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Untapped Potential: An Assessment of Municipal and Industrial Water Efficiency Potential in the United States

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Boxes, Figures, and Tables

Abbreviations

AWE – Alliance for Water Efficiency
AWWA – American Water Works Association
BGD – Billion Gallons Per Day
CBSA – Core Based Statistical Area
CII – Commercial, Industrial, and Institutional
ETAF – Evapotranspiration Adjustment Factor
GASB – Governmental Accounting Standards Board
GPCD – Gallons Per Capita Per Day
GPF – Gallons Per Flush
GPM - Gallons Per Minute
GWh – Gigawatt Hour
IAPMO – International Association of Plumbing and Mechanical Officials
ILI – Infrastructure Leakage Index
kWh – Kilowatt Hour
MAFY – Million Acre-Feet Per Year
MWD – Metropolitan Water District of Southern California
SAWS – San Antonio Water System
SNWA – Southern Nevada Water Authority
U.S. EPA – United States Environmental Protection Agency
USGS – United States Geological Survey
WE-STAND – Water Efficiency and Sanitation Standard

Executive Summary

Water is one of our most precious and vital natural resources and is fundamental for human and ecological health and economic prosperity. Yet, water scarcity is a growing risk for communities across the United States, due in part to natural hydrologic variability, population and economic growth, and the intensifying effects of climate change. The good news is that over the past several decades, communities across the United States have improved the efficiency of their water use, enabling growth and economic activity nationwide. Many communities have seen marked reductions in the amount of water used per person. For some, these reductions have been substantial enough that total water demand has peaked and declined even as the population and economy continue to grow. Even as traditional water sources are stressed, the opportunity to reduce demand through water efficiency remains both vast and largely untapped.

Water efficiency measures, by definition, reduce water demand without affecting the services and benefits water provides. These measures include a variety of technologies and practices, such as replacing old, inefficient toilets, showerheads, and clothes washers with high-efficiency models, as well as installing regionally appropriate landscapes, improving irrigation efficiency, and reducing leakage in the water delivery system. By reducing overall demand and doing more with less, water conservation and efficiency are critical tools for sustaining communities when water supplies are constrained and supporting long-term water resilience.

Water efficiency supports affordability by helping to mitigate rising water and wastewater bills, particularly for lower-income households.

Beyond water savings, water efficiency reduces energy use, lessens water and wastewater treatment costs, and can defer or eliminate the need for costly new infrastructure. Efficiency also supports affordability by helping to mitigate rising water and wastewater bills, particularly for lower-income households. Moreover, improving water efficiency can strengthen environmental resilience, protecting rivers, wetlands, and groundwater systems stressed by overuse. Despite these multiple benefits, water efficiency is often treated as optional rather than foundational in water supply planning. Efficiency efforts remain underfunded compared to new supply projects, and many water utilities rely on outdated water demand forecasts that underestimate ongoing improvements in per capita water demand. Without a shift in priorities, communities risk missing a major opportunity to build resilience at lower cost.

In this first-of-its-kind assessment, we quantify and describe the additional water efficiency opportunities in homes, businesses, institutions, and water distribution systems across the entire United States at the state and national scales. We find that efficiency improvements in these sectors can save 14.0 to 34.1 million acre-feet of water per year, or 12.5 to 30.1 billion gallons per day. These savings represent significant reductions from nationwide water demands, currently estimated at 57.2 million acre-feet per year, or 51.1 billion gallons per day. This means that even basic upgrades to meet current national standards could cut municipal and industrial water demand by one-quarter across the United States. The most ambitious efforts, based on technologies, strategies, and efficiency performance levels that exist today, could reduce municipal and industrial water demands by up to 60% in the most efficient scenario, equal to levels last seen in the 1960s.

Water efficiency gains are possible across all sectors. The residential sector, including both indoor and outdoor water use, offers the largest water savings, while reducing distribution system leakage presents a cost-effective opportunity that has historically been underrepresented in terms of funding and effort. Commercial, industrial, and institutional facilities also have substantial room for improvement through better benchmarking and targeted retrofits.

Efficiency potential exists in every state, and states with the largest efficiency potential tend to fall into two categories. The first category reflects states with the largest populations, where water savings are predominantly driven by the overall number of households, businesses, and water distribution systems affected by efficiency improvements. The second category is states with the highest current-day per capita demands and varying overall populations, where savings are driven by the outsized difference in per capita demands between the current-day estimates and efficiency scenario estimates.

This study also highlights case examples that demonstrate innovative and forward-looking approaches to advancing water efficiency beyond the strategies represented by the efficiency scenarios analyzed. These include strategies such as designing homes with right-sized plumbing and compact hot-water systems to minimize waste; promoting the WaterSense® Labeled Homes program that combines multiple efficiency measures; and proactively managing leaks across water distribution systems. These examples illustrate how communities can build upon the foundational efficiency strategies quantified in this analysis to achieve even greater water savings, operational benefits, and customer satisfaction. They serve as real-world models that can guide water utilities, policymakers, and planners in enhancing and expanding their own water efficiency programs to support long-term water resilience.

Water efficiency is a proven strategy for augmenting and diversifying water supplies, while simultaneously supporting a vibrant economy, reducing water and wastewater utility costs, adapting to and mitigating climate change, supporting water affordability, and maintaining healthy freshwater ecosystems for current and future generations. Communities, water utilities, and policymakers can and should elevate water efficiency as a central element of water management. This includes investing in efficiency programs and incentives; modernizing demand forecasting methods; strengthening regulations for fixtures, landscapes, and buildings; expanding education and outreach; and integrating efficiency savings into infrastructure and financial planning. Here, we offer recommendations to help realize the untapped potential of water efficiency through changes in policies, programs, and investments.

Expand funding and financing opportunities for water efficiency programs. Water efficiency improvements are typically the cheapest, fastest way to meet water needs. Yet, investments in water efficiency are often far less than investments in developing new water supplies, such as recycled water and desalination. Depending on the relevant local and state statutes, some water utilities can leverage capital budgets to finance more extensive efficiency program investments. Accelerating water efficiency improvements will require new funding and financing strategies and policy changes to reduce or remove these obstacles.

