ISSUE BRIEF

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The Untapped Potential of California's Water Supply: Efficiency, Reuse, and Stormwater

California is suffering from a third year of drought, with near-record-low reservoirs, mountain snowpack, soil moisture, and river runoff. As a direct result, far less water than usual is available for cities, farms, and natural ecosystems. There are far-reaching effects that will intensify if dry conditions persist. Several response strategies are available that will provide both near-term relief and long-term benefits. This report examines the significant potential contributions available from four priority opportunities: improved efficiency in urban and agricultural water use, reuse and recycling of water, and increased capture of local rain water.

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California is a land of hydrological extremes, from water-rich mountains and redwood forests in the north to some of the driest deserts in North America in the south. It suffers both epic floods and persistent droughts. The existing water infrastructure and management systems reflect these extremes, with massive dams, canals, and pumping stations to store and transfer water, and hundreds of intertwined laws, institutions, and organizations promoting overlapping and sometimes conflicting water interests. The drought could end next year or it could continue, with even greater consequences in the coming years. But even during good years, disputes over water are common and claims of water shortages rampant. Dry years magnify disagreements over allocation, management, and use of California's water resources.

For much of the 20th century, California's water supply strategy has meant building reservoirs and conveyance systems to store and divert surface waters, and drilling groundwater wells to tap our aquifers. Hundreds of billions of federal, state, and local dollars have been invested in these supply options, allowing the state to grow to nearly 40 million people with a $2 trillion economy (LAO, 2013; Hanak et al., 2012). But traditional supply options are tapped out. Rivers are over-allocated even in wet years. There is a dearth of new options for surface reservoirs, and those that exist are expensive, politically controversial, and offer only modest improvements in water supply for a relatively few users. Groundwater is so severely overdrafted that there are growing tensions among neighbors and damage to public roads, structures, and, ironically, water delivery canals from the land subsiding over depleted aquifers.

The good news is that solutions to our water problem exist. They are being implemented to varying degrees around the state with good results, but a lot more can be done. During a drought as severe as the current one, the incentives to work cooperatively and aggressively to implement solutions are even greater. In this report, we examine the opportunities for four cost-effective and technically feasible strategies—urban and agricultural water conservation and efficiency, water reuse, and stormwater capture—to improve the ability of cities, farmers, homeowners, and businesses to cope with drought and address longstanding water challenges in California. We conclude that these strategies can provide 10.8 million to 13.7 million acre-feet per year of water in new supplies and demand reductions, improving the reliability of our current system and reducing the risks of shortages and water conflicts.

NATURE OF THE CHALLENGE: THE "GAP"

California's water system is out of balance. The current water use pattern is unsustainable, and there is a large and growing gap between the water desired and the water made available by nature. Human demands for water in the form of water rights claims, agricultural irrigation, and growing cities and suburbs greatly exceed—even in wet years—volumes that can be sustainably extracted from natural river flows and groundwater aquifers. Major rivers, such as the San Joaquin, have been entirely de-watered. Declines in groundwater levels in some areas due to overpumping of groundwater are measured in hundreds of vertical feet and millions of acre-feet.

Estimates of the overall "gap" are difficult because large volumes of water use are not measured or reported, California's natural water supply varies greatly between wet and dry years, and because water "demand" can be artificially inflated by over-allocation of rivers, inefficient use, price subsidies, the failure to prevent groundwater overdraft, and other hard limits on supply. But there are a wide variety of signs of the gap:

Sacramento-San Joaquin River Delta

The Sacramento-San Joaquin River Delta illustrates the unsustainable gap between how much water we take from our rivers and how much those rivers can provide. The Delta is vitally important to California. It is the primary hub for moving water from north to south. It is home to hundreds of species of birds, fish, and wildlife (DSC, 2013), including two-thirds of the state's salmon and at least half of the Pacific Flyway migratory water birds (USFWS, 2001). It is also a vibrant farming community. But excessive water diversions have contributed to a crisis that threatens the Delta's ability to perform any of these functions. In response to this crisis, in 2009, the State Legislature directed the State Water Resources Control Board (State Board) to determine how much water the Delta would need to fully protect public trust resources in the Delta.[1] For an average weather year, the State Board found that substantially increased flows from the Sacramento and San Joaquin River basins through the Delta into San Francisco Bay are needed to restore and maintain viable populations of fish and wildlife under existing conditions.[2] The Board's findings indicate that we currently divert almost 5 million acre-feet more water in an average year from the Delta than is compatible with a healthy Delta.[3] While these findings were designed to inform future planning decisions without considering other changes to the system or balancing other beneficial uses, the State Board's determination illustrates the yawning gap between our water demands in California and how much our surface waters can supply.

Groundwater Overdraft

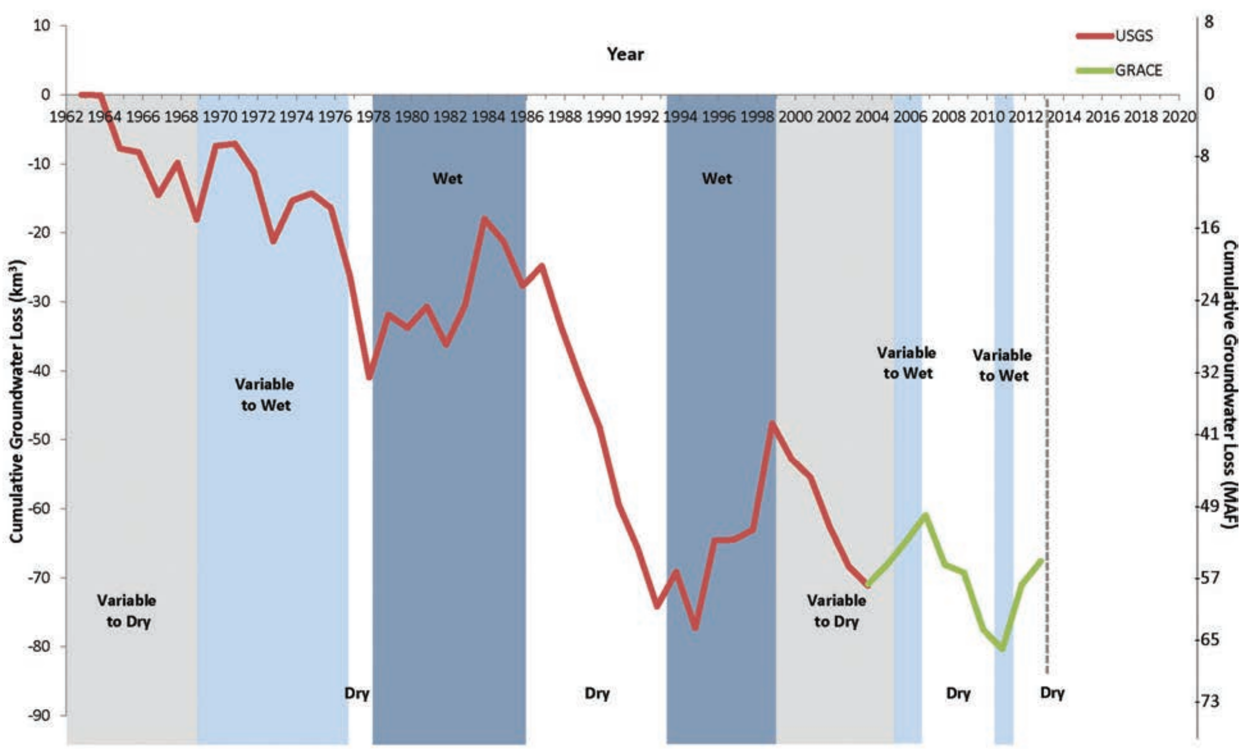
Groundwater is a vital resource for California. In average years, it provides nearly 40 percent of the state's water supply. That number goes up to 45 percent in dry years and close to 60 percent in a drought (DWR, 2014a). Moreover, many small- and medium-sized communities, such as Lodi, are completely dependent on groundwater. A clear indicator of the gap between water supply and water use in California is the extensive and unsustainable overdraft of groundwater, i.e., groundwater extracted beyond the natural recharge rate of the aquifer. Chronic overdraft has led to falling groundwater levels, dry wells, land subsidence, decreased groundwater storage capacity, decreased water quality, and stream depletion (Borchers et al., 2014).

