., replacing an old showerhead with a low-flow head). Both contribute to water demand management. Conservation and efficiency have many benefits, including reducing pollutant loads from outdoor irrigation, reducing the need to develop new water supplies and reducing the demand on already-overdrawn supply sources, potentially leaving more water to maintain the ecology of the Bay and its watersheds.[24]

Cutting water demand can also help the state achieve its climate goals. The conveyance, treatment and heating of water and wastewater consumes nearly 20% of the total electricity and 30% of natural gas consumed in California.[25] During the 2012–16 drought, mandated water conservation requirements saved more energy than programs directly aimed at energy efficiency.[26]

The idea that the region can grow its housing stock and population by half and use the same amount or less water may seem counterintuitive, but it's in line with trends for California over the past half-century. Since 1972, water demand in the state has been more or less flat, even as the population and economy have expanded.[27] The Bay Area is no exception to the decoupling of water use from population growth: The region cut its water use by over a third in the past three decades, even as its population grew by a third (see Figure 7).

22 Modesto Irrigation District, "Comprehensive Water Resources Management Plan," February 28, 2012.

23 Cooley, Heather, Rapichan Phurisamban and Peter Gleick, "The Cost of Alternative Urban Water Supply and Efficiency Options in California," *Environmental Research Communications* 1, no. 4, May 2019: 042001, https://doi.org/10.1088/2515-7620/ab22ca

24 Vorster, Peter, and Greg Reis, *State of the Estuary Report 2019 Update*, Technical Appendix: Urban Water Use, 2019, https://www.sfestuary.org/wp-content/uploads/2019/10/SOTER-Combined-Technical-Appendix.pdf

25 The 30% of natural gas figures is a share of all natural gas consumed outside of electrical power plants. Klein, Gary et al., *California's Water-Energy Relationship*, California Energy Commission, 2005, http://large.stanford.edu/courses/2012/ph240/spearrin1/docs/CEC-700-2005-011-SF.PDF

26 Spang, Edward S., Andrew J. Holguin and Frank J. Loge, "The Estimated Impact of California's Urban Water Conservation Mandate on Electricity Consumption and Greenhouse Gas Emissions," *Environmental Research Letters* 13, no. 1, 2018: 014016.

27 Cooley, Heather, *Urban and Agricultural Water Use in California, 1960–2015*, Pacific Institute, 2020, https://pacinst.org/publication/urban-agricultural-water-use/

FIGURE 7

**In the Bay Area, water use has declined even as the population and economy have grown.**

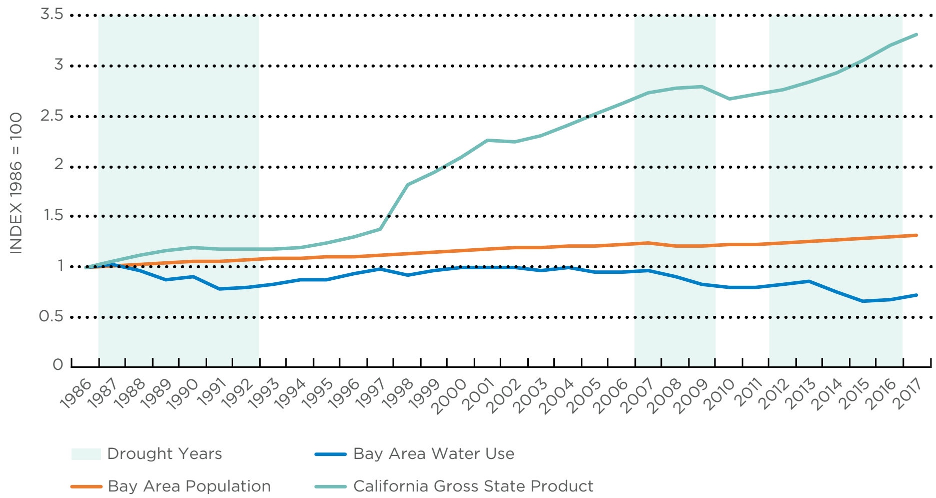
Changing behavior, upgrading appliances, fixing leaks and installing drought-tolerant landscaping have all contributed to a reduction in water use since the 1980s.

SOURCES:

Water Use and Population: Vorster, Peter, and Greg Reis, 2019, https://www.sfestuary.org/wp-content/uploads/2019/10/SOTER-Combined-Technical-Appendix.pdf

Gross State Product: California Department of Finance, https://www.dof.ca.gov/forecasting/economics/indicators/gross_state_product/2021h

Drought Years: California Department of Water Resources, 2021, https://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Publications-And-Reports/DroughtBrochure2021update_ay11.pdf

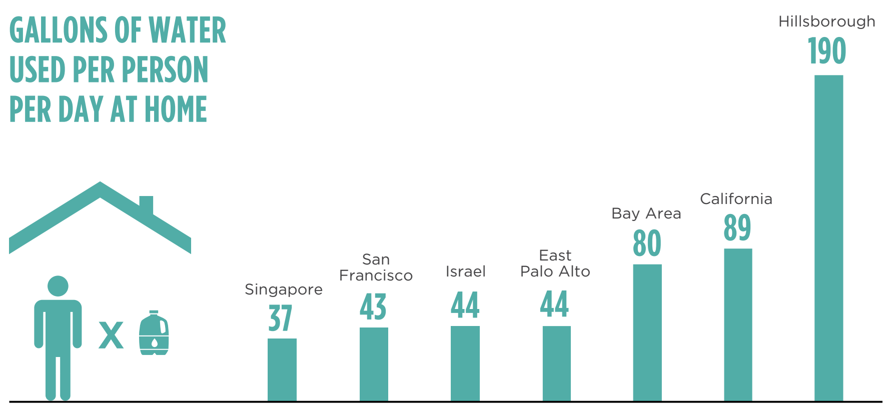



While California has made strides in residential conservation and efficiency in recent decades, examples from other countries make it clear that there are still many unrealized opportunities to reduce water use. Israelis use 44 gallons per person per day at home; Singaporeans use just 37.[28] Californians, by contrast, use 89 gallons per person per day at home. Within the nine-county Bay Area, per-capita residential water use averages about 80 gallons a day, ranging from about 40 gallons a day in urban San Francisco and low-income East Palo Alto to 190 gallons per day in the wealthy suburban town of Hillsborough[29] (see Figure 8). Other countries also draw far more of their water from nontraditional sources such as recycled water, stormwater capture and desalination.[30]

FIGURE 8

**Despite great strides in conservation, Californians still use more water at home than other water-scarce places.**

Residential water use varies widely because of differences in efficiency and the amount of water people use for discretionary purposes, such as outdoor irrigation. In the Bay Area, communities with larger parcel sizes and higher incomes tend to use more water at home.




28 Pacific Institute, "Why Go for Desal When California Has Cheaper Options?," June 2017, https://pacinst.org/publication/why-go-for-desal-when-california-has-cheaper-options/; and Singapore's National Water Agency, "Singapore Water Story," July 2021, https://www.pub.gov.sg/watersupply/singaporewaterstory

29 Figures for residential per-capita gallons per day are averages for 2019–20, calculated from the Water Boards' June 2014–May 2021 Urban Water Supplier Monthly Reports (Raw Dataset), 2021, https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/conservation_reporting.html - monthly_archive

30 U.S. EPA, *National Water Reuse Action Plan (Draft)*, Appendix G: Select International Profiles, September 2019, https://www.epa.gov/sites/default/files/2019-09/documents/water-reuse-2019-appendix-g.pdf

New infill multifamily housing tends to be the most water-efficient type of housing. Several factors contribute to this difference:

→ **Multifamily housing tends to have a smaller lot size per housing unit,** reducing the per-capita amount of water needed for outdoor landscaping.

→ **Infill development often occupies space that was already irrigated.** When unirrigated open space is developed, total demand for irrigation water increases. By contrast, adding an accessory dwelling unit, converting a single-family home to a multiplex, splitting a single lot into two and other forms of infill development do not add new landscaped area to the region.

→ **New construction tends to be more efficient than older buildings.** New construction needs to comply with current building code standards and efficient landscaping requirements. Older buildings also tend to accumulate plumbing leaks over time.

## Why Addressing Water Demand Is Part of Addressing the Housing Crisis

California communities are starting to run up against the limits of their water supply, and this means they have a choice: Decrease demand, increase supply or stop new construction. Decreasing water demand is not a turnkey proposition. It requires long-term investments in more efficient technologies in buildings and more drought-tolerant landscaping outdoors. It also entails having rate structures in place that strongly incentivize saving water. And it calls for cultivating awareness among customers about the importance of saving water, not just during a drought emergency but as a way of life. New supplies likewise require long-term planning and investment. As a result, when a water utility finds it cannot supply new customers with water, the quickest fix is simply to enact a building moratorium.

As of March 2021, 37 communities in California had placed moratoriums on new construction (see Figure 9). Some of these are still active, and some have been rescinded. For others, we were unable to determine their current status. A full list of the building moratoriums is presented in Appendix 2.

Most of these moratoriums were enacted during the 2012–16 drought, when the state required 21 communities to halt new connections, and affected smaller communities with small, geographically isolated water supplies.[31] However, some larger communities have been affected as well. East Palo Alto, a predominantly low-income community of color in San Mateo County, had a building moratorium in effect from 2016–18 because it had insufficient water available.[32] East Palo Alto's population is more than 90% Latino, Black and Native American/Pacific Islander. Like other cities on the Peninsula, East Palo Alto's municipal water system purchases water as a wholesale customer of the San Francisco Public Utilities Commission (SFPUC). Beginning in 1984, it received a far lower per-person allotment of water from SFPUC's wholesale operation than its wealthier, whiter neighboring

31 Dooley, Emily, "Water and Housing Needs Collide in California's Severe Drought," Bloomberg Law, June 28, 2021, https://news.bloomberglaw.com/environment-and-energy/water-and-housing-needs-collide-in-californias-severe-drought

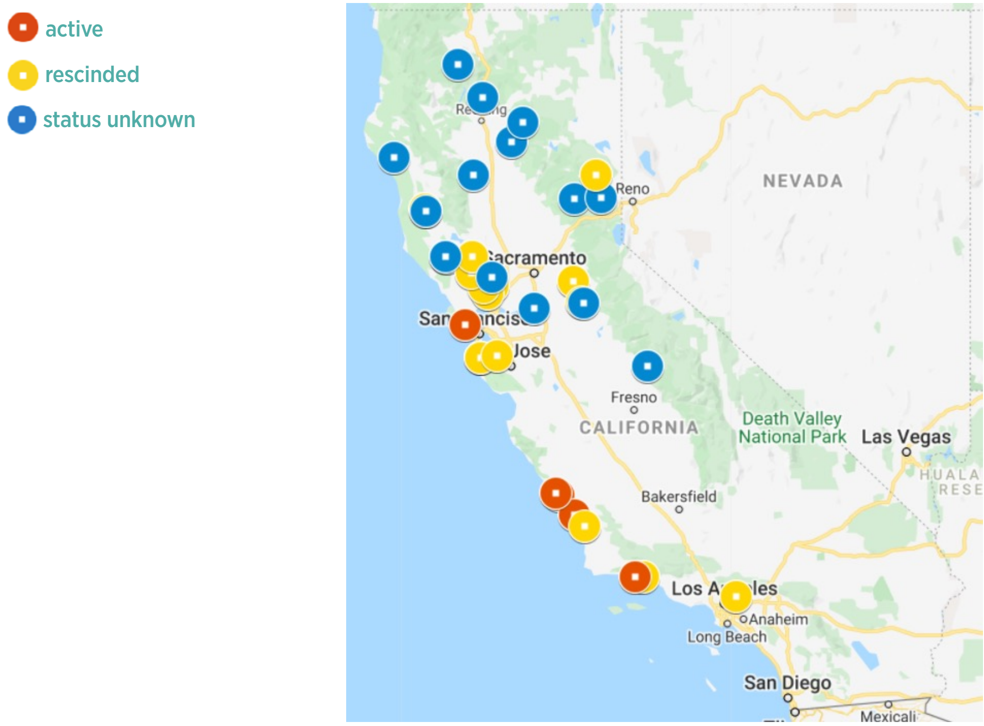
32 For a thorough history of East Palo Alto's water supply, see https://www.siliconvalleycf.org/sites/default/files/publications/east-palo-alto-water-report-reader.pdf

FIGURE 9

**Thirty-seven communities in California have placed moratoriums on new construction due to water supply limitations.**

An interactive version of this map is available at spur.org/buildingmoratoriums.

Source: See Appendix 2.




cities. This situation was only rectified in 2017 and 2018, when first Mountain View and then Palo Alto agreed to transfer a share of their unused water to East Palo Alto.

With drought conditions worsening in 2021, California may be poised to see a new wave of building restrictions. In the Bay Area, the Marin Municipal Water District (MMWD) is considering issuing a temporary ban on new connections.[33] MMWD serves two designated priority development areas in San Rafael and the unincorporated area of Marin City, and loss of new development in those areas would be setbacks for the goals of creating homes and jobs in transit-rich areas.[34] Already one multifamily senior housing development in Marin City is in limbo, unable to proceed without a guarantee of service from the water district.[35]

There is a common perception that some communities use a lack of water as a bad-faith argument to oppose any new development. The truth is more complex. Water supplies are limited and growth cannot proceed indefinitely, and some water utilities are particularly constrained in their options for either new supply or demand management. But at this moment in time, most Californians use more water than they need to, and developing alternative water supplies holds great potential. There are better solutions to addressing water supply limitations than halting the construction of the new housing that the state desperately needs. Ensuring that there is adequate water supply for new development will require careful long-term planning and investments and, as the case of East Palo Alto shows, a better system of allocating water according to need.

33 "Options for New Service Connections During Drought," Marin Municipal Water District, 2021, https://www.marinwater.org/sites/default/files/2021-05/05-18-2021 Options for New Connections During Drought.pdf

34 Metropolitan Transportation Commission and Association of Bay Area Governments, "PDAs and PCAs in Marin County," *Plan Bay Area 2040,* https://www.planbayarea.org/sites/default/files/pdf/files/files10284.pdf

35 See footnote 31.

## Scope of This Report

This report picks up where SPUR's *Future-Proof Water* left off.[36] In that report, we found that soon after 2035, the region will not have enough water to meet its needs without curbing use or developing new supplies. We identified three key strategies to make the Bay Area's water supply more drought-resilient and sustainable, in order of priority:

1. **Reduce demand with conservation and efficiency.**
2. **Require new development to be highly efficient.**
3. **Develop new supplies, storage and transfer options in the following order:**
   - → *Tap local groundwater, store extra water in wet years in local groundwater aquifers and develop reuse projects to supply potable water.* Local groundwater supplies, greater reliance on below-ground water storage, and water reuse to provide drinking-quality water were deemed the most cost-effective, environmentally sustainable options to improve water supply resilience.
   - → *Develop non-potable reuse projects, increase water banking and facilitate the transfer and exchange of water between water utilities.* Other good options for water supply resilience include reusing water for non-drinking purposes, banking water in wet years for use in dry years and enacting agreements to allow movement of water between utilities as needed.
   - → *Consider desalination, development of new surface water supplies and surface storage only when better alternatives have been exhausted.* These options may become necessary but should be considered alternatives of last resort. Desalination is expensive, energy-intensive and harmful to coastal ecosystems. But the technology for desalination is improving, and it may be more feasible in the Delta, where water is only moderately salty. Surface water supplies and surface water storage have largely been developed already; the few remaining opportunities generally come at a high environmental cost.

This report dives into the first two strategies identified in *Future-Proof Water:* managing demand with conservation and efficiency and making new development as efficient as possible. We focus specifically on modeling how the region can decrease its demand for water to free up supply for new homes and jobs. We don't examine alternative supply options in depth or attempt to quantify how much new demand could be met through options such as recycling water and stormwater capture. These are important options, but we leave that topic to another report.

In this report, we explore the future of Bay Area water demand by asking two key questions:

- → What would water demand for the Bay Area be in 2070 with more dense and compact growth and increased water efficiency?
- → Can the Bay Area build the housing it needs to house its growing population given the limits on the region's water supply?

36 Tam, Laura, *Future-Proof Water*, SPUR, 2013, https://www.spur.org/futureproofwater

To address these questions, we examined six alternative scenarios for future water demand. We started with two scenarios for growth and land use in 2070 and crossed them with three scenarios for water use in 2070 (see Figure 10).

**FIGURE 10**
**Six Scenarios for Bay Area Water Use in 2070**
We crossed two growth projections and three water use alternatives to arrive at six possible scenarios for water use in the Bay Area in 2070.

| | INEFFICIENT WATER USE | EFFICIENT WATER USE | HIGHLY EFFICIENT WATER USE |
|---|---|---|---|
| **2070 NEW CIVIC VISION GROWTH:** DENSE INFILL HOUSING, HIGH SHARE OF MULTIFAMILY BUILDINGS | **Scenario 1:** Compact & Inefficient | **Scenario 3:** Compact & Efficient | **Scenario 5:** Compact & Highly Efficient |
| **2070 BUSINESS AS USUAL GROWTH:** SPRAWLING GREENFIELD DEVELOPMENT, HIGH SHARE OF SINGLE FAMILY HOMES | **Scenario 2** Sprawl & Inefficient | **Scenario 4:** Sprawl & Efficient | **Scenario 6:** Sprawl & Highly Efficient |

SPUR first introduced the two growth scenarios in the report *A Civic Vision for Growth,*[37] which projected where growth will likely occur without much change to current policies versus where it would go under new policies that furthered equity and sustainability goals. Both scenarios are based on projections that the Bay Area will add 2 million new jobs.[38] SPUR has projected that in order to meet the increased demand for housing without worsening housing affordability, the region will need to build 2.2 million new homes.[39] If it does, the region could accommodate an additional 6.8 million people in the nine counties. If not, millions of people would be pushed to outlying areas and commute long distances for work, or jobs would go unfilled.

The Business as Usual scenario assumes that recent land use patterns continue, with a high proportion of new housing built as single-family homes in open space and agricultural land. The New Civic Vision scenario uses a set of planning principles to guide where growth should go: more infill housing in already-developed areas and no growth at all in places at greatest risk of natural disaster.[40] By calling for changed zoning rules to add density in existing neighborhoods, as well as a greater proportion of multifamily buildings, the New Civic Vision scenario allows the region to add 800,000 more homes than the Business as Usual scenario.