Increase financial and non-financial water efficiency incentives for customers. Incentives are effective strategies for promoting the adoption of water-efficient technologies, practices, and behaviors. These incentives can take many forms. For example, the WaterSense program is a powerful public-private partnership that provides a simple way for customers to identify high-performing water-efficient products and services while driving innovation in American manufacturing. Likewise, financial incentives, such as tax credits, discounts, and rebates, can motivate customers to purchase efficient products and support new business opportunities.

Provide water efficiency incentives to retailers, installers, and manufacturers. While most water efficiency incentives target individual customers, they can also be designed to incentivize, for example, retailers, installers, and manufacturers. These upstream and midstream incentives are more commonly employed by the energy sector but could also be used to advance water efficiency.

Update standards and codes. Standards and codes have been cost-effective strategies for saving both water and energy and lowering utility bills for households and businesses. The Energy Policy Acts of 1992 and 2005 established maximum water use rates for a variety of plumbing products and appliances sold in the United States. Accelerating efficiency improvements requires broad adoption of these standards and codes, and further revisions as new devices are developed and proven in the field, to reflect the most up-to-date technologies and practices.

Reduce water distribution system leakage. Leaks in the water supply and distribution system result in a loss of both water and revenue. Reliable data on system leakage are limited because adequate monitoring systems and requirements are not in place and available data are often not reported and/or used. However, available data suggest that significant opportunities to reduce system leakage exist across the country. Capturing these savings requires monitoring and reporting, as well as the adoption of performance standards, as has been done in only a minority of states.

Adopt universal metering and conservation-oriented water and sewer rates. Water and sewer rates play an essential role in communicating the value of water and promoting the wise use of water resources. Universal metering supports accurate monitoring of water use for efficiency performance benchmarking and goal-setting, and well-designed rate structures support multiple objectives, including the financial viability of the water utility, efficient allocation of water, water affordability, and environmental sustainability.

Expand data collection and monitoring. Limited data and information are available for water use at the end-use level (i.e., fixtures and appliances). In the commercial, industrial and institutional sector, data for subsector (i.e., industry type) rates and drivers of water use are even less common. Consistently reported data collected at regular time intervals under a standardized framework and customer categories are needed to inform decisions about water efficiency opportunities and challenges, as well as projections of water demand, water availability, and investment needs.

Fill critical research gaps. There remain outstanding research questions that must be addressed for effective implementation of water efficiency measures. Agencies across all levels of government, academics, water utilities, and community-based organizations have a role to play in filling these gaps.

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1. Introduction

Water is one of our most precious and vital natural resources and is fundamental for human and ecological health and economic prosperity. Yet, water scarcity is a growing risk for communities across the United States. The Colorado River, for example, is a lifeline for an estimated 35 million people in the western United States and Mexico, but the river dries up before reaching the Gulf of California because the demand for water exceeds the available supply. In the Midwest, communities surrounding Chicago have been seeking additional diversions from Lake Michigan to combat unsustainable aquifer drawdown. In 2022, nearly 90% of the Lower Mississippi River Basin experienced some level of drought and more than 55% was in extreme drought or worse. Water levels in the Mississippi River reached historic lows, disrupting critical shipping channels and threatening water supplies for communities in Louisiana as saltwater from the Gulf of Mexico moved further upstream (Cassidy 2023).

The good news is that over the past several decades, communities across the United States have improved the efficiency of their water use.[1] Per capita water demand has continued to decline, and many communities have continued to grow while using the same amount or even less water. These improvements have brought enormous benefits, supporting population and economic growth, avoiding costs to build increasingly expensive new infrastructure, saving energy, and helping reduce water withdrawals from rivers, streams, and oceans.

Per capita water demand has continued to decline, and many communities have continued to grow while using the same amount or even less water.

For decades, Pacific Institute has examined strategies to “close the gap” between water supply and demand. In 2024, we released the first of a new series of national assessments of alternative water supplies, quantifying the amount of stormwater runoff generated in urban areas in the United States (Berhanu et al. 2024). In this report, we describe untapped water efficiency opportunities in homes, businesses, institutions, and water distribution systems across the entire United States, marking the first time such an assessment has been published. Our objective is to quantify these opportunities and encourage communities, water supply planning professionals, and decision-makers to adopt or expand their own water efficiency efforts.

1 In this report, “water use” refers to the water used across sectors and end-uses, while “water demand” refers to the volume of that water use.

Water efficiency measures, by definition, reduce water demand without affecting the services and benefits that water provides. These measures include a variety of technologies and practices, such as replacing old, inefficient toilets, showerheads, and clothes washers with high-efficiency models; installing regionally appropriate landscapes; improving irrigation efficiency; and reducing leakage in the water delivery system. By doing more with less, water conservation and efficiency are critical tools for sustaining communities when water supplies are limited. They also save energy, reduce water and wastewater treatment costs, eliminate the need for costly new infrastructure, and support ecosystem health, among other co-benefits.

Section 2 of this study describes trends in municipal and industrial water use, the drivers and co-benefits of water efficiency, as well as the barriers and challenges to wider uptake. It also discusses strategies and approaches for advancing water efficiency. Section 3 describes the methodology used to quantify the volumetric potential for municipal and industrial water efficiency. Section 4 presents key findings from the analysis. Section 5 provides case examples that illustrate the opportunities in diverse geographies. Section 6 provides conclusions of the analysis, and Section 7 offers recommendations for realizing the potential for water efficiency in the United States.

