EXECUTIVE SUMMARY

The Cost of Alternative Water Supply and Efficiency Options in California

Heather Cooley and Rapichan Phurisamban

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Water is one of our most precious and valuable resources. California communities, farms, businesses, and natural ecosystems depend upon adequate and reliable supplies of clean water. Pressures from continued economic and population growth and climate change, as well as the need to restore degraded ecosystems, have led to concerns over our ability to meet future water demands. California is reaching, and in many cases has exceeded, the physical, economic, ecological, and social limits of traditional supply options. Rivers are over-allocated, and options for new surface reservoirs are expensive, politically controversial, and offer only modest improvements in water supply. Likewise, groundwater is so severely overdrafted in parts of the state 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.

In response, we must expand the way we think about both "supply" and "demand." 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.

Economic feasibility is a key consideration in determining how to prioritize investments among the available water supply and demand management options. Yet, only limited and often confusing data are available on the relative costs of these options. To fill this gap, we offer here the first comprehensive analysis of the cost of several urban water management strategies to augment local supplies and reduce demand. These include stormwater capture, recycled water, brackish and seawater desalination, and a set of water conservation and efficiency measures. This study focuses on centralized water-supply options and does not include distributed water supply options, such as rain barrels or onsite reuse, due to the lack of data on the cost and yield of these options. Additional research is also needed on the cost of water supply and demand management options for the agricultural sector.

Our analysis uses methods developed in the field of energy economics to estimate the levelized cost of water in California. This approach accounts for the full capital and operating costs of a project or measure over its useful life and allows alternative projects with different scales of operations, investment and operating periods, or both, to be compared with one another. For each alternative, a ratio of net costs (costs minus benefits) to the output achieved in physical terms is determined.

To the extent possible, we integrate co-benefits associated with these projects, such as reductions in wastewater and/or energy bills; however, the economic value of environmental costs and benefits are not well documented and are thus not included in this analysis.[1] Throughout this report, the cost of water is defined as the annual cost per unit of water produced or saved and is expressed in units of dollars per acre-foot of water.[2] All costs have been adjusted for inflation and are reported in year 2015 dollars.

It is important to note that the cost and availability of these options may vary according to local conditions and should be based on site-specific analyses. Seawater desalination, for example, is not available in inland areas. Where seawater desalination is an option, its cost would be affected by several factors, such as the design and technologies employed and the infrastructure needed to bring the water produced to the existing distribution system. Thus, the costs presented in this report can be used as a general guide for communities and decision makers on the most cost-effective options available and how to maximize the value of their investments.

The results indicate that the cost of new supplies in California is highly varied (Figure ES1). Large stormwater capture projects are among the least expensive of the options to expand water supplies examined in this study, with a median cost of $590 per acre-foot. By contrast, seawater desalination, with a median cost of $2,100 for large projects and $2,800 for small projects, is among the most expensive water supply options. Brackish water desalination is much less expensive due to lower energy and treatment costs. Generally, the cost of municipal recycled water projects is in between that of stormwater capture and seawater desalination. Non-potable reuse is typically less expensive than potable reuse due to the lower treatment requirements; however, the cost of building or expanding a separate "purple pipe" distribution system to deliver non-potable water may be such that indirect potable reuse would be more cost effective.

Further, the results indicate that urban water conservation and efficiency measures are less expensive than most new water-supply options and are thus the most cost-effective ways to meet current and future water needs. Indeed, many residential and non-residential measures have a "negative cost," which means that they save the customer more money over their lifetime than they cost to implement. Nearly all devices that save hot water (and thus energy) exhibit a highly negative cost, while even some devices that save cold water, such as pre-1994 era toilets, may have a negative cost due to lower wastewater bills.

Non-residential water use accounts for about one-third of urban water demand, and the total potential water savings, while significant, are less than for the residential sector.[3] Yet, the potential water savings *for each device* are typically much larger for the non-residential sector than for the residential sector. For example, an efficient ice machine has a negative cost and saves an estimated 13,000 gallons of water per year – nearly ten times as much water as would be saved by installing an efficient showerhead in a home. Likewise, an efficient medical steam sterilizer has a negative cost