## SPUR's Growth Principles:

1. The region should not grow in hazardous areas prone to fires and flooding or in open space, agricultural land or other undeveloped locations.
2. Growth should be densest near transit.
3. Growth should also concentrate near commercial corridors and in pre-war downtowns.

37 See footnote 2.

38 Levy, Stephen, *High and Low Projections of Jobs and Population for the Bay Area to 2070 — Projection Framework, Specific Assumption and Results*, Continuing Center for the Study of the California Economy, November 2019, https://www.ccsce.com/PDF/High-and-Low-Projections-of-Jobs-and-Population-for-the-Bay-Area-to-2070.pdf

39 See footnote 3.

40 See footnote 2.

**4.** New types of housing should be added in places that offer opportunities to build wealth.

**5.** Today's single-family neighborhoods should allow other housing types.

We explored three water use scenarios, all achievable within the limits of existing technology (see Figure 11). Each scenario varies water use for three sectors: indoor residential; outdoor residential; and commercial, industrial and institutional. The Inefficient scenario assumes that current regulations for new housing and retrofits stay in place through 2070, with conversion to more efficient technologies occurring only in new homes and when plumbing fixtures reach the end of their life.[41] The Efficient scenario assumes that all new fixtures sold in the Bay Area are the best technology available on the U.S. market as of 2017, household leaks are reduced as advanced metering infrastructure and similar technologies penetrate the market, many yards are converted to drought-tolerant landscaping and businesses adopt greater efficiency measures. The Highly Efficient scenario assumes that all homes convert plumbing fixtures to the best currently available technology, household leaks are dramatically reduced, all homes install drought-tolerant landscaping and businesses pursue a high level of efficiency. The scenarios are intentionally conservative, likely overestimating water use. First, we assume no improvements in indoor residential technology since 2017. Second, we assume that residents don't change their daily water use behaviors — that is, they still flush the toilet the same number of times, shower for the same number of minutes, and run the dishwasher just as often as they did when California residential water end use was studied in 2011.

FIGURE 11

**Overview of Water Efficiency Scenarios by Type of Water Use**

**We used three scenarios for future water use: inefficient, efficient and highly efficient.**

| WATER USE | INEFFICIENT | EFFICIENT | HIGHLY EFFICIENT |
| --- | --- | --- | --- |
| Indoor Residential | Current plumbing-fixture standards and leak rates remain unchanged | Plumbing fixtures are replaced with efficient models at end of life; leaks cut by 50% | All fixtures are replaced with efficient models by 2070; leaks cut by 75% |
| Outdoor Residential | Only new housing adopts outdoor efficiency standards | 50% of existing housing and all new housing units adopt outdoor efficiency standards | All existing and new housing units adopt outdoor efficiency standards |
| Commercial, Industrial and Institutional | No change from current use | 10% gain in efficiency per decade | 20% gain in efficiency per decade |

41 Plumbing fixtures include toilets, showerheads, faucets, dishwashers and washing machines — anything connected to the plumbing in a building.

## Key Findings

Our scenario modeling showed four important findings for balancing the region's growth and its water use:

→ The Bay Area could add 2.1 million jobs, 6.8 million people and 2.2 million homes by 2070 and still offset all water use from this growth through modest improvements in water use efficiency and more compact land use.

→ The region could grow and use even less water than today if it took some more ambitious but still achievable steps toward greater water efficiency.

→ Compared to sprawl growth, compact growth doesn't decrease total water use, but it decreases per capita consumption dramatically. In the compact growth scenarios, the region is able to fully address housing demand and yet use about the same amount of water as in the sprawl scenarios.

→ In some areas, growth will outstrip the potential to offset demand with local conservation and efficiency. Meeting the demand for every part of the Bay Area will require transferring water within the region or identifying alternative supplies.

The results of the scenario modeling offer a hopeful vision: The Bay Area could offset water demand for all of its growth in housing, population and jobs with improvements in efficiency. With more ambitious increases in efficiency, the Bay Area could import less water from the fragile ecosystems of the Delta and its headwaters, even while keeping up with new housing demand. Achieving these outcomes will not be easy. It will require long-term investments in conservation and efficiency that can be augmented with the strategies for new supplies, storage and transfer options identified in *Future-Proof Water.*

The Bay Area faces tremendous challenges to its environment and an affordable housing crisis. A lack of long-term planning forces communities into bad choices between building new housing and delivering water supplies to existing residents and businesses. With careful planning and long-term investments in conservation and efficiency, the region could continue to grow, build the housing it needs and have a lighter footprint on upstream ecosystems and communities.

## Chapter 1

# Bay Area Water Supplies and Their Stressors

## The Bay Area's Water Supply

The Golden Gate sits at the confluence of the Bay–Delta watershed, the largest watershed in California (see Figure 2 on page 5). Nearly half of all the rain or snow that falls in the state each year falls within the borders of the Bay–Delta watershed. Most of this precipitation falls as snow in the Sierra Nevada mountain range, melting each spring to feed the rivers running from the mountains into the two largest rivers in the state: the Sacramento in the northern Central Valley and the San Joaquin in the southern Central Valley.[42] These two rivers meet in the Delta near Sacramento and Stockton. The waters of the Sacramento–San Joaquin Delta run into San Francisco Bay, then out to the Pacific Ocean.

As people began to establish cities and towns in the Bay Area, they faced the fundamental problem that, while the Delta receives massive amounts of freshwater, by the time water reaches the Bay, it is too salty to use for drinking or irrigation. To resolve this, over the course of the 20th century, federal, state and local governments engineered systems for water to bypass the salty reaches of the Bay–Delta and arrive at its destination fresh and ready for drinking and irrigation (see Figure 12). Today, an elaborate system of canals and aqueducts route water from the rivers of the Sierra Nevada and the Central Valley to coastal population centers and agriculture.

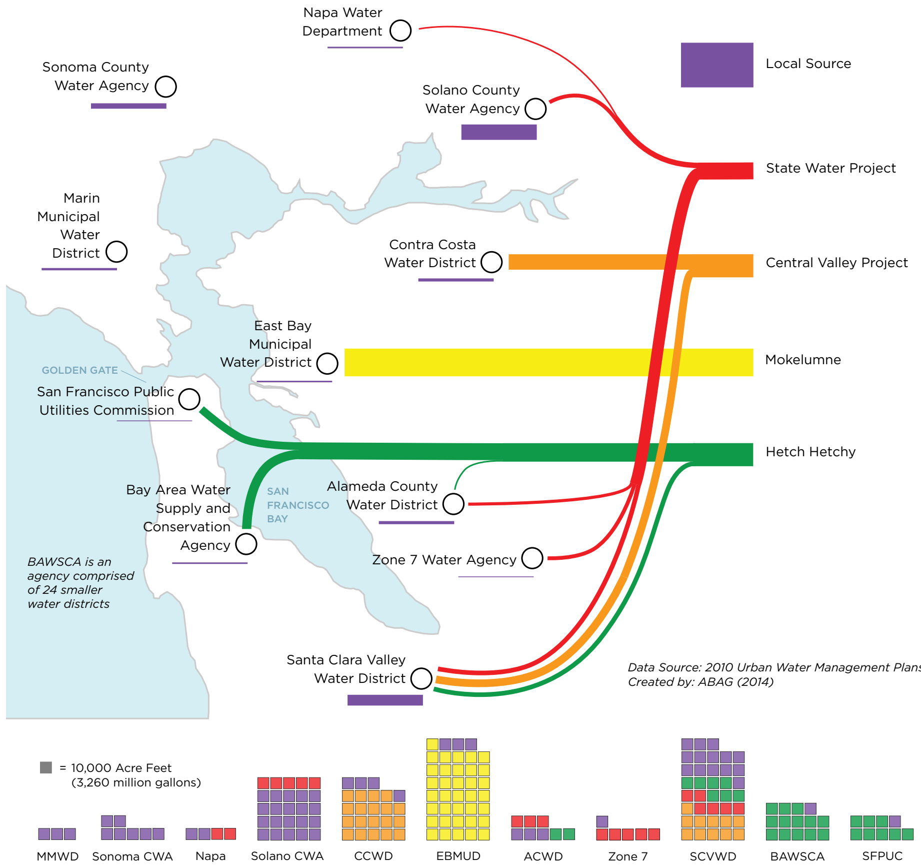
42 A small amount of water is also diverted from the Trinity River in the Trinity Alps of Shasta County to the Sacramento River. See "Trinity River (California)" in Wikipedia, January 26, 2021, https://en.wikipedia.org/w/index.php?title=Trinity_River_(California)&oldid=1002872370

FIGURE 12

**The Bay Area largely relies on water imported from the Sierra Nevada and Central Valley rivers.**

There are four primary sources of water in the Bay Area: the State Water Project (red), the Central Valley Project (orange), the Mokelumne River watershed (yellow) and the Hetch Hetchy/Tuolumne River watershed (green). Local sources (purple) include water from local groundwater, local watersheds such as the Russian River and recycled water.

Source: Association of Bay Area Governments (ABAG), 2014, https://abag.ca.gov/sites/default/files/infrastructurereport_2014.pdf




Water management in the Bay Area is complex, with utilities spanning diverse geographic, administrative and institutional boundaries. There are more than a hundred retail water utilities in the greater Bay Area, many of which receive at least part of their water supply from wholesalers such as the San Francisco Public Utilities Commission (SFPUC). This complexity has led to innovative institutional partnerships, but it can also lead to economic, social and environmental inequities when utilities have differential access to water across the region.

The Bay Area has a diverse water supply portfolio consisting of local sources (groundwater, non-imported surface water and recycled/reused water) and imported[43] sources from federal, state and local projects. Utilities adapt their supply portfolios on a year-to-year basis in response to local hydrologic conditions, economics and changes in the availability of imported supplies. For example, during California's 2012–16 drought, many local water utilities offset the reduced availability of imported supplies with increased use of local supplies such as groundwater.

On average, about 60% of the water supply in the Bay Area is imported from outside the region via a complex system of canals and aqueducts. Imported supplies are typically sourced from snowmelt in the Sierra Nevada and, as such, are very sensitive to changes in precipitation type, quantity and timing resulting from climate change.[44] Access to a diverse range of water supplies can help build the resilience of regional water utilities. Reliance on each of these sources has varied

43 The Bay Area's imported water supplies are sourced from outside the Bay Area hydrologic region while local supplies are sourced from within the Bay Area hydrologic region.

44 Ackerly et al.; see footnote 12.

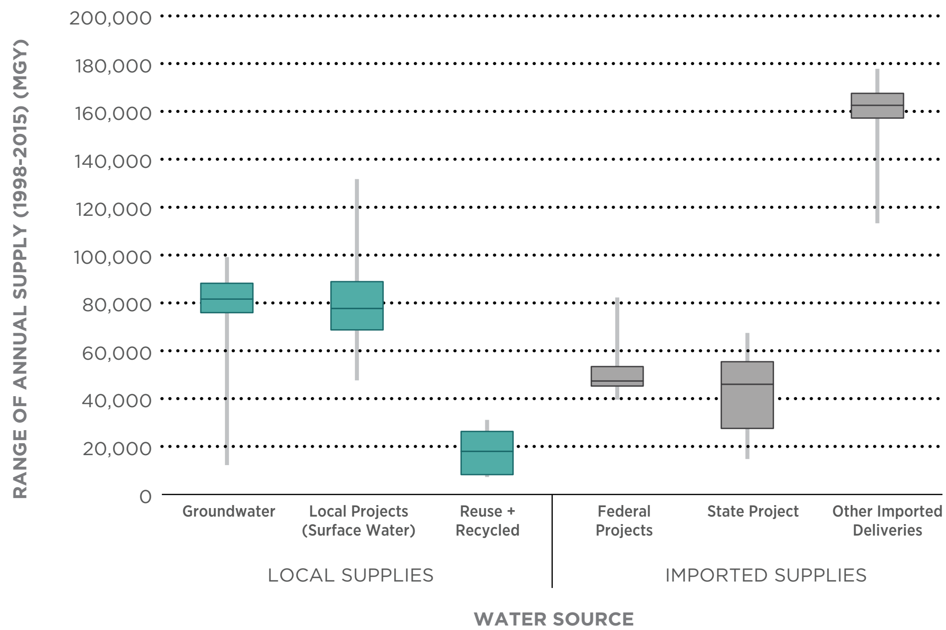
considerably in recent years (see Figure 13). In the Bay Area, local supplies are primarily from groundwater and local projects, such as the series of reservoirs operated by Valley Water that store runoff from local rivers, with a small share of reused and recycled water. Imported water comes from projects owned and operated by local water utilities, such as SFPUC's Hetch Hetchy project and the East Bay Municipal Water District's Mokelumne River project (shown as "Other Imported Deliveries" in Figure 13). Other imported supplies come from federal projects and the State Water Project.

FIGURE 13

**Water supply for the Bay Area comes from a portfolio of sources that vary in amount from year to year.** Ranges of reported water supplies for the Bay Area, 1998–2015

The boxes show the range of annual reported water supplies from 1998–2015. Data are aggregated for the entire Bay Area. The lower end of each box represents the 25th percentile, the upper end represents the 75th percentile and the line bisecting the box represents the median. The vertical lines show the range from the minimum to maximum values.

Source: DWR, "Water Plan Update Water Balance Data," 2018, https://data.cnra.ca.gov/dataset/water-plan-water-balance-datah




Since 2003, the reliance on imported supplies has generally been trending downward (both in absolute terms and as a percentage of total supply), while the use of local supplies has increased (see Figure 14). Precipitation amounts vary significantly year to year across the region and the state. This variability has been a major driver for investments to diversify water supply portfolios. During the 2012–16 drought, the use of local supplies exceeded imported supplies in several years. Greater access to local supplies can help local water utilities better manage reduced access to imported supplies during periods of drought. It can also increase resilience in the face of other stressors such as earthquakes and regulatory changes. Imported supplies from the Bay–Delta and its tributaries are particularly contentious. The State Water Board adopted an update to the Bay–Delta Water Quality Control Plan in 2018 that could sharply curtail supplies for much of the Bay Area, because the board found that the Delta needs higher flows to maintain the health of the ecosystem. Implementation of the new plan's minimum flow requirements were put on hold to allow negotiations on voluntary agreements, but these requirements could return if negotiations fail.[45]

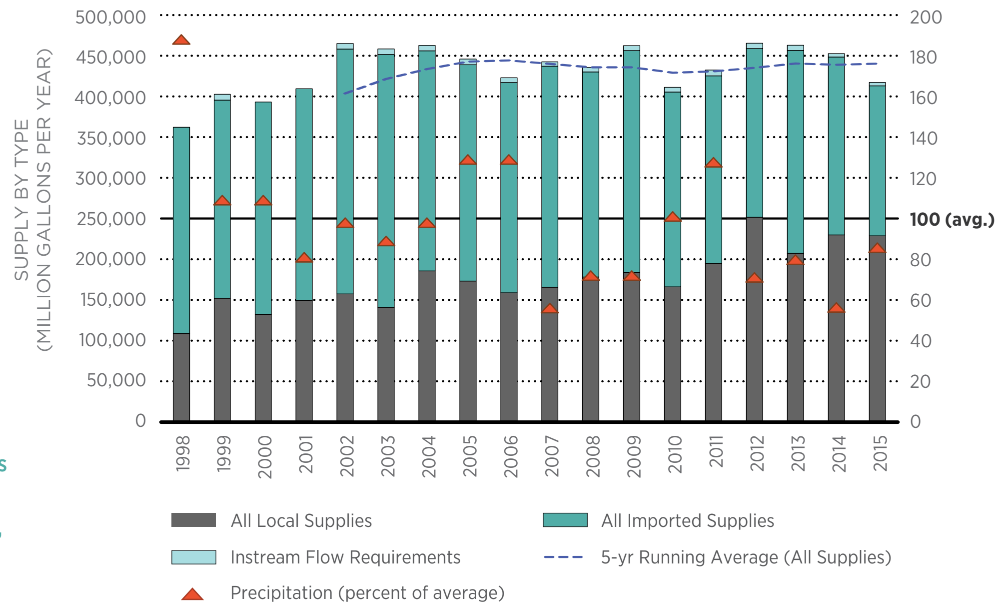
45 Pitzer, Gary, "Framework for Agreements to Aid Health of Sacramento-San Joaquin Delta Is a Starting Point With An Uncertain End," Water Education Foundation, April 17, 2020, https://www.watereducation.org/western-water/framework-agreements-aid-health-sacramento-san-joaquin-delta-starting-point-uncertain

FIGURE 14

**Reliance on local water supplies has generally increased while total water supply has remained fairly consistent since 2002.**

Summary of Bay Area Water supplies relative to percent of average precipitation by year, 1998–2015

**Precipitation was below 30-year average precipitation (100%) in 11 of 18 years. Dry years tend to correspond with greater reliance on local supplies. The dotted line shows the five-year running average for the five previous years; for example, the 2002 average is the mean for 1998–2002.**




Source: DWR, "Water Plan Update Water Balance Data," 2018, https://data.cnra.ca.gov/dataset/water-plan-water-balance-data

# Physical Stressors Impact Future Water Supply Availability

Water infrastructure in the Bay Area is vulnerable to the risks posed by multiple physical stressors, including climate change and earthquakes. These risks threaten many dimensions of the water supply, including the quantity of water available, the physical infrastructure used to deliver water and the ability of communities to safely manage wastewater. Developing water infrastructure that is resilient to these stressors is an essential component in supporting continued growth in the Bay Area. Solutions such as reducing water demand, increasing reliance on local water supplies, building physical connections (interties) between water agencies and increasing cooperation among water utilities and other institutions can all help build resilience to these physical stressors through redundancy, increased operational flexibility and decreased reliance on vulnerable infrastructure and supplies.