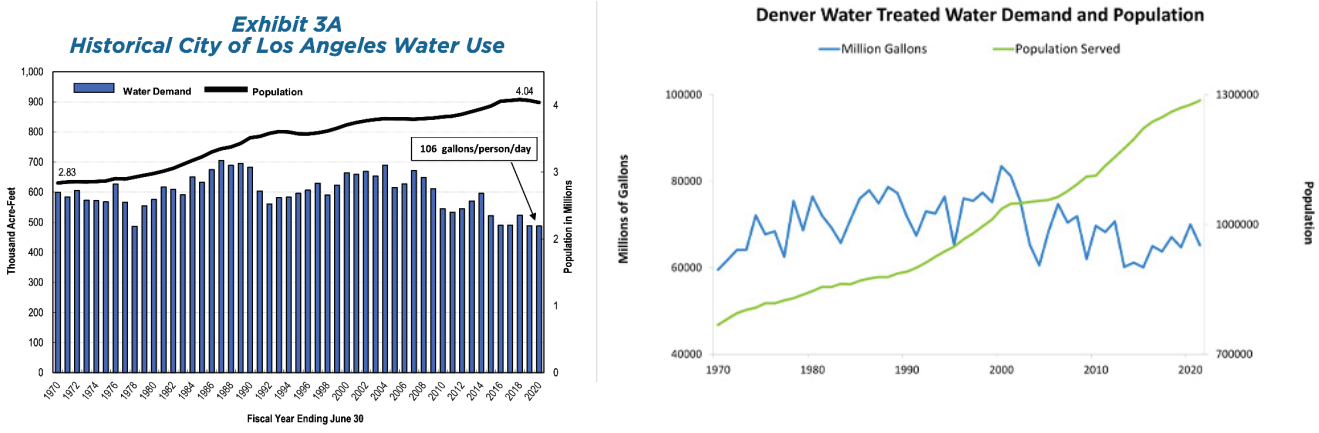
2. Overview of Water Conservation and Efficiency

This section provides an overview of water conservation and efficiency, including water use trends, its drivers and co-benefits, barriers and challenges, and the strategies and approaches for advancing water efficiency.

2.1 WATER DEMAND TRENDS

Communities across the country have made important strides in improving water efficiency. Over the past several decades, many have seen marked reductions in per capita water demand— that is, the amount of water used per person. For some, these reductions have been substantial enough that total water demand declined even as the population and economy continued to grow. In Los Angeles, California, for example, water demand declined from 173 gallons per capita per day (gpcd) in 1990 to 106 gpcd in 2020. In 2020, the city used 13% less water than in 1970, despite a 45% increase in population (Figure 1, left). Likewise, in Colorado, the City of Denver used less water in 2020 than in the early 1970s, despite a 70% increase in population (Figure 1, right).

FIGURE 1. Water Demand Trends in Los Angeles, California (left) and Denver, Colorado (right)



Sources: Los Angeles Department of Water and Power (2020) and Denver Water (2025)

These trends are well documented in the western United States (Cohen 2011; Cooley 2020; Richter 2023). However, they can also be found in other parts of the United States. In Georgia, per capita water demand in metropolitan Atlanta fell from 150 gpcd in 2000 to 99 gpcd in 2020 (MNGWPD 2022). Since 2000, total water withdrawals decreased by 10% while the population increased by about one million people (Atlanta Regional Commission n.d.). Similar trends are found in communities across the United States, including Washington, D.C. (Ahmed et al. 2020), Chicago, Illinois (CMAP n.d.), and across the Great Lakes (Great Lakes Commission 2023).

Several factors have supported this decoupling of water use from growth. For one, the economy has been shifting from one dominated by manufacturing to a less water-intensive service-oriented economy. Federal, state, and local policies and actions have also reduced water use. For example, the Clean Water Act, enacted in 1973, established water-quality standards that prompted the adoption of water efficiency measures to reduce wastewater volumes and costs. Likewise, the National Energy Policy Act of 1992 and later revisions set maximum water use rates for toilets, urinals, faucets, and showerheads sold in the United States. Additionally, many local water utilities offer incentives and other programs for their customers to support water efficiency improvements. Much of the public has also embraced environmental stewardship as an important practice, changing behaviors and reducing water use.

2.2 DRIVERS AND CO-BENEFITS

Water scarcity has been an important driver for water efficiency improvements, with climate change intensifying the effects and expanding risk into new regions. Droughts occur in every part of the United States and are becoming increasingly severe. Some regions, including the southwestern United States, are experiencing hotter, drier conditions that reduce the availability of existing water supplies (Payton et al. 2023).

Saving water reduces pressure on water supplies, making communities — and the economy — more resilient to water shortages. But while water scarcity has been an important driver, water efficiency provides multiple other benefits. Improving water efficiency can, for example, reduce or delay the need to build expensive new water and wastewater infrastructure and lower utility operating costs. The New York City Department of Environmental Protection launched a major toilet rebate program, replacing 1.3 million inefficient toilets between 1994 and 1997. This program reduced daily water demand by an estimated 70 to 80 million gallons per day, helping the city defer the development of new supply sources and expansion of its wastewater treatment capacity (U.S. EPA 2002). Conservation efforts by the Massachusetts Water Resource Authority — a wholesale water utility for 2.2 million people — reduced daily water demand by 80 million gallons per day from 1987 to

1997. This allowed the utility to defer new water supply and treatment infrastructure, saving an estimated $111 million to $153 million (U.S. EPA 2002).

Water efficiency also saves money for both water utilities and their customers and supports efforts to make water more affordable. Reductions in water demand provide an immediate reduction in water bills and, in some instances, wastewater and energy bills for the conserving household. In Detroit, Michigan, the Water Residential Assistance Program (WRAP) helps income-eligible households identify and repair minor leaks, saving participants an average of $420 per year (AWE 2020). In a study of five communities across California between 2010 and 2019, Chesnutt et al. (2022) estimated that avoided marginal costs alone (i.e., the avoided operating cost of treatment and distribution of water per acre-foot, without accounting for additional avoided capital costs) reduced customer bills by 3.2% to 19.9%.