As shown in Figure 1, groundwater levels are declining across major parts of the state. According to the Department of Water Resources (2014a), since spring 2008, groundwater levels have dropped to all-time lows in most areas of the state and especially in the northern portion of the San Francisco Bay hydrologic region, the southern San Joaquin Valley, and the South Lahontan and South Coast hydrologic regions. In many areas of the San Joaquin Valley, recent groundwater levels are more than 100 feet below previous historic lows. While some groundwater recharge occurs in wet years, that recharge is more than offset by pumping in dry and even average years, with over 50 million acre-feet of groundwater having been lost over the last half century (UCCHM, 2014). A comprehensive statewide assessment of groundwater overdraft has not been conducted since 1980, and there are major gaps in groundwater monitoring.[4] DWR has been estimating with considerable uncertainty that overdraft is between 1 million and 2 million acre-feet per year (DWR, 2003).

There are strong indications, however, that groundwater overdraft is worsening. Recent data indicates that the Sacramento and San Joaquin River Basins collectively lost over 16 million acre-feet of groundwater between October 2003 and March 2010, or about 2.5 million acre-feet per year (Famiglietti, 2014). This period captured a moderate drought, and thus we would expect overdraft to be higher than in non-drought periods. But while groundwater levels increased in 2011 and 2012, they did not fully recover to pre-drought levels, resulting in a net loss in groundwater storage at time when California enters a far more severe drought.

The gap between water supply and use from the state's groundwater basins and from the Sacramento-San Joaquin Delta alone exceeds 6 million acre-feet of water per year. We know that this underestimates the gap, as numerous studies have identified considerable unmet environmental flow objectives in other parts of the state (Hayden and Rosekrans, 2004). Moreover, we know that these "gaps" are expected to grow with the increasing challenges posed by population growth and climate change (DWR, 2013a).

Figure 1. Cumulative groundwater loss (in km^3 and million acre-feet) for California's Central Valley since 1962



Note: Cumulative groundwater losses (cubic km and million acre-ft) in California's Central Valley since 1962 from USGS and NASA GRACE data. Figure from UCCHM (2014) and extends figure B9 from *Faunt* [2009]. The red line shows data from USGS calibrated groundwater model simulations [Faunt, 2009] from 1962-2003. The green line shows GRACE-based estimates of groundwater storage losses from *Famiglietti* et al. [2011] and updated for UCCHM(2014). Background colors represent periods of drought (white), of variable to dry conditions (grey), of variable to wet conditions (light blue) and wet conditions (blue). Groundwater depletion mostly occurs during drought; and progressive droughts are lowering groundwater storage to unsustainable levels.

Source: UC Center for Hydrologic Modeling (UCCHM), 2014. Water Storage Changes in California's Sacramento and San Joaquin River Basins From GRACE: Preliminary Updated Results for 2003-2013. University of California, Irvine UCCHM Water Advisory #1, February 3, 2014. Available at https://webfiles.uci.edu/jfamigli/Advisory/UCCHM_Water_Advisory_1.pdf.

Figure courtesy of Jay Famiglietti, UCCHM, UC Irvine

OPPORTUNITIES

The good news is that California can fill the gaps between water supply and use with a wide range of strategies that are cost-effective, technically feasible, more resistant to drought than the current system, and compatible with healthy river and groundwater basins. New supply options include greatly expanded water reuse and stormwater capture. Demand-management options include the adoption of more comprehensive efficiency improvements for cities and farms that allow us to continue to provide the goods and services we want, with less water. Efforts in these areas have been underway in California for decades, and laudable progress has been made, but much more can be done.