Climate change poses multiple risks to water supplies in the Bay Area. The fluctuations between dry and wet years are likely to grow more extreme as the climate changes, making multiyear droughts more common. Higher temperatures mean that plants require more water to survive and that more water is lost to the atmosphere. Much of the state's water comes from snowmelt in the Sierra Nevada. Melting snowpack provides a natural storage mechanism for slowly releasing water from the wet winter season in the dry summer season. But climate change will likely cause more snow to fall as rain and more water to run off earlier in the year, making it harder for Bay Area utilities to capture and store water for dry periods.[46] In addition, sea levels are expected to rise by 1.6 feet to 10

46 Ackerly et al.; see footnote 12.

feet by 2100.[47] A substantial portion of the Bay Area's developed land and wastewater infrastructure is located in areas expected to be impacted by sea level rise.[48] Seawater intrusion into coastal groundwater supply aquifers (caused by both the overextraction of groundwater and sea level rise) is another climate-related challenge faced in some coastal regions of California.[49] On top of this, a major earthquake could significantly disrupt the Bay Area's water supply. The United States Geological Survey estimates that there is a 98% probability that the Bay Area will experience an earthquake of 6.0 magnitude or greater by 2043.[50] The aqueducts conveying water to the Bay Area and other local supply infrastructure cross multiple earthquake faults. A significant amount of developed land surrounding San Francisco Bay is located in areas with a high risk of liquefaction (where the ground behaves like liquid during a quake).[51] Earthquakes pose a serious threat to the Bay Area's infrastructure systems, including water and wastewater systems.

47 Griggs, G. et al., *Rising Seas in California: An Update on Sea Level Rise Science*, California Ocean Science Trust, April 2017.

48 Hummel, Michelle A., Matthew S. Berry and Mark T. Stacey, "Sea Level Rise Impacts on Wastewater Treatment Systems Along the U.S. Coasts," *Earth's Future* 6, no. 4, April 2018, pgs. 622–33, https://doi.org/10.1002/2017EF000805

49 USGS California Water Science Center, "Seawater Intrusion in California," July 2021, https://ca.water.usgs.gov/sustainable-groundwater-management/seawater-intrusion-california.html

50 Aagaard, Brad T. et al., "Earthquake Outlook for the San Francisco Bay Region 2014–2043," USGS, 2014, https://pubs.usgs.gov/fs/2016/3020/fs20163020.pdf

51 California Department of Conservation, "EQ Zapp: California Earthquake Hazards Zone Application," December 2020, https://www.conservation.ca.gov/cgs/geohazards/eq-zapp

## Chapter 2

# Water Use Projections for the Bay Area in 2070

Against the backdrop of increasingly unpredictable water supplies, the prospect that the Bay Area needs to add 2.2 million homes and 2 million jobs is daunting. Can the region accommodate this level of growth without reaching a crisis of insufficient water for people and the environment? In this chapter, we explore how the Bay Area's water demand will change over the next half-century and look at opportunities for improved water use.

As mentioned earlier in this report, our scenario modeling showed four important findings for balancing the region's growth and its water use:

- → The Bay Area could add 2.1 million jobs, 6.8 million people and 2.2 million homes by 2070 and still offset all water use from this growth through improvements in water use efficiency.
- → The region could grow and use even less water than today if it took some more ambitious, but still achievable steps toward greater water efficiency.
- → Compared to sprawl growth, compact growth doesn't decrease *total* water use, but it decreases per capita consumption dramatically. In the compact growth scenarios, the region is able to fully address housing demand and yet use about the same amount of water as in the sprawl scenarios.
- → In some areas, growth will outstrip the potential to offset demand with local conservation and efficiency. Meeting the demand for every part of the Bay Area will require transferring water within the region or identifying alternative supplies.

Efficiency improvements can help reduce overall water use and manage local demand. They include strategies such as upgrading plumbing fixtures to high-efficiency devices, replacing turf and other high-water-use plants and upgrading building cooling towers with new technology.[52] This report focuses on quantifying the water savings possible with increased efficiency and showing how these gains vary across urban development scenarios.

Moreover, there are substantial unrealized opportunities to further advance these gains by increasing the use of alternative supplies such as recycled water and captured stormwater. As of 2019, the Bay Area recycled approximately 16,000 million gallons per year (MGY), which represents roughly 4% of urban water use in the Bay Area.[53] This suggests that there's substantial room to increase the use of recycled water in the region, though any estimates of the potential for recycled

52 In commercial and industrial buildings, cooling towers are often a large source of water use.

53 California State Water Resources Control Board, "Volumetric Annual Report of Wastewater and Recycled Water," January 2021, https://data.ca.gov/dataset/volumetric-annual-report-of-wastewater-and-recycled-water

water use should also incorporate expected gains in indoor water use efficiency. Opportunities for stormwater capture vary with precipitation, but recent work suggests stormwater capture can be a meaningful, cost-effective source of water in California.[54]

## Methods for Water Use Scenario Analysis

This analysis estimated current (baseline) and 2070 water use by sector and in aggregate for the nine counties in the Bay Area.[55] Total water use is the sum of residential (both indoor and outdoor) use and commercial, industrial and institutional (CII) use.[56] Additional details on the data and methods used in this analysis are included in Appendix 1.

We crossed three water efficiency scenarios with two growth scenarios for a total of six scenarios. Each scenario is briefly described in Figure 11 in the previous chapter (see page 16), with additional details in Appendix 1. The water efficiency scenarios are conservative and assume that water-efficient technologies do not advance beyond what was commonly available on the market in 2017. Improvements in technology and/or higher levels of adoption of efficiency measures would reduce water use beyond modeled values. Efficiency adoption rates were selected to reflect a broad range of potential future conditions.

We evaluated two land use scenarios for 2070: Business as Usual and a New Civic Vision. Growth was measured relative to a baseline reflecting current conditions. Each scenario included three key values used in water use estimates: population, number of housing units and number of jobs (see Figure 16). 2070 population was estimated by projecting the Metropolitan Transportation Commission's 2040 county-level household size estimates forward to 2070. Commercial, Industrial and Institutional (CII) water factors — estimates of water use per job — were calculated by dividing current water use for commercial, industrial and large landscapes in each county by the current number of jobs in each county to obtain a composite water factor associated with a generic job in each county.

FIGURE 15

**Overview of Growth Scenarios**

**Housing units, estimated population and jobs vary under current, Business as Usual and New Civic Vision scenarios.**

| SCENARIOS | HOUSING UNITS | ESTIMATED POPULATION | JOBS |
|---|---|---|---|
| Current (Baseline) | 2.98 million | 8.20 million | 5.52 million |
| 2070 Business as Usual | 4.38 million | 12.65 million | 7.62 million |
| 2070 New Civic Vision | 5.18 million | 14.98 million | 7.62 million |

Source: Szambelan, Sarah Jo, and Sarah Karlinsky, *A Civic Vision for Growth,* Technical Appendix, SPUR, 2021, https://www.spur.org/civicvisionforgrowth

54 Qin, Yuwei, and Arpad Horvath, "Use of Alternative Water Sources in Irrigation: Potential Scales, Costs, and Environmental Impacts in California," *Environmental Research Communications* 2, no. 5, May 28, 2020: 055003, https://doi.org/10.1088/2515-7620/ab915e; and Gleick, Peter H. et al., "The Untapped Potential of California's Water Supply: Efficiency, Reuse, and Stormwater — Issue Brief," Pacific Institute, June 2014, https://pacinst.org/publication/ca-water-supply-solutions/

55 The nine Bay Area counties are Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano and Sonoma counties. The political boundaries of the nine Bay Area counties differ somewhat from the San Francisco Bay Hydrologic Region used for planning purposes by the Department of Water Resources.

56 Agricultural water use was not included in this analysis because the changes in agricultural land uses were expected to be fairly minimal in the regions of the Bay Area where population and jobs are expected to increase the most.

**2070 New Civic Vision scenario:** In this scenario, current development patterns shift toward more infill housing in already-developed areas, avoiding altogether existing open space and the areas at greatest risk of natural disaster. A greater share of new housing is in multifamily buildings.[57] Future job growth occurs along transit corridors and in other areas of increasing density (see Figure 16a).

**2070 Business as Usual scenario:** This scenario assumes development patterns similar to the status quo, leading to sprawl into existing open space, as well as more single-family homes. The Business as Usual scenario includes the same number of jobs as the New Civic Vision scenario, but because the amount of housing growth in the nine-county Bay Area is smaller (by 800,000 units), more people are forced to commute from outside the region. Jobs are distributed slightly differently than in the New Civic Vision scenario (see Figure 16a).

FIGURE 16

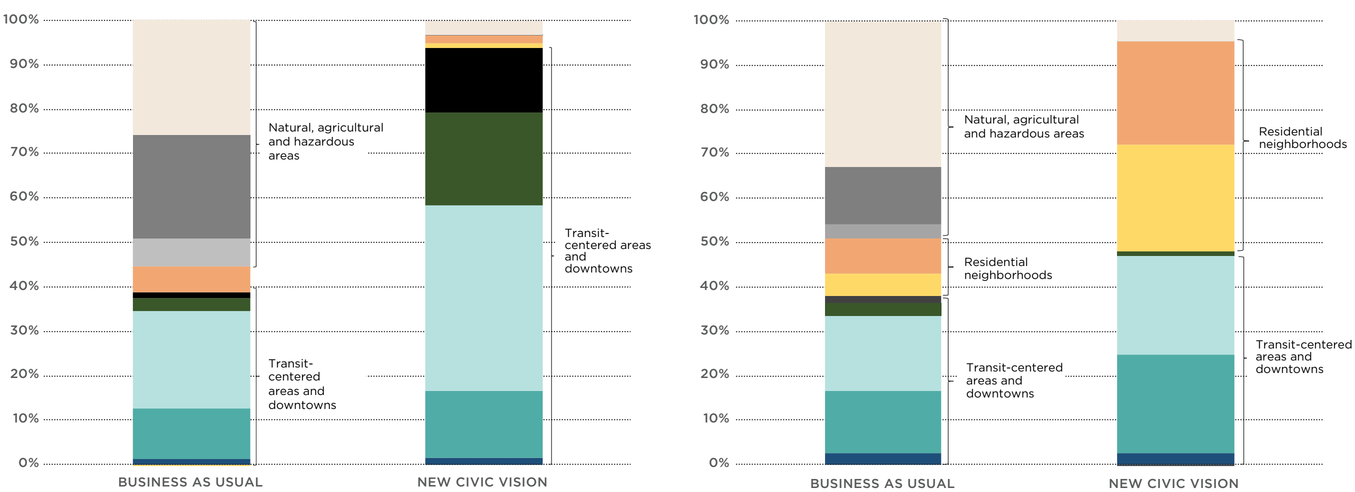
**Location of New Homes and Jobs**

The New Civic Vision scenario adds 96% of new jobs and nearly 50% of new housing in transit-centered areas and downtown, far more than the Business as Usual scenario.

Source: Szambelan, Sarah Jo, and Sarah Karlinsky, *A Civic Vision for Growth*, SPUR, 2021, https://www.spur.org/civicvisionforgrowth

**A. Net jobs added in different parts of the region**

**B. Net residential units added in different parts of the region**




**Current water use:** To estimate current water use in the Bay Area, we used average water use by sector for the Bay Area from 2010–15 from the water balance tool created by the Department of Water Resources (DWR).[58] When calculating water use intensity, we normalized indoor residential water use by person, outdoor residential water use by housing unit and CII water use by job. The DWR water balance data use a top-down approach to estimate water use, which relies on large-scale summary reporting on water deliveries to customers.[59] Our projections of future water use rely on

57 Metcalf, Gabriel et al., *Four Future Scenarios for the San Francisco Bay Area*, SPUR, August 2018, https://www.spur.org/publications/spur-report/2018-08-22/four-future-scenarios-san-francisco-bay-area

58 See footnote 14.

59 See footnote 16.

a bottom-up approach; we estimated water demand by end use and multiplied it by the number of projected people, housing units or jobs in the Bay Area in 2070. The bottom-up approach, despite factoring in projections for greater efficiency, yielded a higher estimate of normalized water use even for the Inefficient scenario than the top-down current data. This suggests that the estimate of future demand in the Inefficient scenario does not fully account for efficiency measures that have already been implemented. Our future projections are likely conservative in that they appear to overestimate future water demand.

# Results

## Total Current and 2070 Projected Water Use

If efficient or highly efficient water management practices are adopted across all sectors, estimated total water use for the two development scenarios (Business as Usual and New Civic Vision) is approximately equal to or less than current levels of water use (see Figure 17). However, this is largely attributable to predicted changes in CII water use and, to a lesser degree, reductions in indoor residential water use. Outdoor residential water use increases in all 2070 scenarios, but incorporating outdoor efficiency measures substantially limits this increase.

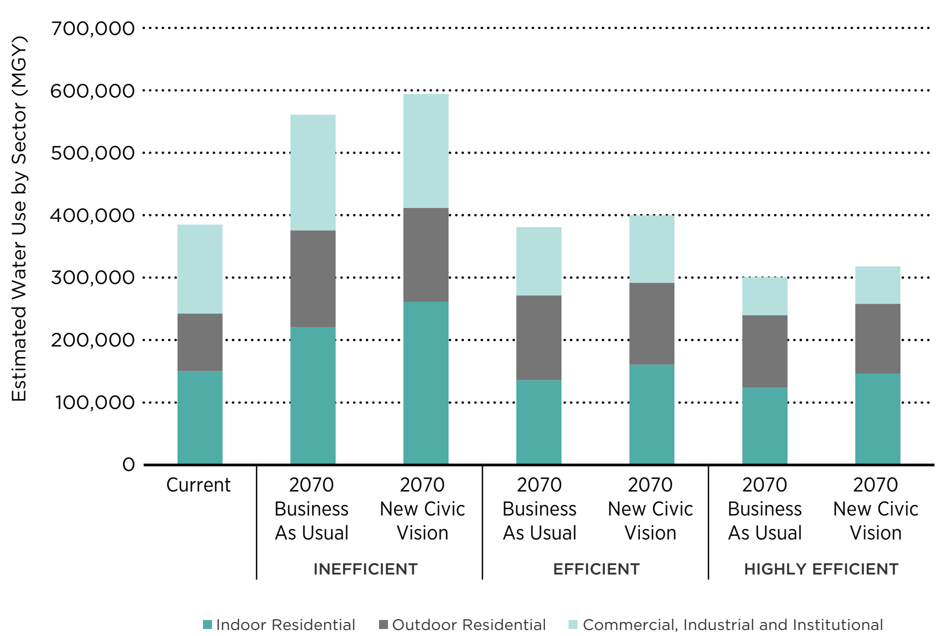
In the New Civic Vision scenario, estimated total water use ranges from 318,000 MGY in the Highly Efficient scenario up to 587,000 MGY in the Inefficient scenario. These values are about 5% higher than the Business as Usual development scenario, but the New Civic Vision scenario adds 800,000 more units of housing than the Business as Usual scenario. In all scenarios, indoor residential water use constitutes the largest portion of total water use (36% to 46%). Outdoor (24% to 39%) and CII (19% to 37%) water uses account for the remaining proportions. The following sections dig deeper into water use across each of the three use classes evaluated.

FIGURE 17

**Estimated water use will increase in Inefficient scenarios, stay about the same in Efficient scenarios and decline in Highly Efficient scenarios.**

Comparison of total current water use to projected use across all scenarios and sectors

Source: Pacific Institute and SPUR analysis.



Total water use in the 2070 Business as Usual scenario is similar to that of the New Civic Vision scenario. But critically, the New Civic Vision scenario includes the development of nearly 800,000 new housing units that would house approximately 2.3 million additional people. Water use intensity (per person, housing unit and job) was also evaluated (see Figure 19) to provide additional insights into the "value" of water use under each scenario. Water use per person and housing unit is lowest in the 2070 New Civic Vision scenario, indicating a higher number of people and housing units served with the same amount of water. Under the Efficient scenario, residential water use per housing unit is about 15 gallons less per day in the New Civic Vision scenario (vs. Business as Usual), largely due to lower outdoor water use in multifamily housing units. The number of jobs created is the same in the Business as Usual and New Civic Vision scenarios, but the location of those jobs varies. Under the Efficient and Highly Efficient scenarios, CII water use per job is substantially less than current use, with some variability between scenarios attributable to the location of jobs.

FIGURE 18

**Water use intensity declines with denser land use and greater efficiency measures.**

This chart shows total annual water use normalized by population, number of housing units and jobs for different development and efficiency scenarios.

Source: Pacific Institute and SPUR analysis.


## Indoor Residential Water Use

Indoor residential water use in 2070 was estimated as the product of per-capita daily water use multiplied by the estimated population in each county for each of the six scenarios considered (see Appendix 1 for additional details). Indoor residential water use varies with household size, behavior, efficiency standards of installed devices and number and severity of leaks. Potential differences associated with different types of housing (such as single-family and multifamily) could not be assessed due to data limitations but were expected to be relatively small for indoor uses of water. For this reason, indoor residential per-capita use was assumed to be the same in the Business as Usual and New Civic Vision scenarios. Estimated 2070 indoor residential water use associated with the three efficiency alternatives ranges from 124,000 to 221,000 MGY in the Business as Usual scenario and from 146,000 to 261,000 MGY in the New Civic Vision scenario. Current indoor residential use is estimated to be around 150,000 MGY.[60]

## Outdoor Residential Water Use

Outdoor residential water demand is the product of the type of irrigated landscape (e.g., turf, drought-tolerant plants), size of the irrigated area, irrigation efficiency and local climate (e.g., precipitation and evapotranspiration). (See Appendix 1 for additional details.) Turf and other water-intensive plants typically require more water than native and/or drought-tolerant plants. Typically, multifamily housing uses less water per household because it has less irrigated area per housing unit. As a result, outdoor residential water use is likely to vary with the type of development that occurs in the Bay Area over the next 50 years.

Estimated 2070 outdoor residential water use associated with the three efficiency alternatives ranges from 116,000 to 155,000 MGY in the Business as Usual scenario and from 111,000 to 150,000 MGY in the New Civic Vision scenario. Current outdoor residential water use is estimated to be about 92,000 MGY. Outdoor residential water use is lowest in the Highly Efficient New Civic Vision scenario because of smaller parcel sizes and projections that new and existing buildings install water-efficient landscaping.