Water efficiency also saves money for both water utilities and their customers and supports efforts to make water more affordable.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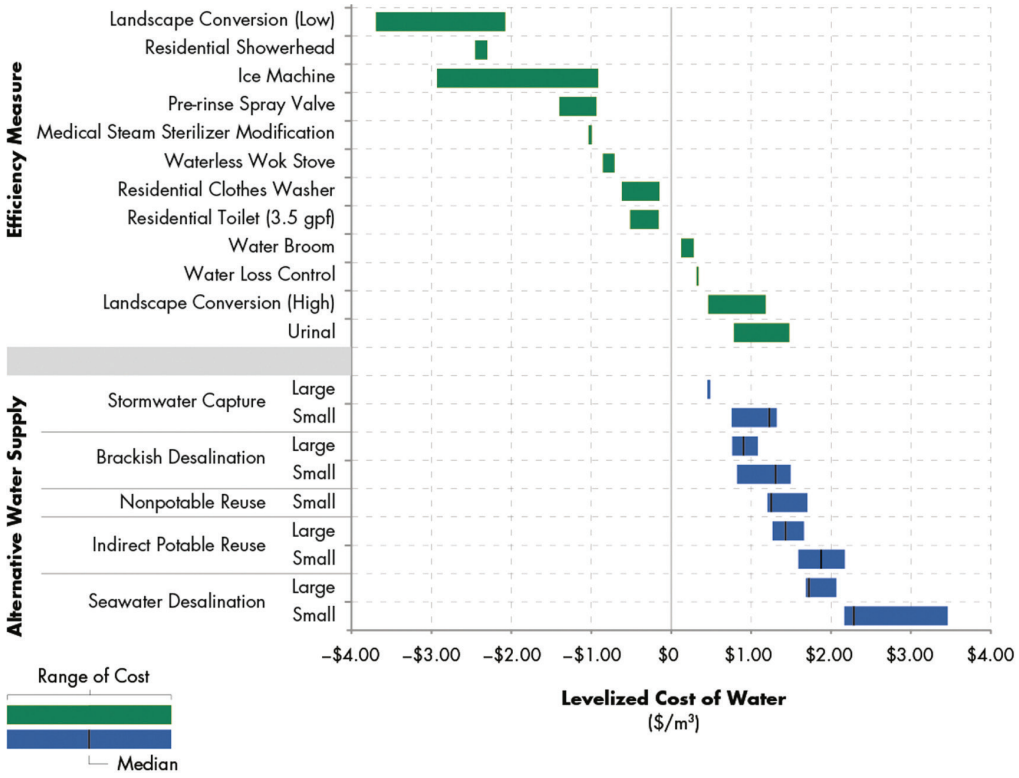
Water efficiency improvements also support affordability by avoiding the need to build, operate, and maintain costly new water and wastewater infrastructure to accommodate population and economic growth. This can represent tremendous cost savings, especially in areas with limited and increasingly expensive sources of new supply. For example, four studies supported by AWE found that in the absence of efficiency improvements, customer bills would have been 6.1% to 91% higher (Chesnutt et al. 2018; Feinglas et al. 2013; Mayer 2017a; Mayer 2017b; as summarized in Cooley et al. 2022).

Numerous studies find that urban water conservation and efficiency measures are less expensive than developing new supply and treatment infrastructure. For example, Cooley et al. (2019) compared the levelized cost of water — which accounts for the full capital and operating cost of a project or device over its useful life — for various water supply and efficiency options in California. They found that water conservation and efficiency were less expensive than new supply options, including stormwater capture, recycled water, and brackish and seawater desalination (Figure 2).

FIGURE 2. Cost Comparison of Alternative Water Supply and Efficiency Options



Source: Cooley et al. (2019)

As shown in Figure 2, some efficiency measures have a negative levelized cost, meaning they save the customer more money over their lifetime than the cost of the device. For example, while a high-efficiency clothes washer costs more than a less-efficient model, it uses less water and energy and produces less wastewater than less-efficient models, reducing household water and energy bills. Over the average 14-year life of the clothes washer, the reductions in energy and wastewater bills offset the higher cost of the more efficient model. Similarly, more efficient showerheads and the addition of faucet aerators provide a cost-effective means for indoor water efficiency improvements that result in net savings for households in most cases (Berhanu et al. 2017).

Further, water efficiency measures save energy and reduce greenhouse gas emissions, helping mitigate climate change. Large amounts of energy are required to collect, treat, distribute, and heat water, as well as to collect, treat, and dispose of wastewater. This energy consumption was estimated to make up roughly 8.4% of the total energy consumption in the United States in 2010, with more than one-third of this estimate attributed to water heating alone (Sanders et al. 2012). By reducing water use, water efficiency programs also reduce these energy requirements. For example, California instituted mandatory drought restrictions in 2015 that reduced urban water demand by nearly 25% compared to 2013 levels. Spang et al. (2018) found that those water conservation mandates reduced electricity use by 1,830 gigawatt hours (GWh) — 11% greater than the savings from the energy efficiency programs run by all the investor-owned water utilities in California combined — and reduced greenhouse gas emissions by 524,000 metric tons of carbon dioxide equivalents.

Water efficiency improvements can also provide benefits to the environment. Water efficiency measures can, for example, reduce withdrawals from rivers, streams, and aquifers, helping improve the amount and timing of instream flows. Additionally, outdoor efficiency measures can reduce the use — and ultimately runoff — of pesticides and fertilizers into rivers, lakes, and oceans. Further, native and/or regionally appropriate plants can enhance biodiversity by creating habitat for local flora and fauna.

Water efficiency measures can, for example, reduce withdrawals from rivers, streams, and aquifers, helping improve the amount and timing of instream flows.

2.3 BARRIERS AND CHALLENGES

Despite its multiple benefits, water efficiency faces several barriers. A key barrier is that water managers, planners, and engineers have assumed that opportunities to reduce demand were relatively small, instead prioritizing new supply investments for decades. Though perspectives are changing, water efficiency is still often seen as a customer service strategy and not as a foundational strategy for improving water reliability.

Water efficiency programs have historically been underfunded compared to other water supply investments. An analysis by AWE (2021) found that federal investments in energy efficiency and renewable energy between 2000 and 2020 were more than 86 times higher than investments in water efficiency and reuse. In contrast to large investments in centralized water supply infrastructure projects that leverage access to funding sources such as capital budgets and debt financing, water efficiency program investments are relatively small and typically paid for out of operational budgets that can fluctuate annually. The Governmental Accounting Standard Board (GASB) updated their governmental accounting guidance in 2010 to effectively allow for debt financing of some water efficiency strategies, increasing the available pool of resources to fund these programs over longer time horizon (GASB 2010). However, this practice has not been widely adopted by water utilities, and some utilities remain unable to leverage capital funding sources due to state-level statutes that do not reflect the updated federal guidance (Box 1).