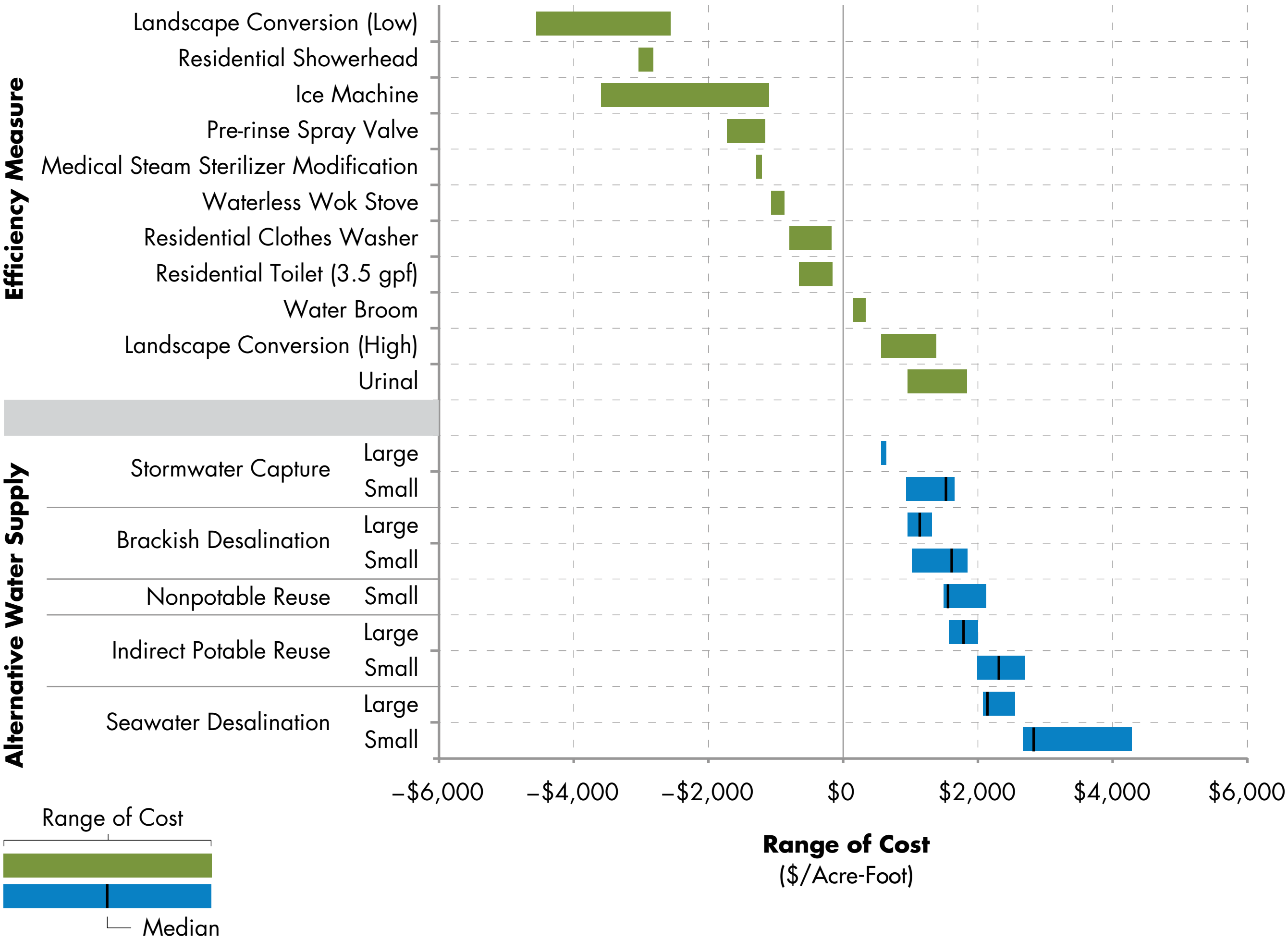
1 While difficult to quantify, they are economically relevant, and further research is needed to develop better environmental benefit and cost estimates.

2 California, and much of the western U.S., uses "acre-feet" as a standard water unit, and we adopt that convention here. An acre-foot of water is 325,851 gallons, or 1,233 cubic meters.

3 Heberger, M., H. Cooley, and P. Gleick (2014). Urban Water Conservation and Efficiency Potential in California. Oakland, Calif.: Pacific Institute.

Figure ES1.

Levelized Cost of Alternative Water Supplies and Water Conservation and Efficiency Measures, in 2015 dollars per acre-foot



Notes: All values are rounded to two significant figures. Costs for water supplies are based on full-system cost, which includes the cost to integrate the supply into a water distribution system. Ranges for water supplies are based on 25th and 75th percentile of project costs, except for large stormwater projects, which include the full cost range of the two projects. Conservation and efficiency measures shown in this figure represent only a subset of the measures examined in this study due to space limitations. Cost ranges for water conservation and efficiency measures are based on varying assumptions about the incremental cost and/or water savings associated with a measure.

and saves up to 650,000 gallons per year, at least 30 times more than would be saved by retrofitting an entire home with efficient appliances and fixtures.

Landscape conversions in residential and non-residential settings can also be highly cost effective. We characterize water savings in five California cities – Fresno, Oakland, Sacramento, San Diego, and Ventura – and estimate that annual water savings from landscape conversions in these cities range from 19 to 25 gallons per square foot. Based on interviews with experts, we estimate that the cost of landscape conversions ranges from $3 to $5 per square foot. If the consumer is in the market for a new landscape, as may occur after a lawn dies or when buying a new home, then the incremental cost of installing the low water-use landscape would be as low as $2 per square foot.[4] In this case, the cost of conserved water ranges from -$4,500 to -$2,600 per acre-foot (i.e., negative costs) because the reduction in maintenance costs outweighs the investment cost of the conversion. At $5 per square foot, the higher end of the landscape conversion cost, the cost of conserved water would be $580 to $1,400 per acre-foot, which is still less expensive than many new water-supply options in California.

Finally, water system leak detection is also highly cost-effective. Throughout California, high-quality treated water is lost from the system of underground pipes that distributes water to homes, businesses, and institutions. By helping to identify leaks earlier than would have occurred otherwise, leak detection surveys can reduce annual water losses by 260,000 gallons per mile surveyed at an estimated cost of $400 per acre-foot.[5] By comparison, water purchased from the Metropolitan Water District of Southern California, which provides water to 23 million Californians, exceeds $900 per acre-foot. This indicates that leak detection is highly cost effective when compared to existing water supplies and most potential new water supply options.

4 Here, the incremental cost is the difference between a new lawn, at $1 per square foot, and a new low water-use landscape, at $3 per square foot.

5 This estimate does not include the cost to repair the leak, as the utility would have fixed the leak regardless of when it was discovered. The surveys help to reduce water losses by more quickly allowing for the identification and repair of the leak.

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Pacific Institute
654 13th Street, Preservation Park, Oakland, CA 94612
510-251-1600 | info@pacinst.org | pacinst.org

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