## Commercial, Industrial and Institutional Water Use

In this analysis, we developed composite, county-level CII water factors (see Figure 20) based on existing water use estimates from DWR.[61] Water factors were calculated by dividing current water use (from DWR water balance data) for commercial, industrial and large landscapes[62] in each county by the current total number of jobs (from SPUR[63]) in each county to obtain a composite water factor associated with a generic job in each county. Because water use in each class has been normalized across the total number of jobs, these values are not substitutable for the industry-specific water factors used in other studies (e.g., Christian-Smith et al. 2012).[64] Additional details on the rationale for our approach and methods are included in Appendix 1.

Composite water use per job varies significantly among counties, reflecting the varying composition of commercial and industrial businesses across counties and the differences in large landscaped areas associated with different types of businesses. Jobs in the Bay Area are expected to continue trending toward professional/office jobs, which typically have lower water use per employee than sectors such as manufacturing.[65] This would reduce the overall water factors in these counties. However, shifts away from industrial jobs can also

60 California Natural Resources Agency, "Water Plan Water Balance Data," https://data.cnra.ca.gov/dataset/water-plan-water-balance-data

61 Ibid.

62 Large landscapes are outdoor irrigated areas such as golf courses, parks, play fields, highway medians and cemeteries.

63 See footnote 2.

64 Christian-Smith, Juliet et al., *Urban Water Demand in California to 2100: Incorporating Climate Change*, Pacific Institute, August 2012, https://pacinst.org/publication/urban-water-demand-to-2100/

65 Ibid.

have significant impacts on a region's low- and middle-income residents who depend on these jobs.

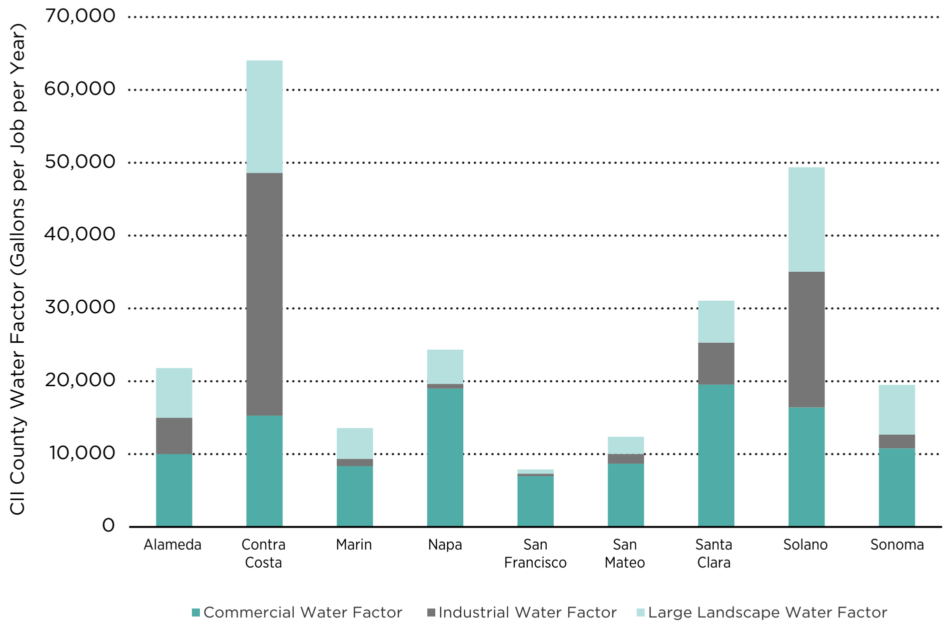
FIGURE 19

**Counties have very different per-job water use.**

Composite CII Water Use Per Job (Water Factor) by County

**Different industries and amounts of landscape cause very different CII water use in Bay Area counties.**

Source: Pacific Institute and SPUR analysis.




The water factors in Figure 19 were multiplied by the projected number of jobs in each county in the New Civic Vision and Business as Usual scenarios to estimate future CII water use. Three efficiency scenarios were examined, covering a broad range of potential future conditions. In the Inefficient scenario, water factors were held constant through 2070. In the Efficient and Highly Efficient scenarios, water factors were reduced by 10% and 20% by decade, respectively. Actual levels of efficiency gains possible will vary by sector and are a topic of ongoing research.

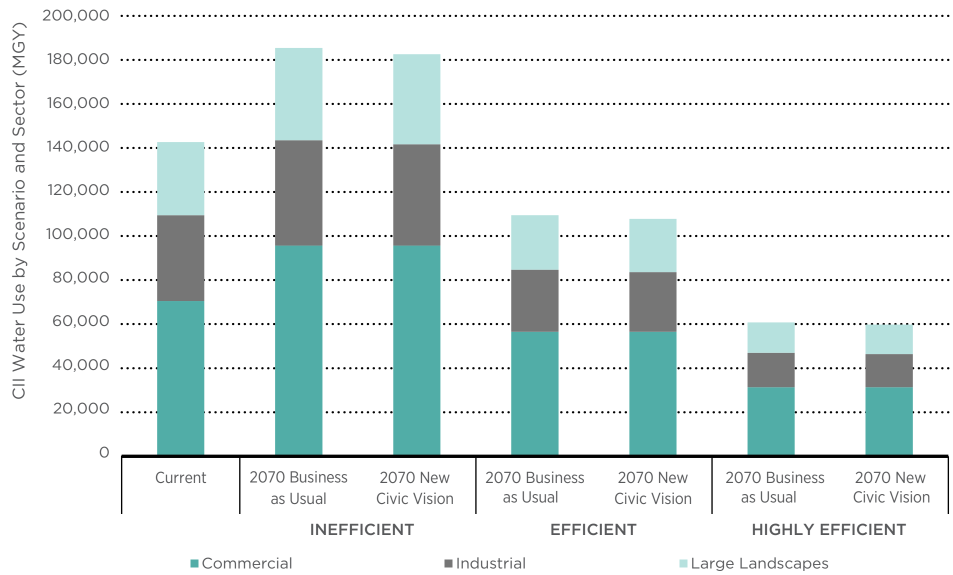
Estimated 2070 CII water use associated with the three efficiency alternatives ranges from 61,000 to 185,00 MGY in the Business as Usual scenario and from 60,000 to 182,000 MGY in the New Civic Vision scenario (see Figure 20). The small differences in these values are attributable to differences in where jobs are located in the Business as Usual and New Civic Vision scenarios. Current CII water use is estimated to be around 142,000 MGY. Projected efficiency gains result in a net reduction in CII water use of 41% and 67% by 2070 in the Efficient and Highly Efficient scenarios, respectively. Under the Highly Efficient scenario, 2070 CII water use is substantially less than current water use in all counties. Under the Efficient scenario, CII water use is less than current use in all counties except San Mateo. This difference is largely attributable to projected increases in the number of jobs in San Mateo County.

FIGURE 20

**Despite job growth, total CII water use could decline with 1% to 2% annual gains in efficiency.**

2070 CII water use is predicted to be below current levels in the Efficient and Highly Efficient scenarios.

Source: Pacific Institute and SPUR analysis.




## Comparison of Outdoor Water Use for Different Types of Residential Development

The nature of future development is an important determinant of whether the Bay Area is able to limit increases in urban water use. While outdoor residential water use intensity is expected to remain steady (Business as Usual) or decrease (New Civic Vision), total outdoor residential water use is predicted to increase in all 2070 scenarios. The magnitude of this change depends on whether the Bay Area adopts water-efficient landscaping in existing housing units, builds compact types of new housing and limits outdoor water use in new development. This analysis took a deeper dive into the impacts of housing development decisions on outdoor water use to better inform our policy recommendations.

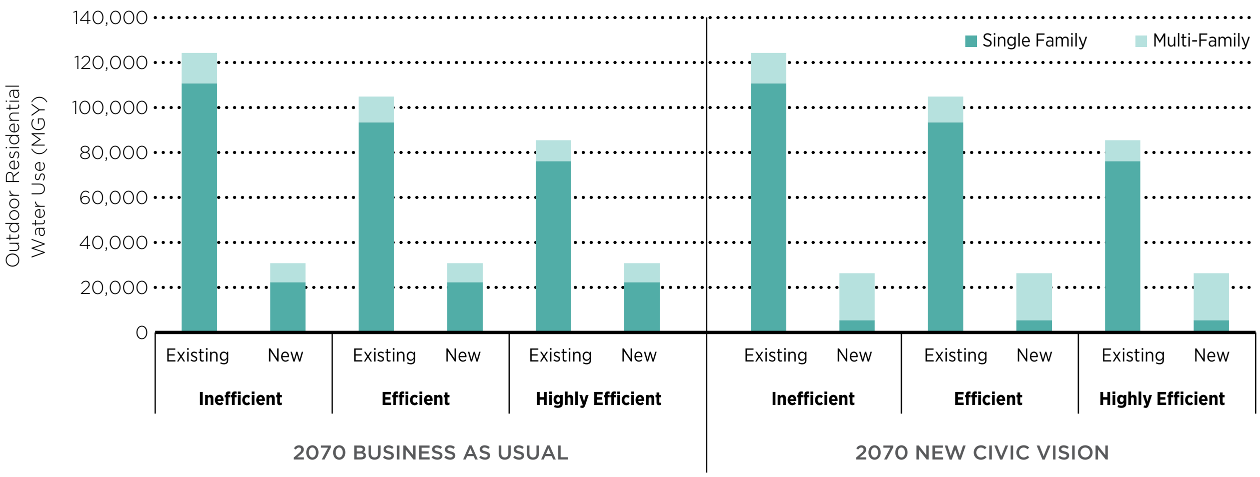
Current outdoor water use on residential properties accounts for nearly one-quarter of all water use in the Bay Area, but usage varies significantly across different types of housing. Large, suburban single-family homes typically have more landscaped area and use more water on a per-housing-unit basis. Installing efficient irrigation and replacing turf with low-water-use plants can also help reduce outdoor water use associated with these properties. Opting for denser forms of housing development (with limited or shared outdoor space) can cut outdoor residential water use even further. Indoor water use varies little across different types of residential development, which underscores the importance of managing outdoor water use for efficiency.

Most outdoor residential water use in the Bay Area is associated with single-family homes. In all of the 2070 scenarios, the majority of outdoor water use (more than 70% in the New Civic Vision and more than 85% under Business as Usual) supports existing single-family homes (see Figure 21).

FIGURE 21

**There are big opportunities to conserve water by making existing homes' landscaping more water-efficient.**

With stronger laws to require landscaping updates, efficiency gains in outdoor water use for existing homes could counterbalance or even exceed the water used outdoors for new homes.




Compared to Business as Usual, the New Civic Vision allows a far greater number of housing units to be built for similar total amounts of outdoor residential water use. In the Business as Usual scenario, additional outdoor water use (above current levels) supports 507,000 additional single-family and 897,000 multifamily homes. In the New Civic Vision scenario, the additional outdoor water use supports 128,000 single-family and 2 million multifamily housing units. Normalizing total outdoor water use by the total number of housing units in each scenario results in annual household outdoor water factors of 31,000 gallons per year per housing unit in the current and Efficient Business as Usual scenarios and 25,000 gallons per year per housing unit in the Efficient New Civic Vision scenario, respectively. Adopting water-efficient landscaping practices, such as replacing turf with plants that use less water and installing drip irrigation, can substantially reduce outdoor water use across all types of housing.

As mentioned above, across the Bay Area, single-family homes are responsible for most of the outdoor residential water use at present, and we assumed this would continue to be true in 2070. However, not all single-family and multifamily homes are created equal. This analysis compared differences in parcels located across a range of Bay Area microclimates[66] with and without the adoption of water-efficient landscaping. Parcels were defined based on the average parcel size associated with six residential "place types" across the Bay Area.[67] We estimated median outdoor

66 Countywide area-weighted irrigation demand (the difference between evapotranspiration and effective precipitation) was used to set the upper and lower bounds of this analysis. Regional median irrigation demand was also calculated to assess the midpoint.

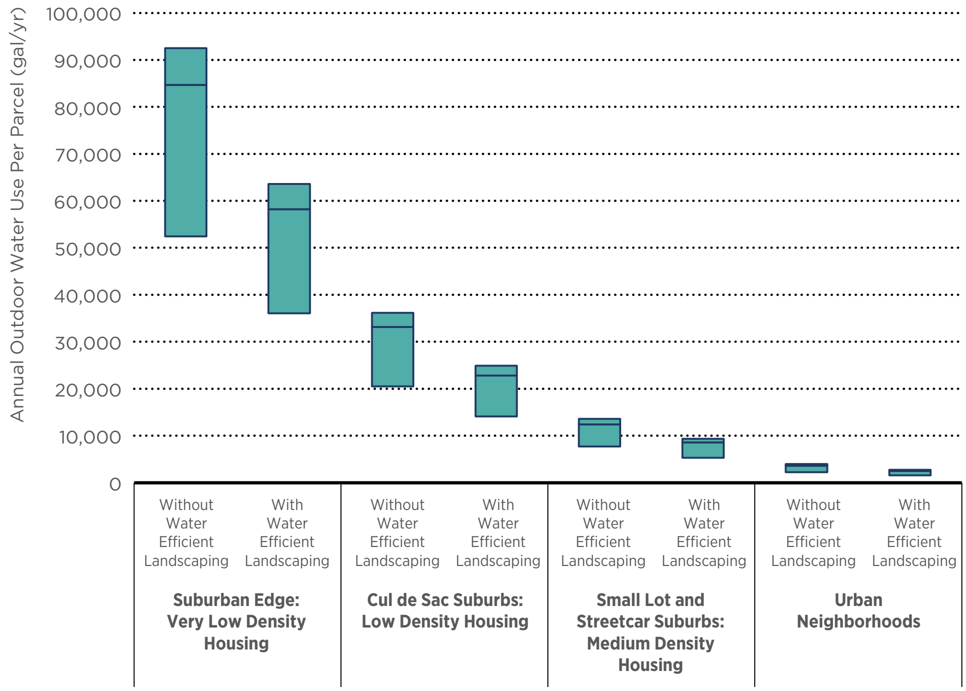
67 In 2019, SPUR conducted an analysis identifying 14 characteristic "place types" across the Bay Area (e.g., Urban Neighborhoods, Cul de Sac Suburbs, Rural and Open Space), of which six would be expected to include a substantial number of housing units. Our parcel analysis results for three of the place types — Urban Neighborhoods, Dense Urban Mix and High-Rise Neighborhoods — were similar, so we only included Urban Neighborhoods in these figures. Place types were defined based on land use circa 2018. See: Grant, Benjamin, and Sarah Jo Szambelan, "Bay Area Place Types," *The Urbanist*, SPUR, March 21, 2019, https://www.spur.org/publications/urbanist-article/2019-03-01/bay-area-place-types

water use of Suburban Edge housing units to be 6.8 times greater than Small Lot and Streetcar Suburb parcels and 23.5 times greater than housing units in Urban Neighborhoods (see Figure 22).

FIGURE 22

**Denser housing development uses far less water per parcel.**

The biggest driver of per-parcel water use is parcel size. Adopting efficient landscape standards mainly decreases water use in homes with big yards. The range of estimated water use is shown with a box plot, where the lower end of each box is the minimum value, the line that bisects the box is the median, and the upper end is the maximum value. Minimum values reflect water use in cool, moist microclimates, while maximum values reflect use in dry, hot microclimates.



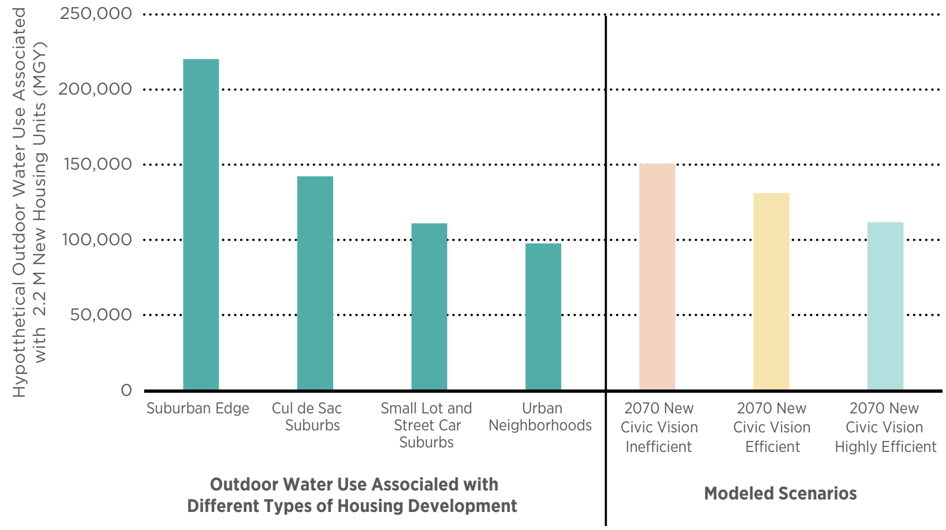

We also estimated the additional annual outdoor water use associated with adding 2.2 million units of different types of housing (assuming all would adopt water-efficient landscaping) and compared these values to the New Civic Vision 2070 efficiency scenarios (see Figure 22). There are currently about 2.9 million housing units in the Bay Area. If future development skews toward Suburban Edge or Cul de Sac Suburb developments, outdoor residential water use in 2070 will be higher. Conversely, if future development skews towards Small Lot and other urban types of development, it may be possible to use substantially less water than predicted for outdoor uses. Full adoption of water-efficient landscaping reduces outdoor water use by about 31%.

FIGURE 23

**Denser housing development could reduce outdoor water use even further.**

This chart compares estimated outdoor residential water use for 2.2 million new housing units, assuming all adopt water-efficient landscaping standards. Building denser types of development could reduce water use below the levels modeled in all three New Civic Vision scenarios.

Source: Pacific Institute and SPUR analysis.




## Water Efficiency and Reuse

Water efficiency improvements are fundamental to meeting the Bay Area's future water needs. To date, the region has made significant efficiency improvements, allowing the population and economy to grow using the same (or less) water. The good news is that there are additional opportunities to use water more efficiently. Greater uptake of widely available water-saving devices, along with water-efficient landscaping practices in homes and businesses, could maintain or even reduce total water demand while accommodating more growth across the region. Likewise, many devices currently available for purchase already exceed the 2017 standards used as a benchmark in this analysis. Reducing overall water use will require both new and existing development to adopt efficient fixtures.