BOX 1: Debt Financing Water Efficiency Improvements

In most instances, achieving the level of water savings through efficiency measures detailed in this study requires a level of investment that typically exceeds what utilities can allocate from their annual operating budgets. Implementing water efficiency measures to maximize water savings requires careful planning and long-term financial strategies that can help mitigate impacts on water rates. Like other major water projects that expand water supplies, water efficiency measures are best envisioned and positioned as long-term capital projects. For most utilities, this process will begin with shifting water efficiency programs, including customer incentive programs, from annual operating plans and budgets to capital improvement plans and budgets. Once a program is included as part of a capital improvement plan, it becomes eligible for debt financing. This first step helps pave the way to securing the upfront funds required to achieve large-scale water savings while minimizing rate impacts.[2]

Municipal bonds and other forms of debt have historically been the primary financing vehicle of public utilities to pay for large water supply projects such as surface water reservoirs, pumping stations, and groundwater well infrastructure. Utilities will also need to finance water efficiency programs and strategies, such as consumer rebates and incentives, as long-term capital projects to reach the level of investment needed to realize the scope of water supply benefits and co-benefits discussed in this study. A debt financing approach for distributed infrastructure, such as conservation easements for turf conversion projects and direct installation of high-efficiency fixtures, is relatively new in the water sector. However, there are legal, accounting, and tax pathways enabling the use of bond and loan proceeds to pay for water efficiency measures on both public and private property. For example, Southern Nevada Water Authority has bond financed its turf conversion rebates for more than 20 years, using permanent conservation easements on properties with turf replacements, cumulatively saving over 450,000 acre-feet of water (Koch et al. 2022).

Leveraging capital funds to finance water efficiency investments is also a sound policy decision. This approach matches the scale and long-term horizon of benefits with the costs of implementation. Matching the time horizons of benefits and costs also supports intergenerational equity by ensuring that both current and future ratepayers can access the benefits of the costs that they bear.

2 Additional information about debt financing water efficiency measures can be found in the Tap into Resilience Toolkit (WaterNow Alliance 2021).

Another challenge is that forecasts of future water demands have not adequately incorporated water efficiency improvements, including those resulting from national and/or state standards. As a result, these forecasts regularly overestimate water demand (Abraham et al. 2020; Diringer et al. 2018; Richter 2023), which can prompt water utilities to build costly water supply and treatment infrastructure that is too large or unneeded. While efficiency improvements inevitably translate into revenue reductions for utilities, which can be mitigated by monetary savings from avoided water supply purchases and reduced operating costs, the failure to account for increasing efficiency in revenue forecasts can exacerbate unexpected revenue shortfalls that threaten the financial viability of the water utility.

Continued reductions in per capita water demand may require water managers and planners to alter the management and design of water and wastewater infrastructure. With lower rates of water use, water stays within water distribution systems and building plumbing systems longer, potentially affecting water quality. Adaptation strategies include right-sizing water mains, storage tanks, meters, and pipes, as well as adjusting disinfection practices (Mayer et al. 2020; U.S. EPA 2022). Indoor water efficiency improvements also concentrate wastewater flows. While impacts are site specific, more concentrated flows can create operational challenges for wastewater collection and treatment systems, such as odors and solids accumulation that reduce capacity, and increased concentration of contaminants in wastewater that are outside of design parameters for treatment facilities (U.S. EPA et al. 2012). In response, wastewater managers can, for example, increase flushing to reduce clogging, conduct more frequent inspections, update treatment facility design guidance, and implement operational adjustments to treatment processes (Porse et al. 2023; U.S. EPA et al. 2012).

Finally, some water managers and planners have argued that extensive conservation "hardens" demand, potentially limiting the ability to further reduce water use during a shortage. Evidence, however, does not support this concern, and it overlooks key factors such as water storage and opportunities for additional reductions through behavioral changes and new technologies (Box 2).

BOX 2: Demand Hardening

Demand hardening is the idea that extensive conservation removes slack in the system, reducing the ability to cut water use during shortages. In practice, conservation can increase water stored in reservoirs or aquifers, lowering drought risk. For example, analysis from the Metropolitan Water District of Southern California — serving roughly 19 million people — found that without conservation, storage would have been depleted three times in the past 30 years (Goshi 2024).

Second, customers who reduce their demand through technological improvements, such as installing high-efficiency toilets and clothes washers, can still reduce their water use through behavioral changes during a shortage (Mayer et al. 2006). Residents in San Francisco, for example, use just 42 gpcd — among the lowest rates in the country — and were able to reduce water demand by 20% during a recent drought (Alexander 2015; Reese et al. 2015; SWRCB, n.d.). Finally, the technologies and economics of water efficiency are constantly changing. New, more efficient technologies are coming onto the market, expanding the water savings potential of existing and new customers.

2.4 STRATEGIES AND APPROACHES FOR ADVANCING WATER EFFICIENCY

There are many strategies and approaches to support the adoption of water conservation and efficiency measures, including financial incentives, regulations, and education and outreach. The most successful water efficiency programs typically employ a mix of incentives, regulations, and customer education and outreach to achieve water savings, with each strategy having strengths in different conditions and for different customer categories. For example, regulatory actions can help curtail water use during drought periods to avoid water supply shortfalls and system shocks and support long-term shifts in demand patterns, while robust incentives and sustained communication and outreach efforts can support long-term culture change and awareness among utility customer bases. In this section, we describe these strategies and provide examples of policies and programs from across the United States.

2.4.1 Financial Incentives

Financial incentives are commonly used to spur the adoption of water efficiency technologies and practices in homes, businesses, and institutions. For example, water and wastewater rates, sometimes referred to as tariffs, play an important role in communicating the value of water and wastewater services. Well-designed rates can support the efficient allocation of water as well as the financial viability of the water utility, the fair and equitable allocation of cost among customers, and environmental sustainability.

Water utilities are increasingly offering incentives targeting outdoor uses of water, such as installing efficient irrigation systems and replacing grass with water-efficient landscapes.