Efficiency, water reuse, and stormwater capture can provide effective drought responses in the near-term and permanent water-supply reliability benefits for the state. Moreover, by reducing reliance on imported water supplies and groundwater pumping, they can cut energy use and greenhouse emissions, reduce the need to develop costly new water and wastewater infrastructure, and eliminate pollution from stormwater and wastewater discharges. Finally, these strategies can also generate new jobs and provide new business opportunities.

To better understand the extent to which these alternatives could reduce pressure on the state's rivers and groundwater basins, the Pacific Institute, Natural Resources Defense Council, and Professor Robert Wilkinson from the University of California, Santa Barbara undertook a series of assessments of the potential for urban and agricultural water conservation and efficiency, water reuse, and stormwater capture. In particular, we evaluated the technical potential, i.e., the total water supplies and demand reductions that are feasible given current technologies and practices.[5] These measures are already being adopted in California and have been shown to be cost-effective compared to other water supply alternatives (Cooley et al. 2010; DWR, 2013b). The next section provides a short summary of the additional technical potential for each of these strategies.

Improving Agricultural Water-Use Efficiency

Agriculture uses approximately 80 percent of California's developed water supply (DWR, 2014b). As such a large user, it is heavily impacted by the availability and reliability of California's water resources. Moreover, agriculture can play an important role in helping the state achieve a more sustainable water future. California irrigators have already made progress in modernizing irrigation practices, but more can be done to promote long-term sustainable water use and ensure that agricultural communities remain healthy and competitive. Since 2000, several research studies—including two sponsored by the CALFED Bay-Delta Program and a third by the nonprofit Pacific Institute—have shown that there is significant untapped agricultural water-use efficiency potential in California (CALFED, 2000 and 2006; Cooley et al., 2009). Although the studies varied in their geographic scope and in their approach, the researchers came up with remarkably similar numbers, finding that agricultural water use could be reduced by 5.6 million to 6.6 million acre-feet per year, or by about 17 to 22 percent, while maintaining current irrigated acreage and mix of crops. As much as 0.6 million to 2.0 million acre-feet per year represent savings in consumptive use, which can then be allocated to other uses. The rest of the savings reflect reductions in the amount of water taken from rivers, streams, and groundwater, leading to improvements in water quality, instream flow, and energy savings, among other benefits. Additional water savings could be achieved by temporarily or permanently fallowing land or switching crop types, but these options were not evaluated here.

Improving Urban Water-Use Efficiency

Greater urban water conservation and efficiency can reduce unnecessary and excessive demands for water, save energy, reduce water and wastewater treatment costs, and eliminate the need for costly new infrastructure. Between 2001 and 2010, California's urban water use averaged 9.1 million acre-feet per year, accounting for about one-fifth of the state's developed water use (DWR, 2014b). By adopting proven technologies and practices, businesses can improve water-use efficiency by 30 to 60 percent. Residential users can improve home water-use efficiency by 40 to 60 percent by repairing leaks, installing the most efficient appliances and fixtures, and adopting landscape designs with less turf grass and more native and drought tolerant plants. In addition, water utilities can expand their efforts to identify and cut leaks and losses in underground pipes and other components of their distribution systems. Together, these savings could reduce urban water use by 2.9 million to 5.2 million acre-feet per year.

Greater Water Reuse

Water reuse is a reliable, local water supply that reduces vulnerability to droughts and other water-supply constraints. It can also provide economic and environmental benefits by reducing energy use, diversions from rivers and streams, and pollution from wastewater discharges. There is significant opportunity to expand water reuse in California. An estimated 670,000 acre-feet of municipal wastewater is already beneficially reused in the state each year (SWRCB and DWR, 2012). Onsite reuse—including the use of graywater—is also practiced across California, although data are not available to estimate the extent of reuse. We estimate that the water reuse potential in California, beyond current levels, ranges from 1.2 million to 1.8 million acre-feet per year, after taking into account efficiency opportunities. Approximately two-thirds of the reuse potential is in coastal areas where wastewater is discharged into the ocean or into streams that drain into the ocean. In these areas, expanding water reuse can provide both water-supply and water-quality benefits.