Increasing water reuse is another critical strategy for meeting the Bay Area's future water supply needs. The quantity of water available for reuse is intrinsically linked with indoor water use, since the wastewater from buildings becomes the supply for reuse. We anticipate indoor residential use will hold steady or decline slightly as gains in efficiency are offset by increases in population. On the other hand, CII water use would sharply decline in the efficient and highly efficient scenarios. Future reuse planning should incorporate observed and projected changes in water available for reuse.[68]

## How Much Water We Can Save Varies by County

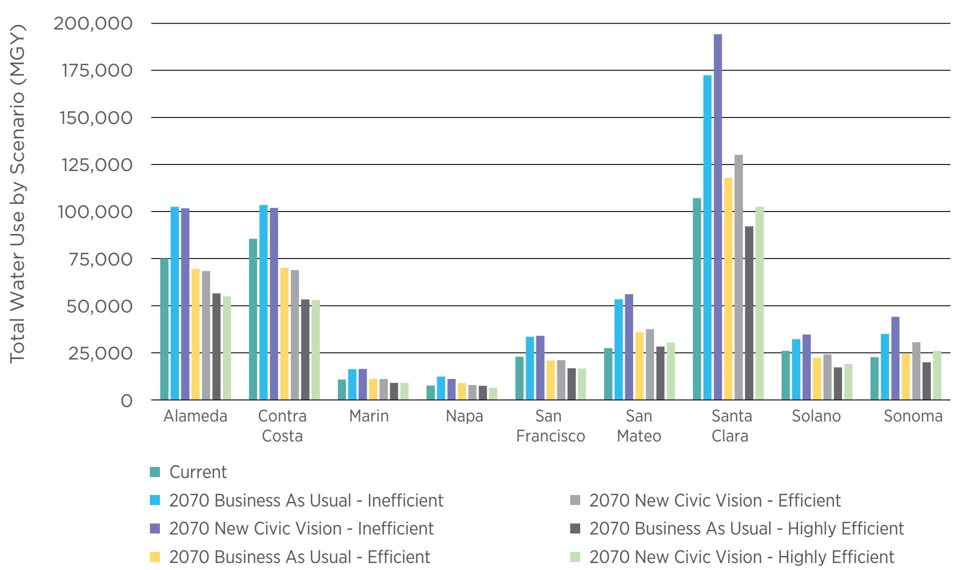
Different parts of the Bay Area vary greatly in their current water use intensity, which means they have different levels of opportunity to increase water efficiency. Areas of concentrated growth are unlikely to be able to meet projected future demand through improvements in conservation and efficiency alone. In these regions, increases in water use associated with more housing units and jobs will outpace the water savings associated with increases in efficiency measures. However, it is important to note that we have been purposefully conservative in our estimates of efficiency potential; further efficiency gains may be possible with improvements in available technologies and greater adoption of water efficiency measures. SPUR's growth modeling isn't intended to produce

68 Valley Water, *Water Supply Master Plan 2040*, July 2020, https://www.valleywater.org/sites/default/files/Water Supply Master Plan 2040_11.01.2019_v2.pdf; and Brown and Caldwell, *Draft Countywide Water Reuse Master Plan*, Valley Water, 2020, https://fta.valleywater.org/dl/UXjDc8xoQ4

precise target numbers for new development by county. However, we break out water demand by county for illustrative purposes to show how areas of concentrated growth will likely see greater increases in demand than other areas. Under the Efficient scenario, 2070 water use in Santa Clara and San Mateo counties is roughly equivalent to or slightly higher than current water use (see Figure 24). Investing in efficiency and alternative supplies in these counties is especially important. Likewise, these differences in projected water use between counties underscore the utility of regional cooperative agreements to allow transfers of surplus water to where it is most needed.

FIGURE 24
**Projected water use varies by county.**
Current and 2070 water use, by county
**While total regional water use stays the same in the Efficient scenarios and declines in the Highly Efficient scenarios, the patterns vary depending on how much each county is predicted to grow.**

Source: Pacific Institute and SPUR analysis.




# Looking Forward to 2070

Projections of future water use that incorporate additional efficiencies yield a hopeful finding: Developing more housing and jobs can be compatible with available water supplies in the Bay Area. However, this is only true if the Bay Area invests in efficiency and alternative supplies, manages local supplies for long-term sustainability, actively manages water supply portfolios to adapt to the impacts of climate change and develops strategies for regional cooperation and management of water supplies. These are all actions that build on the efforts many Bay Area water utilities have underway. The Inefficient scenarios (which assume very limited gains in efficiency over the next 50 years) serve as a caution. They exceed current levels of supply and underscore the importance of sustained investments and innovation in efficiency programs. It is critical to note that there is significant uncertainty in what future supply levels will look like (see Chapter 1). It will be important to aggressively pursue a full portfolio of water efficiency and alternative supply options to build resilience in the face of this uncertainty.

## Chapter 3

# Solutions and Recommendations

The Bay Area can continue to meet water demand as it grows either by increasing water use efficiency, finding new supplies or both. In this report, we focus on strategies for increasing water use efficiency in new and existing development to offset demand associated with new growth. That will require decreasing water demand per person, per housing unit and per job. Since some areas will grow faster than others, mechanisms to transfer and exchange water between water utilities will allow the region to better match supply and demand.

SPUR and Pacific Institute propose three key strategies to grow without increasing the region's demand for water: improve conservation and efficiency; pursue compact land use strategies with a high share of multifamily housing; and develop better mechanisms for water transfers and exchanges. On top of those strategies, investing in alternative water supplies such as water recycling reduces demand for water from overtapped rivers and groundwater. Conserved water should be used to enable new infill housing and a portion of it should be restored to vulnerable ecosystems.

Conservation and efficiency are typically the least expensive and most environmentally sound ways to meet water demand. Conservation happens when people change their behavior to use less water, such as watering their yards less often; efficiency means changing the physical environment so less water is needed to accomplish the same goal, such as using a more efficient irrigation system or planting a drought-tolerant garden.

There are many strategies to drive greater customer conservation and efficiency. *Pricing signals* increase the cost of water as customers use more, incentivizing them to reduce their use. *Financial incentive programs* offer discounts and rebates to encourage customers to improve their property by fixing leaks, upgrading fixtures and retrofitting their landscaping. *Education and technical assistance* give people the motivation and knowledge they need to reduce their water use. Mandates require greater conservation and efficiency practices, such as banning grass on traffic medians or prohibiting the sale of toilets that use more than 1.6 gallons per flush. Conservation and efficiency can also be practiced by water suppliers themselves, for example by repairing leaks in the distribution system or reducing waste when flushing out water mains.

The form and location of growth have a major impact on per-household water consumption. Homes with larger lots and neighborhoods with fewer homes per lot tend to use more water per household.[69] In addition, adding new homes and yards on undeveloped land means converting unirrigated areas to more water-intensive land uses. In an important tradeoff, adding more housing

69 Mini, Caroline, Terri S. Hogue and Stephanie Pincetl, "Patterns and Controlling Factors of Residential Water Use in Los Angeles, California," *Water Policy* 16 (6), 2014, pgs. 1054–69; and Quesnel, Kimberly J., Saahil Agrawal and Newsha K. Ajami, "Diverse Paradigms of Residential Development Inform Water Use and Drought-Related Conservation Behavior," *Environmental Research Letters* 15 (12), 2020: 124009.

units within the nine counties will push up water demand within the nine counties, but forestalling sprawl into surrounding counties could reduce demand in neighboring counties.

If growth is concentrated in certain locations, the water providers for those areas may not be able to meet future water demand through conservation and efficiency alone. In that case, water transfers and exchanges — a mechanism for redirecting water from one district to another — could enable the Bay Area to grow without increasing regionwide demand. These direct agreements between water utilities allow them to lease or purchase water from one another. Transfers are a one-way movement of water, while exchanges involve a commitment to return some amount of water at a later date.[70] The Bay Area Regional Reliability partnership is in the early stages of developing a framework to facilitate exchanges and transfers in the Bay Area.[71] The partnership is a cooperative effort among eight San Francisco Bay Area water agencies to address water supply reliability concerns and drought preparedness. Seven of the eight members are crafting a Strategy Report on a Shared Water Access Program by 2022 to describe how to facilitate transfers and exchanges within the Bay Area. The program, if successful, would provide a model for how regional water utilities can develop agreements that allow better matching between water supply and demand.

Conservation and efficiency measures have a strong nexus with water pricing and affordability, which impact low-income customers most. Overall, conservation and efficiency efforts tend to improve affordability for low-income customers. Conservation and efficiency allow water utilities to avoid investing in unnecessary infrastructure, which helps keep rates low over the long term.[72] Conservation pricing sets the per-unit cost of water higher for high-volume water users. Since most low-income customers tend to be low-volume water users, they stand to benefit from conservation pricing.[73]

However, there will inevitably be some low-income households that use more water than average and will incur higher costs under conservation pricing. There are a variety of reasons for this. A common one is that households with more than the average number of people use more water. In other cases, low-income households are stuck with leaks or inefficient fixtures that they cannot repair, either because they don't have the cash on hand to invest in a repair or upgrade or because they're renters who don't have authority to make changes to their homes. In our recommendations, we highlight ways to ensure that efforts to promote conservation and efficiency promote equitable outcomes.

### STRATEGY 1

## Manage demand with conservation and efficiency.

Conservation (using less water) and efficiency (accomplishing the same task with less water) are the least expensive and most environmentally sound ways to meet water demand.

70 DWR and State Water Resources Control Board, *Background and Recent History of Water Transfers in California*, July 2015, https://cawaterlibrary.net/wp-content/uploads/2018/03/Background_and_Recent_History_of_Water_Transfers.pdf.

71 Bay Area Regional Reliability, "Bay Area Shared Water Access Program," https://bayareareliability.com/bay_area_swap

72 Alliance for Water Efficiency and California Water Efficiency Partnership, *Lower Water Bills: The City of Los Angeles Shows How Water Conservation and Efficient Water Rates Produce Affordable and Sustainable Use*, 2018, https://www.allianceforwaterefficiency.org/impact/our-work/study-demonstrates-water-conservation-pay-ratepayers

73 DeOreo, William B., Peter Mayer, Benedykt Dziegielewski and Jack Kiefer, *Residential End Uses of Water, Version 2*, Water Research Foundation, 2016, https://www.waterrf.org/research/projects/residential-end-uses-water-version-2

### *Increasing Conservation and Efficiency for All Sectors*

Residential and commercial, industrial and institutional (CII) water use are very different, but some tools are useful for both homes and businesses, such as public awareness on water conservation, pricing structures, reducing leaks and installing more efficient landscaping.

→ Potential for water savings from all sectors: 243,000 million gallons per year (Highly Efficient New Civic Vision scenario vs. Inefficient Business as Usual scenario)

## Recommendation 1: Continue to raise public awareness on water conservation with public education, regular feedback to customers on water use and technical support.

**Who's responsible:** Water utilities

Research has shown that public education on water scarcity and the importance of saving water produces dramatic changes in customer behavior. For example, residential customers decreased their water use in response to heavy news coverage of the 2012–16 drought in California.[74] Customer awareness campaigns were particularly effective when they reinforced a message that mandatory conservation measures were in place.[75]

Customers are also highly motivated to save water when they receive easy-to-understand feedback on how their consumption compares with that of their neighbors.[76] Even more than mass media campaigns, customer behavior is strongly influenced by personalized information on how their consumption compares to local norms.[77] Education campaigns telling customers why they should be motivated to save water need to be coupled with technical information on how to do so. For example, Seattle's highly effective 1% Program coupled a marketing campaign with a set of proven strategies to decrease water use.[78]

## Recommendation 2: Reduce leaks for all sectors.

**Who's responsible:** Water utilities, with technical assistance from the State Water Board for small utilities

Leaks occur in homes, businesses, institutions and the water delivery system. An estimated 11% to 13% of water used in homes is lost to leaks.[79] The U.S. Environmental Protection Agency estimates

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74 Quesnel, Kimberly J., and Newsha K. Ajami, "Changes in Water Consumption Linked to Heavy News Media Coverage of Extreme Climatic Events," *Science Advances* 3, no. 10, 2017: e1700784.

75 Harvell, E., "How Important Was Water Pricing in Achieving Conservation Goals During the California Drought?," Environmental Finance Blog (blog), January 14, 2019, http://efc.web.unc.edu/2019/01/14/how-important-was-water-pricing-in-achieving-conservation-goals-during-the-california-drought/

76 Ideas 42, "Encouraging Water Conservation: Inexpensive, Replicable Behavioral Interventions," January 2017, https://www.ideas42.org/wp-content/uploads/2017/02/Project-Brief_Belen.pdf

77 California Water Efficiency Partnership, *Customer Water Use Messaging (2015)*, March 24, 2015, https://calwep.org/pbmp-customer-water-use-messaging-2015/

78 Mayer, Peter, "Water Conservation: Customer Behavior and Effective Communications," Water Research Foundation, July 30, 2010, pg. 350, https://www.waterrf.org/resource/water-conservation-customer-behavior-and-effective-communications

79 DeOreo, William B. et al., *Residential End Uses of Water, Version 2*, Project 4309, Water Research Foundation, 2016, https://www.waterrf.org/research/projects/residential-end-uses-water-version-2; and DeOreo, William B. et al.,. California Single-Family Water Use Efficiency Study, Aquacraft Water Engineering and Management, 2011, https://cawaterlibrary.net/document/california-single-family-water-use-efficiency-study/

that water utilities lose on average about 16% of their water, mainly due to infrastructure leaks.[80] Technology that monitors water use for customers (such as advanced metering infrastructure and water use sensors), coupled with daily feedback on water consumption, helps customers monitor and reduce their water use.[81] Since 2009, California statute has required the State Water Board to develop greater regulations on system leaks.[82] The early stages of the new rules focus on data gathering, and full compliance with water loss standards begins in 2028. Effective implementation of this program will help make more water available for useful purposes.

## Recommendation 3: Price discretionary uses high and essential uses low. Use rate structures that charge more per gallon of water as a customer's usage increases.

**Who's responsible:** Water utilities

Rate structures that charge customers for the amount they use, and charge more per unit of water at higher levels of water usage, are effective at decreasing water use.[83] Water rates have three common types of charges. Fixed charges are constant regardless of how much a customer uses in a billing cycle and do not incentivize conservation. Uniform volumetric rates are charged at a certain rate per unit of water and moderately incentivize conservation. Tiered volumetric rates charge more per unit of water as usage increases and strongly incentivize conservation, with the strength of the incentive growing when the price tiers are more steeply inclined. The typical customer in the Bay Area receives a bill that includes a fixed charge with a volumetric charge added on top. The tiers are generally set so the lowest-cost tier accounts for average indoor water use, a middle-cost tier provides a reasonable outdoor water budget and the highest-cost tier reflects high-end, potentially wasteful uses. Steeply tiered water rates with low fixed charges encourage conservation while keeping the cost of basic needs low.[84] In the Bay Area, most utilities use tiered water rates and get the minority of their revenue from fixed charges. But there are exceptions to this rule, with some Bay Area utilities still relying on uniform rates.[85] And when there are droughts, many utilities use drought fees to increase the fixed charge, which does not encourage conservation and places a disproportionate burden on low-volume water users.[86] CII rates are often a fixed charge plus a uniform rate – commercial users do not necessarily pay more as they use more.[87] Utilities in the Bay Area should

80 Duffy, Daniel P., "Non-Revenue Water Loss: Its Causes and Cures," *WaterWorld*, May 26, 2016, https://www.waterworld.com/home/article/14070145/nonrevenue-water-loss-its-causes-and-cures

81 Godwin, Angela, "Advanced Metering Infrastructure: Drivers and Benefits in the Water Industry," *WaterWorld*, August 1, 2011, https://www.waterworld.com/technologies/amr-ami/article/16192432/advanced-metering-infrastructure-drivers-and-benefits-in-the-water-industry

82 California Water Boards, "Water Loss Control," https://www.waterboards.ca.gov/water_issues/programs/conservation_portal/water_loss_control.html

83 Tiger, Mary, Jeff Hughes and Shadi Eskaf, "Designing Water Rate Structures for Conservation and Revenue Stability," February 2014, pg. 40, https://efc.web.unc.edu/2014/02/26/water-rate-structures-for-conservation-and-revenue-stability/; and California Water Efficiency Partnership and Alliance for Water Efficiency, *Lower Water Bills: LA Shows How Water Conservation and Efficient Water Rates Produce Affordable and Sustainable Use*, 2018, https://www.allianceforwaterefficiency.org/resources/publications/la-shows-how-water-conservation-and-efficient-water-rates-produce-affordable

84 Mukherjee, Monobina, Katie Mika and Mark Gold, "Overcoming the Challenges to Using Tiered Water Rates to Enhance Water Conservation," *California Journal of Politics and Policy* 8, August 2, 2016, https://doi.org/10.5070/P2CJPP8331954

85 American Water Works Association, California-Nevada Section, Raftelis and California Data Collaborative, *2017 Water Rate Survey*, 2017, https://ca-nv-awwa.org//canv/downloads/2018/CA-NV_RateSurvey-2017_final.pdf

86 Feinstein, Laura et al., *Drought and Equity in California*, Pacific Institute and Environmental Justice Coalition for Water, 2017, http://pacinst.org/publication/drought-equity-california/

87 SWRCB. "Large Water System Electronic Annual Reports for 2017," 2018. https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/eardata.html

universally use tiered water rates and should put in place drought rate structures that increase the volumetric charge during dry periods.

## Recommendation 4: Increase enforcement and compliance with California's Model Water Efficient Landscape Ordinance by simplifying the requirements and increasing oversight and technical support.

**Who's responsible:** Department of Water Resources

Despite the promise of California's Model Water Efficient Landscape Ordinance (MWELO) to increase drought resilience, compliance rates have been low, ranging from 26% to 35%.[88] The Department of Water Resources (DWR) is engaged in a study to better understand the causes of low compliance. Problems that need to be addressed are the complexity of the law, unenforceable provisions and lack of awareness among property owners.[89] Cities and other enforcing agencies report that building permit applicants often are unaware of MWELO requirements and building permit staff lack appropriate expertise to review the substance of the documents.[90] DWR should also increase its feedback on inadequate MWELO reports and provide trainings on how to determine MWELO compliance from a building permit.