The earliest water utility incentive programs targeted indoor water end-uses, such as toilets and showerheads. Water utilities are increasingly offering incentives targeting outdoor uses of water, such as installing efficient irrigation systems and replacing grass with water-efficient landscapes. These “cash-for-grass” programs were pioneered by the Southern Nevada Water Authority in the early 2000s and have been widely adopted in other regions, including in California, Colorado, New Mexico, and Utah.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Most incentive programs have been structured as rebates that require participants to pay upfront costs before receiving the money back, which can take several months. These programs may be cost-prohibitive for households with lower incomes that cannot afford the initial upfront investment (Clements et al. 2017; Pierce et al. 2021). Providing devices at no cost for qualified households through device giveaways or direct-install programs can make these programs more accessible. Vouchers at the time of sale can also eliminate the need for reimbursement. Some water utilities offer renter-friendly programs, such as Glendale, Arizona, which allows renters to participate in rebate programs with written permission from the property owner (City of Glendale n.d.).

Some water utilities also offer incentives to businesses and other non-residential customers, sometimes employing a wider variety of strategies that can accommodate the diversity of water demand volumes and end-uses seen in the commercial, industrial, and institutional (CII) sector. For example, the Metropolitan Water District of Southern California (MWD) and San Antonio Water System (SAWS) provide businesses, agriculture, and institutions with performance-based incentives, paying up to $0.60 and $3.68 per 1,000 gallons of water saved, respectively (MWD 2023; SAWS n.d.-a). The SAWS also provides commercial incentives as rebates for adoption of water saving technologies — such as irrigation smart controllers and real-time flow-monitoring devices — as well as landscape design rebates for retrofit and/or replacement of inefficient irrigation systems (SAWS n.d.-b).

2.4.2 Regulations

Regulations have also been an effective tool for advancing water efficiency. Beginning in the late 1980s, states and municipalities across the United States began establishing efficiency standards with maximum water use rates for certain plumbing fixtures. Building on these efforts, the Energy Policy Act of 1992 established national efficiency standards for toilets, faucets, and showerheads. Since these standards went into effect in 1994, new toilets sold in the United States cannot use more than 1.6 gallons per flush (gpf) and faucets and showerheads must not exceed 2.5 gallons per minute (gpm). Eighteen states, including Colorado, California, Georgia, and Texas, have adopted stronger standards for one or more of these fixtures.

While the earliest regulations were focused on indoor water use, regulations designed to limit outdoor use are becoming more common. Some communities restrict the amount of grass that can be installed in new developments, for example, limiting grass to no more than 20% of the landscape area. California opted for a performance-based approach, establishing a water budget for new landscapes that effectively limits the amount of grass and other high-water-use plants. Southern Nevada went a step further, passing a law to prohibit the use of Colorado River water on grass used only for decorative purposes (so called “non-functional turf”) for all commercial, multi-family, and government properties beginning in 2027. California passed a similar law, and dozens of other urban water agencies that rely on water from the Colorado River committed to replacing 30% of their non-functional turf with drought- and climate-resilient landscaping.

In another first, the Southern Nevada Water Authority (SNWA) — which serves more than 2 million residents in and around Las Vegas, Nevada — banned evaporative cooling systems in new commercial and industrial buildings. The SNWA estimates that evaporative cooling is the second largest consumer of water in Southern Nevada, behind outdoor irrigation (SNWA n.d.). Instead, new commercial buildings will be required to use alternatives, including air conditioning units with a recirculating refrigerant.

2.4.3 Education and Outreach

Education and outreach are effective strategies for promoting water conservation and efficiency. The U.S. Environmental Protection Agency (U.S. EPA), for example, launched the WaterSense® labeling program in 2006 to promote water-conserving devices that are 20% more efficient than standard products on the market and meet rigorous performance criteria. This program helps consumers to

identify high-performing devices that save water. Through the end of 2023, WaterSense has helped save 8.7 trillion gallons of water, 997 billion kilowatt hours (kWh) of electricity, and $207 billion in water and energy bills (US EPA 2024b).

Some water utilities also run public education and outreach campaigns to encourage customers to save water. For example, Denver Water received the OBIE Hall of Fame Award from the Out of Home Advertising Association of America in 2022 for its impactful water conservation campaign. After testing several messages, Denver Water launched the "Use Only What You Need" campaign in 2006 (Brown and Caldwell 2015). The campaign, which combined a simple tagline with clever visuals and a call to action, helped Denver Water meet its water savings goals (Brown and Caldwell 2015; Christiano et al. 2017; Finley 2015).

Social marketing has also gained prominence in recent years, with some programs tapping into new metering technologies and web-based platforms. Home water reports — which provide customers with information on their current water use and comparisons to their past use, use by similar households, and efficient use — have been found to reduce water demand by 5% and were especially effective in reaching the highest water users (Mitchell et al. 2013).

3. Methods

For this study, we estimated the "current-day" water demands (defined as annual average demands based on 30-year average weather conditions for calendar years 2022 and 2023) and water efficiency potential across the three major sectors of municipal and industrial water use: residential (both single-family and multi-family); CII; and utility water loss (i.e., the distribution system leakage). For each sector, we estimate current and efficient water demands, with the difference between these values representing the water efficiency potential. Efficient water use was based on three efficiency scenarios (Basic Efficiency, High Efficiency, and Leading-Edge Efficiency) that were selected to represent increasing efficiency levels that are currently achievable from existing strategies and technologies.

This section describes the analytical approach used to develop these estimates, with additional details on analysis methods and supporting information provided in and Appendix B respectively. The results in this study represent a "snapshot" of current-day efficiency potential across the three efficiency scenarios, assuming 100% uptake of efficiency improvements using currently available technologies and practices. Therefore, we did not investigate additional savings potential generated from population growth or from more efficient technologies that could be developed in the future. Estimates are presented at the state and national levels, and additional refinement would be needed to interpret these results for local contexts due to the variability of water use drivers and patterns.

The results in this study represent a "snapshot" of current-day efficiency potential across the three efficiency scenarios, assuming 100% uptake of efficiency improvements using currently available technologies and practices.