Expanding Stormwater Capture and Use

Municipalities used to manage stormwater by channeling it away from developed land and urban centers as quickly as possible. This approach reduces the amount of freshwater available for groundwater recharge and use, and it creates tremendous pollution problems with stormwater discharges to rivers, lakes, and ocean waters. As water resources have become increasingly constrained, there is new interest in capturing stormwater runoff as a sustainable source of supply (CNRA, 2014). In California, there are substantial opportunities to use stormwater beneficially to recharge groundwater supplies or for direct use for non-potable applications. Our assessment indicates that capturing stormwater from paved surfaces and rooftops in urbanized Southern California and the San Francisco Bay Area can increase average annual water supplies by 420,000 to 630,000 acre-feet or more each year, while also reducing both flooding and a leading cause of surface water pollution in the state.

Combined Water Supply and Demand Reductions

Together, these improvements in water conservation and efficiency, water reuse, and stormwater capture can provide 10.8 – 13.7 million acre-feet in new supplies and demand reductions. As shown in Figure 2, these savings can be realized throughout the state. There are, however, important regional differences. In the Central Valley and the Colorado River hydrologic region, for example, the majority of savings are from agriculture, although savings from other strategies are also available. In coastal areas, the majority of savings are in urban areas. Statewide, urban conservation and efficiency combined with water reuse and stormwater capture provide the equivalent in new supplies and demand reductions as agricultural efficiency (Table 1).

Along the coast and in areas that drain into a salt sink, these measures provide water supply and water quality benefits. In inland areas, some portion of the yield of these measures may already be used by a downstream user and thus do not constitute "new" supply. However, even in such locations, the measures described here can improve the reliability of water supplies, leave water instream for use by ecosystems, replace the need for potable water, and reduce pressure on the state's overtaxed rivers and groundwater basins.

Figure 2. Total water supply and demand changes with four drought response strategies, in thousand acre-feet per year, by hydrologic region

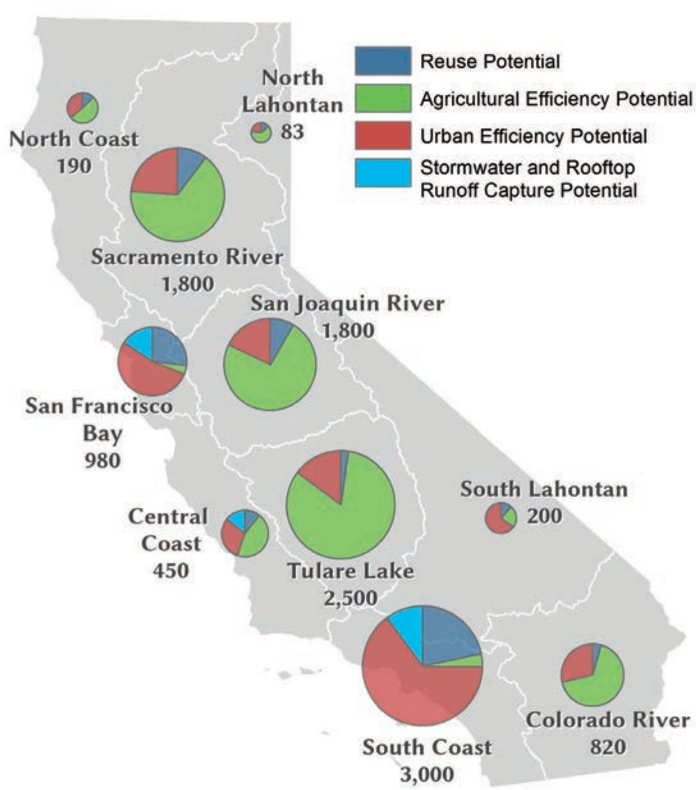


Table 1. Statewide water supply and demand changes with four drought response strategies

Strategy	Water Savings (million acre-feet per year)
Agricultural water conservation and efficiency	5.6 – 6.6
Urban water conservation and efficiency	2.9 – 5.2
Water reuse	1.2 – 1.8
Stormwater capture	0.4 – 0.6

Note: Stormwater capture was only examined in the San Francisco Bay Area and the South Coast. There is additional potential to capture stormwater in other regions of the state, although we did not evaluate that here. The values shown in this figure represent the midpoint of the ranges for each strategy.