Plants adapted to the Bay Area's Mediterranean climate require less water and are beautiful (left). Gardens with native plants, such as the one at San Francisco's Garden for the Environment (right), also provide habitat for local birds and insects.

Photos by Sergio Ruiz.

88 DWR, "DWR Findings Regarding an Update of the Model Water Efficient Landscape Ordinance," March 2019, https://cwc.ca.gov/-/media/CWC-Website/Files/Documents/2019/03_March/March2019_Agenda_Item_9_Attach_2_Findings.pdf?la=en&hash=FB05787DCBC1F4CBADD6A38E6A2EBD350A46FDB0

89 Ibid.

90 See MWELO compliance reports at https://water.ca.gov/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Model-Water-Efficient-Landscape-Ordinance, e.g., County of Napa 2019 report.

## Recommendation 5: Increase funding to incentivize property owners to install water-efficient landscaping in existing properties.

**Who's responsible:** Water utilities to administer programs, State Legislature to put bond on ballot or allocate general funds to drought resilience, Water Board to administer drought resilience grants

MWELO requires water efficiency improvements for many new and retrofitted landscape projects, but it does not apply to existing landscapes. During the last drought, many water utilities offered rebates for customers to replace thirsty lawns with drought-tolerant landscaping. While some of these programs are ongoing, many districts cut back on landscape rebates in recent years, in part because there has been less funding available from water bonds and the California General Fund for drought resilience. The state should dedicate more funding to building climate resilience, and funding to improve drought resilience should be used in part to expand cash incentives to install drought-tolerant landscapes. A higher share of the funding should be directed to disadvantaged communities to enable lower-income households to install water-efficient landscaping.

Nonfunctional turf is purely ornamental, such as this lawn next to an office building (left). Functional lawns are those in yards or public spaces where people play, gather and rest (right).

Photos by Laura Feinstein (left) and Sergio Ruiz (right).

## Recommendation 6: Ban nonfunctional turf.

**Who's responsible**: Cities, water utilities, State Legislature

MWELO has been difficult for local permitting departments to interpret and enforce. Nevada has taken a simpler approach, banning all "nonfunctional turf" from Las Vegas Valley and surrounding areas by 2027.[91] Nonfunctional turf is grass whose only purpose is ornamental: People are not expected to walk, sit or play on it. It includes grass planted on street meridians, in office parks and in any place that is marked by a sign that tells people to "keep off the grass." Nonfunctional turf does not include turf in people's yards, at parks or on sports fields. The idea is that water-hungry grass should either serve a useful purpose or be replaced by more drought-tolerant options. Cities or water utilities could ban nonfunctional turf, or the Legislature could take action at the state level.

91 Burdick, Alan, "Where the Grass Is Greener, Except When It's 'Nonfunctional Turf,'" *New York Times*, June 11, 2021, https://www.nytimes.com/2021/06/11/science/drought-las-vegas-grass-mars.html

### *Increasing Conservation and Efficiency for Indoor Residential Water Use*

California law mandated replacing fixtures in single-family homes by January 1, 2017, and in multifamily and commercial buildings by January 1, 2019. However, there are more efficient products readily available on the market than what is currently required. Achieving the goal of growing without increasing water demand will depend on passing more rigorous standards for new plumbing fixtures available for sale in California. Plumbing fixtures include toilets, showerheads, faucets, dishwashers and clothes washers — anything connected to the plumbing in a building. As fixtures reach the end of their life, they are swapped out for newer, more efficient devices, and average residential water use gradually declines without a conscious change of behavior by the customer.

Based on our scenario development, the greatest points of leverage for reducing indoor residential demand are, first, passing regulations that require all fixtures sold by 2025 to meet the standards of the most efficient Energy Star/WaterSense devices available as of 2017; second, reducing residential leaks by 50% to 75%; and third, requiring fixtures to be replaced before the end of their life.

→ Potential for water savings from indoor residential water efficiency: 74,000 million gallons per year (Highly Efficient New Civic Vision scenario vs. Inefficient Business as Usual scenario)

## Recommendation 7: Update California's legal definition of "non-compliant" water fixtures, and address leaks during alterations and improvements.

**Who's responsible: State Legislature**

The California Legislature passed Senate Bill 407 in 2009 to require homes built before 1994 to swap out any "non-compliant" water fixtures by 2017. The same was required of commercial and multifamily buildings by 2019. Going forward, any property undergoing alterations or improvements will also need to replace non-compliant water fixtures. However, the definition of what was considered non-compliant in 2009 is now out of date. For example, non-compliant toilets were defined as using more than 1.6 gallons per flush, but toilets that use half that amount were available on the market in 2017.[92] The law could be changed to build in continuous improvement, such that fixture standards would automatically ratchet up on a predictable time horizon.[93] The change in standards could require all fixtures sold in California to match the efficiency of the best commonly available technology on the U.S. market within a reasonable time frame, such as the amount of time it takes for new product development.

In our modeling, we assumed no technological improvements to indoor fixtures after 2017. Instituting regular updates to the standards between now and 2070 would produce even larger indoor efficiency gains than predicted in our model.

92 Figure A4 in Appendix 1 gives the flow rating for these devices.

93 Energy Policy Solutions, "Energy Policy Design: Performance Standards," 2021, https://energypolicy.solutions/energy-policy-design/performance-standards

## Recommendation 8: Require that alterations and improvements requiring a building inspection also trigger an inspection for compliant fixtures and leaks.

**Who's responsible:** State Legislature

At present, the enforcement of SB 407's requirements to update plumbing fixtures has been handled primarily through self-certification by property owners. If building inspectors did the certifications, compliance would likely improve, and including the certification process when a building is inspected for other reasons would minimize the additional burden on the inspection department. However, requiring permitting agencies to shift from self-certification to an official inspection requires an act of the Legislature. Improving the building inspections and permitting process to make it less time-consuming and costly and ensuring that building departments are adequately resourced to take on new duties are major challenges in themselves.[94] Efforts to expand the duties of building inspection departments should go hand in hand with efforts to improve the inspection and permitting process.

## Recommendation 9: Make incentive programs for water-wise home improvements more accessible to low-income households.

**Who's responsible:** Water utilities, Bay Area Regional Energy Network

At present, consumer rebate programs are commonly used to incentivize improvements on residential properties. But low-income households often do not have the cash on hand to make water efficiency improvements. Financial incentives need to be structured to require little or no upfront investment from low-income customers. Discounts and point-of-sale coupons can reduce the upfront cost of buying more efficient fixtures. Direct install programs, in which utilities offer free installations of more efficient fixtures, are another option. Utilities can also offer on-bill financing, in which customers pay back the cost of an efficiency improvement on their subsequent bills. The on-bill charge should be no greater than the savings provided by the improvement. The Bay Area Regional Energy Network (BayREN) offers water efficiency upgrades to customers with on-bill financing, using funding from the California Public Utilities Commission.[95] BayREN's program provides an example of a financial incentive program with low upfront costs that could be replicated by others.

### *Increasing Conservation and Efficiency for Commercial, Industrial and Institutional Water Use*

There are substantial knowledge gaps surrounding typical current water use in the commercial, industrial and institutional (CII) sector and the scale of efficiency gains possible. Legislation passed in 2018 (Assembly Bill 1668, Friedman) attempts to rectify these gaps by requiring state utilities to develop performance measures for CII water use by June 2022. Until better data are available, it's not possible to make detailed recommendations on increasing indoor water conservation and efficiency

94 Local Housing Solutions, "Streamlined Permitting Processes," https://www.localhousingsolutions.org/housing-policy-library/streamlined-permitting-processes/

95 BayREN, "Water Upgrades $ave," https://www.bayren.org/waterupgradessave

for the CII sector. Consequently, the recommendations on CII water use are about improving data collection, and offering efficiency incentive programs that don't require detailed knowledge of the types of devices a business uses. In addition, a sizeable share of CII water use is for landscaping, and the same recommendations made above for residential water use apply to CII outdoor water use.

→ Potential for water savings from CII water efficiency: 126,000 million gallons per year (Highly Efficient New Civic Vision scenario vs. Inefficient Business as Usual scenario)

## Recommendation 10: Develop a local baseline understanding of CII water use and estimate conservation and efficiency potential in the CII sector.

**Who's responsible:** DWR and State Water Board to develop CII categories, water utilities to gather and report data

The state utilities should adopt a CII classification system for different types of businesses as required by AB 1668. Regional water suppliers should collect information on water use by CII category and release the information publicly.

At present, decision-makers don't have a good understanding of how water is used in the CII sector, much less where there are opportunities for greater conservation and efficiency. Thorough public studies should be conducted to develop industry-specific and regionally specific estimates of the water conservation and efficiency gains possible over the next 50 years.

## Recommendation 11: Establish local programs to encourage CII conservation and efficiency.

**Who's responsible:** Water utilities, nongovernmental organizations

Utilities should offer more incentive programs for CII water conservation and efficiency. But one challenge in offering rebates to the commercial sector is that many of their water uses rely on custom equipment. In addition to a traditional model of offering rebates for installing an upgraded device, water utilities should also offer performance-based incentives, in which a water utility subsidizes projects based on the amount of water saved.[96] Water utilities and nongovernmental organizations could also incentivize corporate conservation and efficiency with public recognition for good actors.

96 SoCal WaterSmart, "Water Savings Incentives Program," https://socalwatersmart.com/en/commercial/water-savings-incentive-program/

STRATEGY 2

# Pursue compact land use strategies with a high share of multifamily housing.

Smaller yards and multifamily housing with shared outdoor spaces use less water per person than large, single-family yards. Business as Usual and the New Civic Vision result in similar water use — but the New Civic Vision strategy accommodates 800,000 more housing units.

Downtown areas can make up for smaller yards with beautifully landscaped, water-efficient public spaces such as Salesforce Park in San Francisco. The park features plants adapted to Mediterranean climates similar to the Bay Area's — temperate, with moderate rain in the winter.

Photo by Sergio Ruiz.

## Recommendation 12: Change land use laws to encourage denser development in infill areas and stop sprawl development in existing open space.

**Who's responsible:** City councils, county boards of supervisors, city and county planning departments

Housing a greater share of the region's new residents in dense, multifamily, infill housing reduces outdoor water use while providing other community benefits. Dense, urban development typically uses less water than large-lot suburban development, a difference that's due largely to higher outdoor water use in suburban developments. SPUR's report *Meeting the Need*[97] explains in detail how land use laws should be changed to encourage infill development and stop sprawl development into existing open space.

97 Karlinsky, Sarah, and Kristy Wang, *Meeting the Need*, SPUR, April 2021, https://www.spur.org/publications/spur-report/2021-04-21/meeting-need

## Recommendation 13: Prioritize conservation, efficiency and alternative supplies over moratoriums on new connections. Only apply building moratoriums to infill housing as a last resort.

**Who's responsible:** Water utilities, State Legislature

Building new infill housing is a top priority for addressing the region's housing crisis and reducing carbon emissions. Moratoriums on new residential construction have been used to ensure that a utility can deliver enough water to its existing customers for basic health and human safety. However, these should be used only as a last resort. First, there should be concerted temporary efforts to curb water use, as well as aggressive emergency conservation orders, such as limiting outdoor watering to once a week and banning the watering of nonfunctional turf. Second, water utilities should put long-term efforts in place to find efficiencies elsewhere in the system or look for new supplies and transfers that will allow new infill housing to be constructed in the future.

## Recommendation 14: Require communities to demonstrate low water use and investment in alternative supplies before they can lower housing allocations based on water limitations.

**Who's responsible:** Association of Bay Area Governments, State Water Board

Bay Area per-capita residential water use averages about 80 gallons per day, ranging from about 40 gallons per day in urban San Francisco and low-income East Palo Alto to 190 gallons per day in the wealthy suburb of Hillsborough. Water-stressed countries like Singapore use just 37 gallons per person per day. Meanwhile, 28 cities in the Bay Area appealed their 2023 Regional Housing Needs Allocation from the Association of Bay Area Governments. Sixteen pointed to insufficient water as a limiting factor for growth.[98] These claims should only be considered valid if a city can demonstrate that it has implemented conservation and efficiency measures in line with the best standards set by other cities in the same hydrologic region with similar land use patterns and that it has invested in alternative supplies. This evaluation would require expertise and careful modeling and should be validated by a third-party expert such as the State Water Board.

98 Association of Bay Area Governments (ABAG), "2023-2031 RHNA Appeals Process," https://abag.ca.gov/our-work/housing/rhna-regional-housing-needs-allocation/2023-2031-rhna-appeals-process

STRATEGY 3

# Invest in alternative water supplies, strengthen mechanisms for cooperation to share water regionally and ensure a portion of water saved through conservation and efficiency is returned to ecosystems.

While the region could grow without increasing total water demand, the same is not true locally, with some areas receiving a larger proportion of growth than others. Water transfers and exchanges offer a way to move water from areas with a surplus to those that need it. These agreements are legally complex. The Bay Area — home to nine counties, 101 municipalities and 225 special districts — has a multitude of different water utilities, each with its own set of constraints. Who has the right to divert and use water is determined through a complex set of laws and contracts, and water users cannot simply transfer or exchange water at the drop of a hat. The complexity of water transfers and exchanges means that these arrangements take time and effort to develop; transfers are not a quick and easy fix for water scarcity.

## Recommendation 15: Invest in alternative supplies and new storage, with a focus on the most resilient, cost-effective and sustainable options.

**Who's responsible:** Water utilities

Strategies to increase water supplies and storage act in tandem with efficiency measures to meet new water demand. Options include water reuse, stormwater capture, tapping local groundwater supplies, increasing local groundwater storage and groundwater banking (when a water user pays to store water underground for later use). Desalination — the process of extracting salt from water to make it drinkable — remains an option but tends to be more expensive, use more energy and have a higher environmental impact than other options for now, although the technology is changing. While not the focus of this report, these options are reviewed thoroughly in SPUR's report *Future-Proof Water.*[99]

## Recommendation 16: Grow and strengthen mechanisms for water transfers and exchanges.

**Who's responsible**: Water utilities, Bay Area Regional Reliability partnership

The capacity to transfer water can build drought resiliency by giving water utilities access to a more diverse set of supplies, allowing entities with surplus water to move it to places with shortages. The Bay Area Regional Reliability Shared Water Access Program is one effort to create a framework for regional water transfers and exchanges that can serve as a basis for expanded efforts in this arena.[100]

99 Tam, Laura, *Future-Proof Water*, SPUR, March 2013, https://www.spur.org/publications/spur-report/2013-03-18/future-proof-water

100 Bay Area Regional Reliability, "Bay Area SWAP," https://bayareareliability.com/bay_area_swap

## Recommendation 17: **Look for opportunities to invest in efficiency in agricultural districts to facilitate transfers or exchanges of excess water.**

**Who's responsible:** Water utilities working in partnership with irrigation districts

In some cases, urban water suppliers are willing to pay for water efficiency projects in agricultural districts, and then lease or purchase the conserved water. Several Bay Area water utilities (Contra Costa Water District, Solano County Water Agency and Zone 7 in eastern Alameda County) already have long-term agreements with irrigation districts for water transfers.[101] Other utilities should look for similar opportunities. The San Francisco Public Utilties Commission has been pursuing a transfer agreement with an irrigation district along the Tuolumne River, though negotiations haven't yet been successful.[102]

## Recommendation 18: **Strengthen mechanisms to ensure that a portion of water saved through conservation and efficiency is restored to the environment.**

**Who's responsible:** State Water Board

Our modeling indicates that the Bay Area could grow and, with concerted long-term effort, use less water than it does at present. This implies that the region could have enough water to address the housing crisis and still divert less water from fragile ecosystems such as the Bay–Delta. But water saved through conservation and efficiency can easily be absorbed by other human users elsewhere in the system. To ensure that a portion of water conserved is returned to the environment requires a central regulator — in this case, the State Water Resources Control Board — to regulate instream flows. Although the Water Board has regulatory authority over environmental water, it has lacked a clear policy on how to prioritize environmental flows relative to water rights. This could be done by assigning the environment a water budget. An environmental water budget could be defined as a regulatory baseline that would be subtracted from the water available for diversions by water-rights holders, or the environment could be designated its own water right.[103]

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101 *San Francisco Bay Area Integrated Regional Water Management Plan*, October 2019, https://www.ccwater.com/DocumentCenter/View/8741/Bay-Area-IRWM-Plan-2019-Update-PDF

102 San Francisco Public Utilities Commission, "Dry Year Transfers," *Alternative Water Supply Program Quarterly Report*, June 2021, https://www.sfpuc.org/sites/default/files/programs/0_Alt%20Water%20Supply%20Planning%20Quarterly%20Report_June2021_FINAL.pdf

103 Gray, Brian et al., *Allocating California's Water: Directions for Reform*, Public Policy Institute of California, 2015, https://www.ppic.org/wp-content/uploads/rs_archive/pubs/report/R_1115BGR.pdf

# Appendices

## Online Appendices
## Estimates for Bay Area Urban Water Use Scenarios

Three online appendices provide the data used to generate the figures and results in Chapter 2. They can be downloaded at spur.org/bayareawater

Online Appendix A: Residential Indoor Use

Online Appendix B: Residential Outdoor Use

Online Appendix C: Commercial, Industrial and Institutional Use

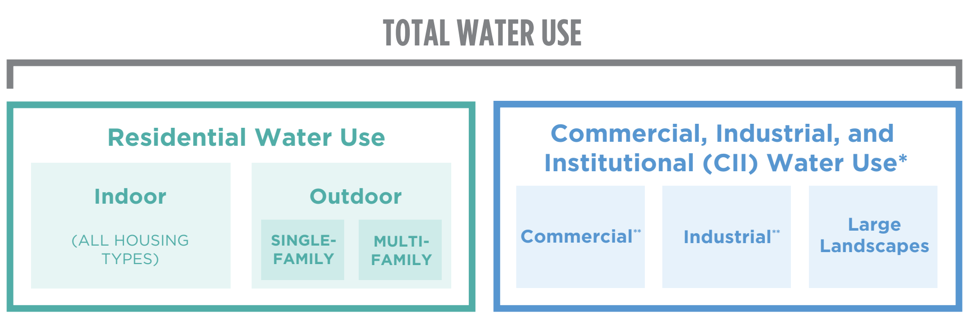
## Appendix 1
## Technical Resources

### Overview

Total water use was calculated as the sum of multiple classes of water use (see Figure A1). The methods used to estimate water use in each of these classes are detailed in subsequent sections of this appendix. For each of the classes of water use, two development scenarios (New Civic Vision and Business as Usual) and three efficiency scenarios (Inefficient, Efficient and Highly Efficient) were assessed for a total of six scenarios within each class of water use. This technical appendix includes a description of each of the development and efficiency scenarios, data sources and further details on analysis methods.