3.1 ADVISORY GROUP

Throughout the project, we engaged an advisory group consisting of 12 members with relevant expertise in and representing diverse stakeholder groups, for example, water utilities, academia, and environmental organizations. The advisory group provided input on the analytical approach, interpretation of results, recommendations, and materials generated.

3.2 CURRENT-DAY WATER DEMAND ANALYSIS

We modeled current-day water demands using monthly records of billed water consumption for over 100 water utilities from 2005 to 2017, disaggregated by sector, that were analyzed for time-based trends and projected to the present.[3] We disaggregated water demand estimates to the end-use level for the residential sector only, due to limitations in available data and lack of adequate analysis methods for the CII sector (end-use disaggregation is not applicable to utility water loss).

3.2.1 Data Sources

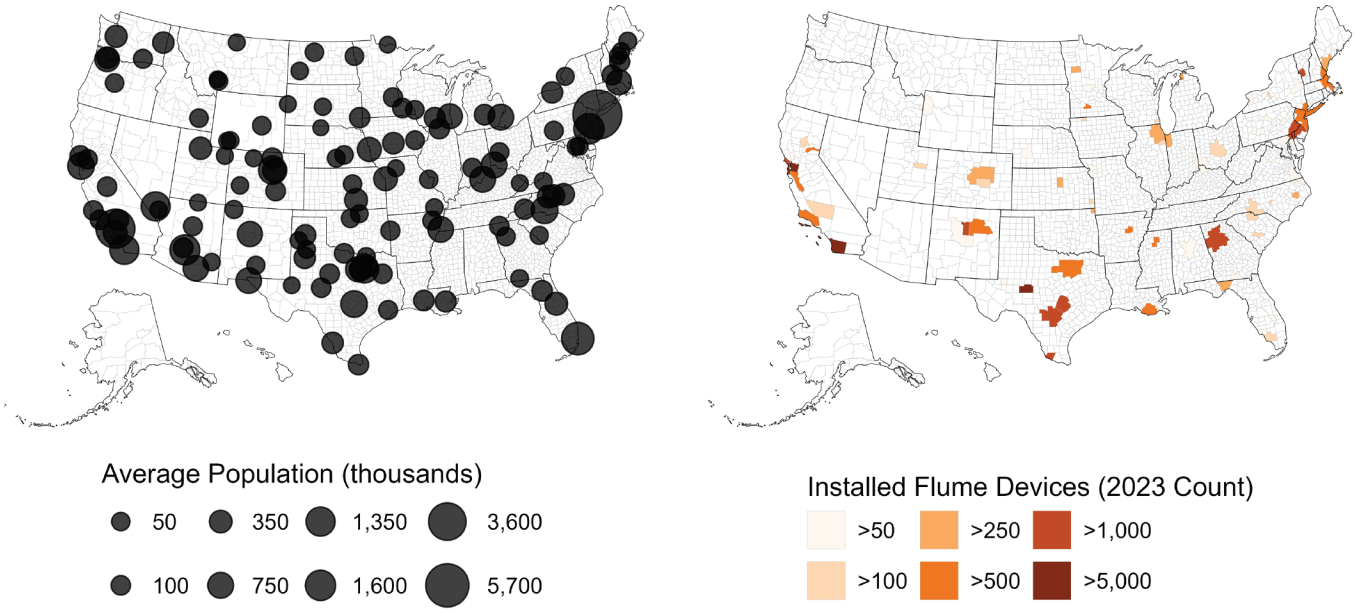
We primarily relied on two sources of data for historical water use: a collection of monthly water utility records of billed consumption volume for over 100 water utilities from 2005 through 2017 (Chinnasamy et al. 2021) and a sample of monthly water demand data for Flume, Inc., customers spanning 20 U.S. Census Core-Based Statistical Areas (CBSAs) for calendar years 2022 and 2023 (Flume Data Labs 2024). For the remainder of this report, we refer to the dataset developed by Chinnasamy et al. (2021) as the "Billing Dataset" and the dataset provided by Flume, Inc., (2024) as the "Flume Dataset." Figure 3 shows the locations of the water utilities represented in the Billing Dataset (left) and the CBSAs represented by the Flume Dataset (right). A complete listing of all variables used in the analysis is provided for the Billing Dataset, Flume Dataset, and additional datasets in Appendix B. These data sources were used to develop current-day water demand estimates for the residential and CII sectors.

For utility water loss, we collected publicly available utility-level water-loss-audit data reported to state agencies using the framework provided in the American Water Works Association's (AWWA) Water Audit Software tool (AWWA 2020). This software provides guidance and tools for water utilities to systematically collect utility water-loss-related data on an annual basis for reporting, benchmarking, and performance goal-setting purposes. For the remainder of this report, we refer to this dataset as the "Water Loss Dataset." The Water Loss Dataset represents water loss audit data for 4,213 utilities across 15 states (Figure A12 in Appendix B).[4] In general, water systems in states that require water loss reporting via water audit (California, Texas, Tennessee, and Georgia) were disproportionately represented compared to other states. For each water audit, we collected system characteristics (i.e., served population, number of connections, miles of distribution system pipe, and average operating pressure) and leakage volume estimates, and converted volumetric leakage (where available) and/or per-connection leakage values to per capita leakage. We discuss the approach used to develop leakage estimates for states not represented in the Water Loss Dataset in more detail in and Appendix B.

3 For this analysis, "current-day water demands" are defined as the average of water demand for calendar years 2022 and 2023.

4 The states represented in the Water Loss Dataset (in alphabetical order) are Arizona, California, Georgia, Connecticut, Delaware, Florida, Indiana, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island, Tennessee, Texas, and Wisconsin.

FIGURE 3. Locations of CBSAs Represented in the Flume Dataset



Note: Locations of water utilities are represented in the Billing Dataset, symbolized by served population (left) and number of installed Flume devices (right).

3.2.2 Seasonality and Per Capita Demand Trend Analysis

For this analysis, we assumed that the seasonal component of residential water use is primarily outdoor irrigation, as total indoor water demand is not likely to have a major seasonal component (Polebitski et al. 2010). Using a clustering analysis on the Billing Dataset, we classified each water utility by its average monthly "seasonality pattern" and the magnitude of per capita daily water demand for each month (in gpcd).[5] Clustering analysis provides a method to group observations according to one or more parameters based on a similar average values across observations (Hartigan et al. 1979). In this fashion, each water utility was classified into one of three categories of both seasonality pattern and per capita demand magnitude: low, moderate, or high for both parameters.