CONCLUSIONS

We conclude that there is tremendous untapped potential to improve efficiency and augment supplies in California. Water efficiency, water reuse, and stormwater capture can provide 10.8 million – 13.7 million acre-feet of water in new supplies and demand reductions. These alternatives can provide both effective drought responses in the near-term and permanent water-supply reliability benefits for the state. Additionally, they can reduce energy use and greenhouse emissions, lower environmental impacts, and create new business and employment opportunities. Given the large potential and broad agreement about these strategies, state, federal, and local water agencies should move much more rapidly to implement policies to capture this potential.

California is reaching, and in many cases has exceeded, the physical, economic, ecological, and social limits of traditional supply options. We must expand the way we think about both "supply" and "demand"—away from costly old approaches and toward more sustainable options for expanding supply, including water reuse and stormwater capture, and improving water use efficiency. There is no "silver bullet" solution to our water problems, as all rational observers acknowledge. Instead, we need a diverse portfolio of sustainable solutions. But the need to do many things does not mean we must, or can afford, to do everything. We must do the most effective things first.

Identifying the technical potential to expand non-traditional supply options and increase water-use efficiency savings is just the first step in tackling California's water problems. Equally, if not more, important is adopting policies and developing programs to achieve those savings. A substantial body of law and policy already points the way to a more sustainable future for our state. For example, the California Constitution prohibits the waste of water. Likewise, the Brown Administration's California Water Action Plan supports local water projects that increase regional self-reliance and result in integrated, multi-benefit solutions. Many of these themes are also expressed in policy documents and recommendations from the California Urban Water Conservation Council, the Pacific Institute, the Association of California Water Agencies, the Delta Stewardship Council, the California Council on Science and Technology, the California Water Foundation, and others.

There is broad agreement on the value of improved efficiency, water reuse, and stormwater capture. The challenge is not a lack of knowledge or vision about what to do, but rather the urgent need for more effective implementation of strategies already known to work. Many innovative policymakers around the state have proposed new approaches to promote more widespread implementation of these strategies. We look forward to working with the Governor, agency heads, legislative leaders, water suppliers, and civic and business leaders to follow up with more specific actions for bringing the supply and demand for water in California into a sustainable balance.

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Footnotes

1 Water Code section 85086(c)(1): "For the purpose of informing planning decisions for the Delta Plan and the Bay Delta Conservation Plan, the board shall, pursuant to its public trust obligations, develop new flow criteria for the Delta ecosystem necessary to protect public trust resources."

2 See, e.g., page 5 of SWRCB and California EPA (2010a), recommending the general magnitude and timing of 75 percent of unimpaired Delta outflow from January through June, from approximately 30 percent in drier years to almost 100 percent in wetter years; 75 percent of unimpaired Sacramento River inflow from November through June, from an average of about 50 percent from April through June; and 60 percent of unimpaired San Joaquin River inflow from February through June, from approximately 20 percent in drier years to almost 50 percent in wetter years.

3 SWRCB and California EPA (2010b) at 180, Scenario B (2,258 thousand acre-feet (TAF) north-of-Delta delivery difference + 1,031 TAF south-of-Delta delivery difference = 1,609 TAF Vernalis flow difference = 4,898 TAF).

4 Of California's 515 alluvial groundwater basins, 169 are fully or partially monitored under the CASGEM Program and 40 of the 126 High and Medium priority basins are not monitored under CASGEM. The greatest groundwater monitoring data gaps are in the Sacramento, San Joaquin River, Tulare Lake, Central Coast, and South Lahontan hydrologic regions (DWR 2014a).

5 The technical potential estimated in these analyses is based on current use patterns and does not include population and economic growth, or changes in the total acreage or types of crops grown in the state. Increased population can result in increased demand, and these tools can help offset that growth. We do not examine the economic or market potential of these alternatives.

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