FIGURE A1

**Classes of Water Use Evaluated in Baseline and 2070 Water Use Estimates**




* Institutional water use is incorporated into commercial, industrial and large landscape use categories.

** Commercial and industrial uses include a combination of indoor and outdoor water use when outdoor water use is not metered separately.

## Housing, Population and Job Growth Scenarios

Changes in population and the number and type of housing units and jobs all impact water use in variable ways. Our analysis evaluated the impacts of each of these variables — housing units, population, and jobs — on water use across three development scenarios: baseline (current), 2070 Business as Usual and 2070 New Civic Vision. Each of the housing, population and job scenarios (and aggregate values for the nine-county Bay Area) are described in Figure A2. Data sources included SPUR's Bay Area 2070 modeling, American Community Survey (ACS) data from 2019 and population projections by the Bay Area Metropolitan Transportation Commission (MTC) in 2019.

FIGURE A2
**Summary of Development Scenarios Considered in Water Use Projections**

| SCENARIOS | | HOUSING UNITS[1] | POPULATION[2] | JOBS[3] |
|---|---|---|---|---|
| **Baseline** | DESCRIPTION | Estimate of existing housing units from SPUR. Housing type from ACS (2019). | 2019 estimate from ACS. | Current estimate from SPUR. |
| | VALUE | 2,977,819 | 8,196,828 | 5,516,653 |
| **2070 Business as Usual** | DESCRIPTION | Assumes future development is similar to current development (high proportion of single-family homes). | Estimated from number of housing units multi-plied by the MTC-pro-jected household population. | Assumes the distribution of future jobs growth is similar to current growth. |
| | VALUE | 4,382,224 | 12,652,953 | 7,616,653 |
| **2070 New Civic Vision** | DESCRIPTION | Assumes increasing density and development of multifamily hous-ing along transit corridors. | Estimated from number of housing units multi-plied by the MTC-pro-jected HH population. | Assumes future job growth occurs along transit corridors and other areas of increasing density. |
| | VALUE | 5,177,819 | 14,976,866 | 7,616,653 |

1. Housing units were used to estimate 2070 population and outdoor residential water use.
2. Population was used in estimates of indoor residential water use.
3. Jobs were used in estimates of commercial, industrial and institutional water use.

## Water Efficiency Scenarios

Three efficiency scenarios were evaluated for each of the three classes of water use (see Figure A3). Water efficiency scenarios were selected based on past observations of uptake and designed to cover a range of potential water management futures.

FIGURE A3
**Description of Water Use Efficiency Scenarios Considered**

| WATER USE | EFFICIENCY SCENARIO | DESCRIPTION OF SCENARIO |
|---|---|---|
| **Indoor Residential** | INEFFICIENT | 2017 standards stay in place through 2070. Passive uptake. Per-capita water use = 47.75 gallons/day. |
| | EFFICIENT | More rigorous standards for new devices implemented in 2025, followed by passive uptake of efficient fixtures. Leaks cut by 50%. Per-capita water use = 29.4 gallons/day |
| | HIGHLY EFFICIENT | Universal uptake of efficient fixtures. Leaks cut by 75%. Per-capita water use = 26.8 gallons/day |
| **Outdoor Residential** | INEFFICIENT | Only new housing units adopt MWELO.[104] |
| | EFFICIENT | 50% of existing housing units adopt MWELO and all new housing units adopt MWELO. |
| | HIGHLY EFFICIENT | All existing and new housing units adopt MWELO. |
| **Commercial, Industrial and Institutional (CII)** | INEFFICIENT | No change from existing water factors |
| | EFFICIENT | 10% gain in efficiency per decade |
| | HIGHLY EFFICIENT | 20% gain in efficiency per decade |

# Calculating Water Use Estimates

## Indoor Residential Water Use

Indoor residential water use was estimated by multiplying per-capita daily use (for the scenario) by population.

Per-capita daily use was estimated as a function of the water use of common household devices and their rates of uptake. Uptake in 2070 (penetration rate) was estimated using the stock model developed in Diringer et al.[105] The input values for each scenario are summarized in Figure A4. More detailed explanations for the numbers in this table are provided in the online appendix “Indoor Residential Water Use.”

Technology exists on the market for more efficient plumbing devices than required under current California regulations. The “cutting-edge technology” devices in Figure A4 are those devices with the most efficient rating certified by Energy Star or WaterSense in 2017.

104 MWELO is the Model Water Efficient Landscape Ordinance. MWELO specifies a range of outdoor water efficiency improvements that should be incorporated into new and redevelopment projects. See https://water.ca.gov/Programs/Water-Use-And-Efficiency/Urban-Water-Use-Efficiency/Model-Water-Efficient-Landscape-Ordinance

105 “Integrating Water Efficiency into Long-Term Demand Forecasting,” Pacific Institute (blog), https://pacinst.org/publication/integrating-water-efficiency-into-long-term-demand-forecasting/

FIGURE A4

## Indoor Device Standards and Difference Between California Standard and Cutting-Edge Technology Flow Rate (2017 Energy Star or WaterSense)

| DEVICE | SUBTYPE | UNITS | CALIFORNIA STANDARD FLOW RATE | CUTTING-EDGE TECHNOLOGY FLOW RATE | △ |
|---|---|---|---|---|---|
| Bathroom faucet | | gallons per minute | 1.2 | 1 | -0.20 |
| Kitchen faucet | | gallons per minute | 1.8 | NA | NA |
| Showerhead | | gallons per minute | 1.8 | 0.75 | -1.05 |
| Toilet | | gallons per flush | 1.28 | 0.79 | -0.49 |
| Clothes washer | Front-loading, compact | gallons/cycle/cubic foot | 8.3 | 2.6 | -5.70 |
| Clothes washer | Front-loading, standard | gallons/cycle/cubic foot | 4.7 | 2.6 | -2.10 |
| Clothes washer | Top-loading, compact | gallons/cycle/cubic foot | 12 | 2.6 | -9.40 |
| Clothes washer | Top-loading, standard | gallons/cycle/cubic foot | 6.5 | 2.6 | -3.90 |
| Dishwasher | Compact | gallons/cycle | 3.5 | 1.95 | -1.55 |
| Dishwasher | Standard | gallons/cycle | 5 | 1.95 | -3.05 |

FIGURE A5

## Water Use by Device, 2070 Penetration Rate and Total Water Use (GPCD) for Water Efficiency Scenarios

### Inefficient Scenario: 2017 Standards Stay in Place Through 2070 With Passive Uptake

| END USE | STANDARD | GPCD | EFFECTIVE DATE | LIFE SPAN (YEARS) | PENETRATION RATE 2070 |
|---|---|---|---|---|---|
| Toilet | California 2014 | 6.09 | 2014 | 25 | 0.95 |
| Toilet | California average use (DeOreo 2011)[106] | 13.14 | NA | 25 | 0.05 |
| Showerhead | California 2014 | 11.62 | 2014 | 10 | 1.00 |
| Faucets (bathroom/kitchen) | Bathroom California 2016; kitchen California 2014 | 11.00 | 2016 | NA | 1.00 |
| Clothes washer | National 2018 | 6.40 | 2018 | 11 | 1.00 |
| Dishwasher | National 2013 | 0.60 | 2013 | 11 | 1.00 |
| Bathtub | NA | 1.30 | | NA | NA |
| Leaks | NA | 10.40 | NA | NA | NA |
| **Total GPCD (weighted by penetration rate)** | | **47.75** | | | |

106 DeOreo, William B. et al. *California Single Family Water Use Efficiency Study*, Aquacraft Water Engineering and Management, April 20, 2011, https://cawaterlibrary.net/document/california-single-family-water-use-efficiency-study/

**Efficient Scenario: Cutting-Edge Technology Standards Implemented in 2025 With Passive Device Uptake; Leaks Cut by 50%**

| END USE | STANDARD | GPCD | EFFECTIVE DATE | LIFE SPAN | PENETRATION RATE 2070 |
|---|---|---|---|---|---|
| Toilet | Highest efficiency level for WaterSense/Energy Star–certified product as of 2017[107] | 3.76 | 2025 | 25 | 0.88 |
| Showerhead | “ | 4.36 | 2025 | 10 | 0.97 |
| Faucet | “ | 11.00 | 2025 | NA | 1.00 |
| Clothes Washer | “ | 3.54 | 2025 | 11 | 0.95 |
| Dishwasher | “ | 0.23 | 2025 | 11 | 0.95 |
| Toilet | California average use | 4.76 | | | 0.12 |
| Showerhead | California average use | 5.81 | | | 0.03 |
| Clothes Washer | California average use | 0.32 | | | 0.05 |
| Dishwasher | California average use | 0.12 | | | 0.05 |
| Bathtub | NA | 1.30 | NA | NA | NA |
| Leaks | NA | 5.20 | NA | | NA |
| **Total GPCD (weighted by penetration rate)** | | **29.40** | | | |

**Highly Efficient Scenario: Universal Installation of Cutting-Edge Technology Devices; Leaks Cut by 75%**

| END USE | STANDARD | GPCD | EFFECTIVE DATE | LIFE SPAN | PENETRATION RATE 2070 |
|---|---|---|---|---|---|
| Toilet | Highest efficiency level for WaterSense/Energy Star–certified product as of 2017 | 3.76 | | 25 | 1.00 |
| Showerhead | “ | 4.36 | | 25 | 1.00 |
| Faucet | “ | 11.00 | | 10 | 1.00 |
| Clothes Washer | “ | 3.54 | | NA | 1.00 |
| Dishwasher | “ | 0.23 | | 11 | 1.00 |
| Bathtub | NA | 1.30 | | 11 | NA |
| Leaks | NA | 2.60 | | NA | NA |
| **Total GPCD (weighted by penetration rate)** | | **26.79** | | **NA** | |

SPUR provided data estimating the number of housing units in the Bay Area in 2070 at the census block group (CBG) scale. These estimates were joined with U.S. Census Bureau CBG data to identify the county of each CBG and summed to estimate the number of housing units per county under SPUR’s 2070 Business as Usual and New Civic Vision scenarios. These data only included the number of housing units, not population (which was needed to estimate water use). The MTC developed projections on population and number of households by census tract for the Bay Area through 2040

107 EPA, “WaterSense Calculator,” February 3, 2017, https://www.epa.gov/watersense/watersense-calculator

(in five-year increments).[108] These data were summed by county to estimate household size at each five-year increment for each county. Linear regression was used to estimate the 2070 household size in each county. 2070 household size was multiplied by SPUR's estimates of the number of housing units in 2070 under the Business as Usual and New Civic Vision scenarios (see Figure A6 and online appendix "Indoor Residential Water Use").

FIGURE A6

**Current and 2070 Housing Unit, Household Size and Population Estimates by County**

| COUNTY | CURRENT UNITS | 2070 BUSINESS AS USUAL UNITS | 2070 NEW CIVIC VISION UNITS | 2020 PEOPLEPER HOUSEHOLD | 2070 PEOPLE PER HOUSEHOLD | CURRENT POPULATION | 2070 BUSINESS AS USUAL POPULATION | 2070 NEW CIVIC VISION POPULATION |
|---|---|---|---|---|---|---|---|---|
| Alameda | 600,925 | 939,704 | 921,626 | 2.78 | 2.99 | 1,672,728 | 2,807,836 | 2,753,819 |
| Contra Costa | 420,081 | 591,581 | 660,171 | 2.82 | 2.99 | 1,186,365 | 1,769,418 | 1,974,572 |
| Marin | 121,392 | 169,471 | 183,197 | 2.46 | 2.67 | 298,314 | 452,522 | 489,172 |
| Napa | 56,588 | 93,982 | 82,436 | 2.80 | 2.86 | 158,483 | 269,107 | 236,048 |
| San Francisco | 383,132 | 492,542 | 460,898 | 2.35 | 2.50 | 899,627 | 1,231,502 | 1,152,383 |
| San Mateo | 297,140 | 432,123 | 554,703 | 2.80 | 2.91 | 833,041 | 1,258,430 | 1,615,406 |
| Santa Clara | 713,593 | 1,152,671 | 1,583,046 | 2.93 | 2.95 | 2,087,859 | 3,400,034 | 4,669,512 |
| Solano | 153,795 | 176,025 | 219,318 | 2.94 | 3.15 | 451,747 | 554,215 | 690,524 |
| Sonoma | 231,173 | 334,125 | 512,423 | 2.63 | 2.72 | 608,664 | 909,889 | 1,395,430 |
| **TOTAL** | **2,977,819** | **4,382,224** | **5,177,819** | | | **8,196,828** | **12,652,953** | **14,976,866** |

## Outdoor Residential Water Use

While housing type does not make a substantive difference in indoor residential water use, it is a critical variable in estimates of outdoor water use due to differences in the landscaped area associated with different types of housing development. Because of this fact and other data constraints, the outdoor water use for single-family and multifamily homes were calculated separately and summed to obtain total outdoor residential water use.

### Part 1: Calculating Number of Single-Family and Multifamily Housing Units Now and in 2070

The first part of this analysis estimated the number of single-family and multifamily housing units now and in 2070 under the Business as Usual and New Civic Vision scenarios. We needed to estimate the total irrigated area of single-family housing units in the Bay Area by county, but had data on: 1) the total current number of housing units and 2) new single-family housing units in 2070 under the Business as Usual and New Civic Vision scenarios.

108 MTC, *Plan Bay Area 2040 Forecast*, "Population and Demographics," https://opendata.mtc.ca.gov/datasets/plan-bay-area-2040-forecast-population-and-demographics

To estimate the current number of single-family housing units and total number of existing and new single-family housing units in 2070, we used ACS 2019 data to calculate the relative proportion of single-family to multifamily housing units. These proportions were multiplied by New Civic Vision's number of housing units to obtain the number of single-family and multifamily housing units (see Figure A7). The number of 2070 single-family housing units was estimated as the sum of existing single-family housing units and new single-family housing units built in the Business as Usual or New Civic Vision scenarios. The inputs and results from these calculations are summarized in Figure A7.

FIGURE A7
**Estimated Number of Single and Multi-Family Homes by County Now and in 2070**

**Current Housing (ACS 2019)**

| County | All Current Units | Single-Family (SF) | Multifamily (MF) | ACS SF proportion | ACS MF proportion |
|---|---|---|---|---|---|
| Alameda | 622,691 | 383,303 | 239,388 | 0.62 | 0.38 |
| Contra Costa | 418,095 | 315,189 | 102,906 | 0.75 | 0.25 |
| Marin | 112,946 | 78,272 | 34,674 | 0.69 | 0.31 |
| Napa | 55,659 | 44,645 | 11,014 | 0.80 | 0.20 |
| San Francisco | 405,897 | 121,674 | 284,223 | 0.30 | 0.70 |
| San Mateo | 280,152 | 177,217 | 102,935 | 0.63 | 0.37 |
| Santa Clara | 685,903 | 436,642 | 249,261 | 0.64 | 0.36 |
| Solano | 159,348 | 123,192 | 36,156 | 0.77 | 0.23 |
| Sonoma | 208,033 | 164,136 | 43,897 | 0.79 | 0.21 |
| **TOTAL** | **2,948,724** | **1,844,270** | **1,104,454** | | |

**Current (SPUR All Housing Units × ACS Type proportion)**

| County | All | SF | MF |
|---|---|---|---|
| Alameda | 600,925 | 369,905 | 231,020 |
| Contra Costa | 420,081 | 316,686 | 103,395 |
| Marin | 121,392 | 84,125 | 37,267 |
| Napa | 56,588 | 45,390 | 11,198 |
| San Francisco | 383,132 | 114,850 | 268,282 |
| San Mateo | 297,140 | 187,963 | 109,177 |
| Santa Clara | 713,593 | 454,269 | 259,324 |
| Solano | 153,795 | 118,899 | 34,896 |
| Sonoma | 231,173 | 182,393 | 48,780 |
| **TOTAL** | **2,977,819** | **1,874,481** | **1,103,338** |

**Business as Usual 2070**

| COUNTY | EXISTING UNITS (ALL) | EXISTING SF | NEW SF | EXISTING MF | NEW MF |
|---|---|---|---|---|---|
| Alameda | 600,925 | 369,905 | 67,792 | 231,020 | 273,963 |
| Contra Costa | 420,081 | 316,686 | 84,891 | 103,395 | 79,491 |
| Marin | 121,392 | 84,125 | 17,247 | 37,267 | 32,647 |
| Napa | 56,588 | 45,390 | 30,474 | 11,198 | 8,052 |
| San Francisco | 383,132 | 114,850 | 3,872 | 268,282 | 103,389 |
| San Mateo | 297,140 | 187,963 | 51,191 | 109,177 | 86,359 |
| Santa Clara | 713,593 | 454,269 | 222,653 | 259,324 | 213,142 |
| Solano | 153,795 | 118,899 | 5,149 | 34,896 | 17,754 |
| Sonoma | 231,173 | 182,393 | 23,826 | 48,780 | 82,514 |
| **TOTAL** | **2,977,819** | **1,874,481** | **507,095** | **1,103,338** | **897,310** |

**New Civic Vision 2070**

| COUNTY | EXISTING UNITS (ALL) | EXISTING SF | NEW SF | EXISTING MF | NEW MF |
|---|---|---|---|---|---|
| Alameda | 600,925 | 369,905 | 18,994 | 231,020 | 295,195 |
| Contra Costa | 420,081 | 316,686 | 19,596 | 103,395 | 210,938 |
| Marin | 121,392 | 84,125 | 6,730 | 37,267 | 56,364 |
| Napa | 56,588 | 45,390 | 5,855 | 11,198 | 20,176 |
| San Francisco | 383,132 | 114,850 | 294 | 268,282 | 74,732 |
| San Mateo | 297,140 | 187,963 | 17,784 | 109,177 | 239,461 |
| Santa Clara | 713,593 | 454,269 | 42,389 | 259,324 | 834,747 |
| Solano | 153,795 | 118,899 | 1,540 | 34,896 | 64,179 |
| Sonoma | 231,173 | 182,393 | 15,268 | 48,780 | 275,757 |
| **TOTAL** | **2,977,819** | **1,874,481** | **128,451** | **1,103,338** | **2,071,549** |

## Part 2: Calculating Outdoor Residential Water Use

### Single-Family Outdoor Water Use

Outdoor residential water use is typically estimated using the standard outdoor water use equation (below). This equation is a function of irrigated area, net evapotranspiration, plant factor (aka crop coefficient) and irrigation system efficiency (see Figure A8). The calculation of each of these parameters is detailed below.

$$Outdoor\ Water\ Use\ (W) = \frac{(A * ET * P)}{e}$$

FIGURE A8

**Summary of Input Variables in Outdoor Water Use Equation**

| VARIABLE NAME | VARIABLE | CURRENT VALUE | WITH MWELO-COMPLIANT LANDSCAPING |
|---|---|---|---|
| Irrigated area, square feet ($ft^2$) | A | See below | See below |
| Net evapotranspiration ($ET_o - P_{eff}$) | ET | See below | See below |
| Plant factor/crop coefficient, dimensionless | P | 0.64 | 0.55 |
| Irrigation system efficiency, dimensionless | e | 0.6 | 0.75 |

Plant factor/crop coefficient values are reflective of a change from turf to low-water-use plants. Changes in irrigation system efficiency were obtained from MWELO documentation.

**Estimating Irrigated Area**

**Step 1:** Calculate typical vegetated area within residential-containing parcels.

Landscaped area within single-family parcels varies widely across the Bay Area, ranging from smaller city lots with limited turf in older Oakland neighborhoods to large suburban lots on the east side of the East Bay hills. Estimating these differences was a critical component in capturing this spatial variability in outdoor water use. We used SPUR's place type[109] data to define the six different classes of residential land use included in this analysis. This analysis consisted of the following steps, with results summarized in Figure A9.

1. Evaluate the distribution of parcels across SPUR place types to estimate average parcel size by place type (scale: entire Bay Area).
2. Use USGS National Land Cover Dataset impervious cover data to estimate the average percent of impervious cover by typical place type parcel (scale: entire Bay Area).
3) Multiply impervious area percentage by typical parcel area and subtract that area from the place type average parcel area to estimate typical vegetated area by place type.

109 Grant, Benjamin, and Sarah Jo Szambelan. *Bay Area Place Types*. SPUR, 2019. https://www.spur.org/publications/urbanist-article/2019-03-01/bay-area-place-types

FIGURE A9

## Summary of Average Parcel Area, Impervious Area and Vegetated Area by Residential-Containing Place Types

| RESIDENTIAL-CONTAINING PLACE TYPES | TYPICAL PARCEL AREA ($FT^2$) | MEDIAN IMPERVIOUS AREA (%) | TYPICAL IMPERVIOUS COVER AREA PER PARCEL ($FT^2$) | VEGETATED AREA (PARCEL AREA – IMPERVIOUS COVER AREA) ($FT^2$) |
|---|---|---|---|---|
| Suburban Edge: Very-low-density housing | 12,876 | 29 | 3,734 | 9,142 |
| Cul de Sac Suburbs: Low-density housing | 7,946 | 55 | 4,370 | 3,576 |
| Small Lot and Streetcar Suburbs: Medium-density housing | 5,418 | 65 | 3,522 | 1,896 |
| Urban Neighborhoods | 3,814 | 81 | 3,089 | 725 |
| Dense Urban Mix | 9,903 | 90 | 8,913 | 990 |
| High-Rise Neighborhoods | 4,919 | 88 | 4,329 | 590 |

**Step 2:** Calculate place type area-weighted estimates of irrigated area for each county. In this analysis, we translated the parcel-level estimates of vegetated area into county-wide estimates of irrigated area, which we used as the input for the irrigated area variable "A" in the equation above. This analysis consisted of the following steps, with results summarized in Figure A10.

1. Calculate the area of each residential-containing place type within each county.
2. Use county place type area to calculate place type area-weighted estimates of parcel area and vegetated area per parcel in each county.
3. Multiply parcel-level vegetated area by typical irrigated area (county level estimates)[110] to obtain the typical irrigated area per parcel.

110 DeOreo, William B. et al., *California Single Family Water Use Efficiency Study*, Aquacraft Water Engineering and Management, April 20, 2011, https://cawaterlibrary.net/document/california-single-family-water-use-efficiency-study/

FIGURE A10

### Place Type Area-Weighted Estimates of Vegetated Area and Irrigated Area Per Single Family Parcel by County

| COUNTY | SINGLE-FAMILY VEGETATED AREA PER PARCEL (FT²) | ESTIMATED PERCENT OF LANDSCAPE AREA IRRIGATED (%) | SINGLE-FAMILY ESTIMATED IRRIGATED AREA PER PARCEL (FT²) |
|---|---|---|---|
| **Alameda** | 5,967 | 29.7 | 1,771 |
| **Contra Costa** | 7,938 | 29.7 | 2,356 |
| **Marin** | 8,420 | 30.3 | 2,547 |
| **Napa** | 7,992 | 30.3 | 2,418 |
| **San Francisco** | 3,470 | 18.2 | 630 |
| **San Mateo** | 6,432 | 41.1 | 2,645 |
| **Santa Clara** | 5,834 | 41.1 | 2,399 |
| **Solano** | 7,562 | 38.1 | 2,883 |
| **Sonoma** | 7,449 | 30.3 | 2,253 |

4. Calculate irrigated area associated with single-family housing units in each county by multiplying irrigated area per parcel by the number of single-family homes in each county for each development scenario (see Figure A11).

FIGURE A11

### Estimated Single-Family Home Irrigated Area in the Current, Business as Usual and New Civic Vision Scenarios

| SCENARIO | CURRENT | BUSINESS AS USUAL | | NEW CIVIC VISION | |
|---|---|---|---|---|---|
| COUNTY | IRRIGATED AREA EXISTING SF (FT²) | IRRIGATED AREA NEW SF (FT²) | IRRIGATED AREA ALL SF (FT²) | IRRIGATED AREA NEW SF (FT²) | IRRIGATED AREA ALL SF (FT²) |
| Alameda | 654,951,067 | 120,031,980 | 774,983,047 | 33,631,229 | 688,582,296 |
| Contra Costa | 745,968,793 | 199,964,094 | 945,932,887 | 46,159,847 | 792,128,640 |
| Marin | 214,265,552 | 43,928,391 | 258,193,944 | 17,141,341 | 231,406,893 |
| Napa | 109,737,760 | 73,674,816 | 183,412,576 | 14,156,007 | 123,893,767 |
| San Francisco | 72,341,922 | 2,438,759 | 74,780,681 | 184,961 | 72,526,883 |
| San Mateo | 497,208,446 | 135,411,894 | 632,620,340 | 47,041,971 | 544,250,417 |
| Santa Clara | 1,089,831,921 | 534,164,411 | 1,623,996,333 | 101,695,328 | 1,191,527,249 |
| Solano | 342,768,598 | 14,844,400 | 357,612,999 | 4,440,414 | 347,209,012 |
| Sonoma | 410,967,905 | 53,685,212 | 464,653,117 | 34,402,910 | 445,370,815 |
| **TOTAL** | **4,138,041,964** | **1,178,143,959** | **5,316,185,924** | **298,854,008** | **4,436,895,973** |

## Estimating Net Evapotranspiration

$$Net\ Evapotranspiration\ (ET) = ET_0 - (.25 * P)$$

**In the equation above, $ET_0$** is the crop reference evapotranspiration, and P equals mean annual precipitation. For each county, California Department of Water Resources ET Zones were used to calculate area-weighted estimates of $ET_0$ for each county. Current average precipitation for each county was estimated using gridded precipitation data from CalAdapt. These input values are summarized in Figure A12. Changes in precipitation and evapotranspiration are anticipated in the Bay Area, but estimating these changes at the county level was beyond the scope of what was feasible in this analysis due to data inconsistencies.

FIGURE A12
**Area-Weighted Estimates of Current ET0 and Precipitation**

| COUNTY | AREA-WEIGHTED ANNUAL AVERAGE $ET_0$ (INCHES/YEAR) | AREA-WEIGHTED ANNUAL AVERAGE PRECIPITATION (INCHES/YEAR) |
|---|---|---|
| **Alameda** | 48.08 | 21.99 |
| **Contra Costa** | 50.06 | 23.99 |
| **Marin** | 35.29 | 36.94 |
| **Napa** | 48.67 | 29.85 |
| **San Francisco** | 31.25 | 22.99 |
| **San Mateo** | 38.18 | 29.11 |
| **Santa Clara** | 51.65 | 26.62 |
| **Solano** | 49.36 | 20.99 |
| **Sonoma** | 44.37 | 38.09 |

## Multifamily Outdoor Water Use

SPUR's modeling data included estimates of the number of new multifamily units but not the number of existing multifamily units or the number of multifamily units per parcel. The number of existing multifamily units was estimated using the methods discussed earlier, but the data gap around units per parcel necessitated taking a modified approach to estimate multifamily outdoor water use. To complete this portion of the analysis, we instead calculated county-level per-unit outdoor residential water factors using DWR's water balance data for multifamily outdoor residential water use. Water factors were calculated by dividing multifamily outdoor water use by the total number of multifamily units in each county (see Figure A13). Mathematically, the MWELO-compliant landscaping crop coefficients represent a 31.25% reduction in outdoor water use. This value was used to develop the water factors for the Efficient and Highly Efficient scenarios.

FIGURE A13
**Multifamily Outdoor Residential Water Use and Water Factors**

| COUNTY | DWR 2010–15 AVERAGE MF OUTDOOR WATER USE (AFY) | STANDARD DEVIATION OF DWR 2010–15 MF OUTDOOR WATER USE (AFY) | MF INEFFICIENT WATER FACTOR (AFY/UNIT) | MF MWELO-COMPLIANT LANDSCAPING WATER FACTOR (AFY/UNIT) |
|---|---|---|---|---|
| **Alameda** | 10,950 | 7,169 | 0.047 | 0.033 |
| **Contra Costa** | 7,117 | 1,158 | 0.069 | 0.047 |
| **Marin** | 583 | 223 | 0.016 | 0.011 |
| **Napa** | 1,433 | 320 | 0.128 | 0.088 |
| **San Francisco** | 1,883 | 449 | 0.007 | 0.005 |
| **San Mateo** | 3,000 | 1,819 | 0.027 | 0.019 |
| **Santa Clara** | 11,283 | 8,254 | 0.044 | 0.030 |
| **Solano** | 3,150 | 1,944 | 0.090 | 0.062 |
| **Sonoma** | 2,133 | 539 | 0.044 | 0.030 |

AFY – Acre Feet per Year

## Commercial, Industrial and Institutional (CII) Water Use

Estimating current and future CII water use has been a persistent challenge in water demand forecasting and has historically relied on 20-plus-year-old industry-specific water use factors (i.e., sector-specific water use per job).[111] We initially used this approach but found the calculated baseline values were significantly higher than current DWR estimates of CII water use. In this analysis, we developed composite, county-level water use factors based on current CII water use (county data from DWR) and the number of jobs per county. Water factors were calculated by dividing current water use for commercial, industrial and large landscapes in each county by the current number of jobs in each county to obtain a composite water factor associated with a generic job in each county. Because water use in each class is normalized across the total number of jobs, these values are not substitutable for the industry-specific water factors used in other projects.[112]

111 Christian-Smith, Julia, Matthew Heberger and Lucy Allen, *Urban Water Demand in California to 2100: Incorporating Climate Change*, Pacific Institute, August 2012, https://pacinst.org/wp-content/uploads/2014/04/2100-urban-water-efficiency.pdf

112 Ibid.

# Appendix 2
# Water-Related Building Moratoriums

FIGURE A14
**California Cities/Water Utilities That Have Issued Building Moratoriums Because of Insufficient Water Supplies**
See a map of affected communities at spur.org/buildingmoratoriums

| NUMBER (corre-sponding to number on map) | GEOGRAPHIC AREA AFFECTED | UTILITY DISTRICT AFFECTED | NAME OF GOVERNMENT AGENCY ISSUING BUILDING MORATORIUM | TYPE OF GOVERNMENT AGENCY | DATE MORATORIUM BEGAN – DATE ENDED | SOURCES | NOTES |
|---|---|---|---|---|---|---|---|
| 1 | Village of Cambria | Cambria Community Services District | Cambria Community Services District Board of Directors | Special District – Water Supplier | 2001–ongoing (as of March 2021) | Source #1 Source #2 | |
| 2 | Half Moon Bay, El Granada, Miramar, Princeton by the Sea | Coastside County Water District | Coastside County Water District Board of Directors | Special District – Water Supplier | 1976–1994 | Source #1 | |
| 3 | City of Half Moon Bay | Coastside County Water District | City of Half Moon Bay | Municipal Government | 1991–1999 | Source #1 | Sewer moratorium |
| 4 | Circle Oaks Unincorporated Community | Circle Oaks County Water District | Circle Oaks County Water District Board of Supervisors | Special District – Water Supplier | 2000– 2006, 2006–2007 | Source #1 Source #2 Source #3 | 2000–2006 (Moratorium on new water connections), 2006–2007 (Moratorium on new sewer connections) |
| 5 | Congress Valley Unincorporated Community | Congress Valley Water District | Congress Valley Water District Board of Directors | Special District – Water Supplier | 1975–1989 | Source #1 | |
| 6 | City of Willits | City of Willits Water Department | State Water Resources Control Board | State Regulatory Agency | October 2014–2015 | Source #1 Source #2 | |
| 7 | City of Plymouth | City of Plymouth Water Department | (1) City of Plymouth (2) California Department of Public Health | (1) Municipal Government (2) Public Agency | 1987–2010 | Source #1 Source #2 | |
| 8 | Montecito, Summerland and parts of Carpinteria | Montecito Water District | Montecito Water District Board of Directors | Special District – Water Supplier | February 2014–May 2019 | Source #1 Source #2 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 9 | City of Goleta | Goleta Water District | Goleta Water District Board of Directors | Special District – Water Supplier | 1972–1997, 2014–ongoing (as of March 2021 | Source #1 Source #2 Source #3 |
| 10 | Calaveras County | Calaveras County Public Utility District | State Water Resources Control Board | State Regulatory Agency | 2014–2016 | Source #1 |
| 11 | Brooktrails Township | Brooktrails Township Community Services District | State Water Resources Control Board | State Regulatory Agency | 2003–2010, 2014–2017 | Source #1 |
| 12 | Baywood– Los Osos Unincorporated Community | Los Osos Community Services District | California Regional Water Quality Control Board | State Regulatory Agency | January 1988– ongoing (as of March 2021) | Source #1 Source #2 |
| 13 | City of East Palo Alto | East Palo Alto Water District | East Palo Alto City Council | Municipal Government | July 2016– July 2018 | Source #1 Source #2 Source #3 |
| 14 | Cal Fire/Ishi Camp State Prison (Tehama County) | | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |
| 15 | Siskiyou County | Callahan Water District | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |
| 16 | Sierra County | Downieville Public Utility District | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |
| 17 | Tehama County | Lakeshore Heights Mutual Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |
| 18 | Tower Park Village and Tower Park Marina (San Joaquin County) | Little Potato Slough Mutual Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |
| 19 | Mill Creek (Tehama County) | Mill Creek– Lassen Mutual Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |
| 20 | City of Cloverdale (Sonoma County) | Palomino Lakes Mutual Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014– unknown | Source #1 Source #2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | City of Cloverdale (Sonoma County) | South Cloverdale Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1<br>Source #2 |
| 22 | Paskenta (Tehama County) | Paskenta Community Services District | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1<br>Source #2 |
| 23 | Sierraville (Sierra County) | Sierraville Public Utility District | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1<br>Source #2 |
| 24 | San Simeon (San Luis Obispo County) | San Simeon Community Services District | San Simeon Community Services District | Special District – Water Supplier | January 1986–January 2021 | Source #1<br>Source #2<br>Source #3 |
| 25 | Bolinas (Marin County) | Bolinas Community Public Utility District | Bolinas Community Public Utility District Board of Directors | Special District – Water Supplier | November 1971–ongoing (as of March 2021) | Source #1 |
| 26 | City of Pismo Beach | | Pismo Beach City Council | Municipal Government | 1988–1990, December 2015–May 2017 | Source #1<br>Source #2 |
| 27 | Crocker Mountain Estates | Grizzly Lake Community Services District | Grizzly Lake Community Services District | Special District – Water Supplier | Late 1990s–2007 | Source #1 |
| 28 | Town of Yountville | | Town of Yountville | Municipal Government | 1998–September 2005 | Source #1 (pg. 18)<br>Source #2<br>Source #3<br>Source #4 |
| 29 | City of Calistoga | | City of Calistoga | Municipal Government | Late 1970s (after 1977)–1982 | Source #1 (pg. 136)<br>Source #2 (pg. 103) |
| 30 | Hidden Valley Lake | Hidden Valley Lake Community Services District | State Water Resources Control Board | State Regulatory Agency | October 2014–July 2020 | Source #1<br>Source #2 |
| 31 | City of Sierra Madre | | Sierra Madre City Council | Municipal Government | July 2014–March 2020 | |
| 32 | Sheep Ranch (Calaveras County) | Calaveras County Water District | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1 |
| 33 | Spanish Flat (Napa County) | Spanish Flat Water District | Napa County Department of Public Health | Public Agency | Mid-1970s–unknown | Source #1 |
| 34 | Bass Lake (Madera County) | Bass Lake Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 35 | City of Willits | Pine Mountain Mutual Water Company | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1 |
| 36 | Briceland (Humboldt County) | Briceland Community Services District | Briceland Community Services District | Special District – Water Supplier | 1992–unknown | Source #1<br>Source #2 |
| 37 | City of Cloverdale (Sonoma County) | Rains Creek Water District | State Water Resources Control Board | State Regulatory Agency | October 2014–unknown | Source #1<br>Source #2 |

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