For each water utility, we collected the historical monthly values of cooling-degree days (as a single proxy for temperature-related variables) and precipitation in inches during the 30-year period from1990 to 2020, at the scale of U.S. Climate Divisions developed by the National Oceanic and Atmospheric Administration (Vose et al. 2014). These variables are commonly used as explanatory variables in the water demand modeling and forecasting literature and exhibit strong correlation both with both water demand volumes and monthly seasonality (Donkor et al. 2014; House-Peters and Chang 2011; Kenney et al. 2008; Polebitski et al. 2010; Strong et al. 2008).

5 We define "seasonality pattern" as the average proportion of monthly water demand to annual water demand as a 12-month time-series. In this fashion, the sum of monthly seasonality proportions over the 12-month year always equals 1.

We then normalized historical water demand to reflect the 30-year average weather conditions for each water utility, removing the influence of year-to-year weather variations on monthly water demands. We further disaggregated residential water use into indoor and outdoor components based on the seasonality assessment and weather-normalized water demand estimates. Since outdoor irrigation can occur during winter months in some communities, we then performed additional seasonal adjustment for areas where landscapes can endure average winter temperatures, such as in the southern states and the West Coast. Finally, we estimated the time-based trends in the weather-normalized per capita demands as annual percentage changes.[6] The motivations and procedure for the indoor-outdoor disaggregation and seasonal adjustment are discussed in more detail in Appendix A.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3.2.3 Current-Day Water Demand Projections

We extended the weather-normalized record of historical monthly water demands for each sector and cluster through calendar year 2023. To do this, we first estimated the median time-based trend across water utilities within each cluster and applied this cluster-level trend to their constituent water utilities, combined with the 30-year average monthly weather input values, to estimate utility-level current-day monthly per capita demands by sector.

The linear regression model specifications for each parameter (seasonality and per capita demand), including weather-normalization variables, are provided in Appendix A. Each equation was first applied to the Billing Dataset to estimate regression coefficients, then applied to the constructed monthly time series using 30-year average values of input weather variables for calendar years 2018–2023 to project per capita water demands to current day. These per capita demand estimates were then multiplied by current-day estimates of the served population for each water utility to calculate monthly water demands by sector.

We performed additional analyses to further disaggregate residential and CII sector water demands, detailed in Appendix A. For the residential sector, we disaggregated projected total water demands into indoor and outdoor components, and further disaggregated indoor water demands by end-use (i.e., fixtures, appliances, and leaks). We disaggregated CII water demands into 10 subsectors representing the most prevalent CII property/building types identified from literature review of CII

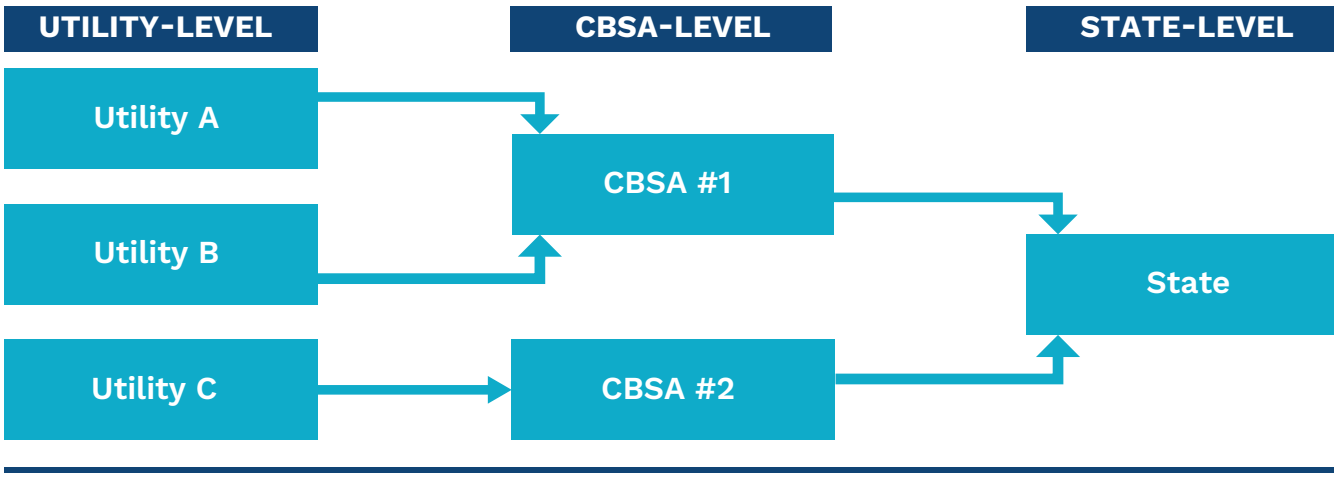
6 These time-based trends can represent the effects passive and active conservation and efficiency improvements made throughout the historical period as well as cultural and behavioral changes to water use.

water efficiency research: accommodation, education, food service, healthcare, industrial, office, places of assembly, retail, warehousing, and other CII properties. We did not perform additional disaggregation for utility water loss beyond the distribution system leakage projections described in this section.

3.2.4 Geospatial Aggregation of Utility-Level Water Demand Estimates

The final step for each of the sectors was to geospatially aggregate utility-level estimates of sector-specific water use metrics (i.e., per capita residential demand, CII water intensity, and per capita distribution system leakage) and calculate average values for the remainder of the U.S. population not represented within the Billing Dataset and Flume Dataset. The aggregation process, illustrated in Figure 4, involved: 1) iteratively calculating the population-weighted average value of each water use metric at the CBSA and then state levels, 2) multiplying this average water use metric by the corresponding input variables (i.e., population or gross conditioned floor area) not included in the previous geographic scale to calculate water demand, and 3) summing the resulting water demand for each geographic area (water utility, CBSA, remaining state area) to the state level.

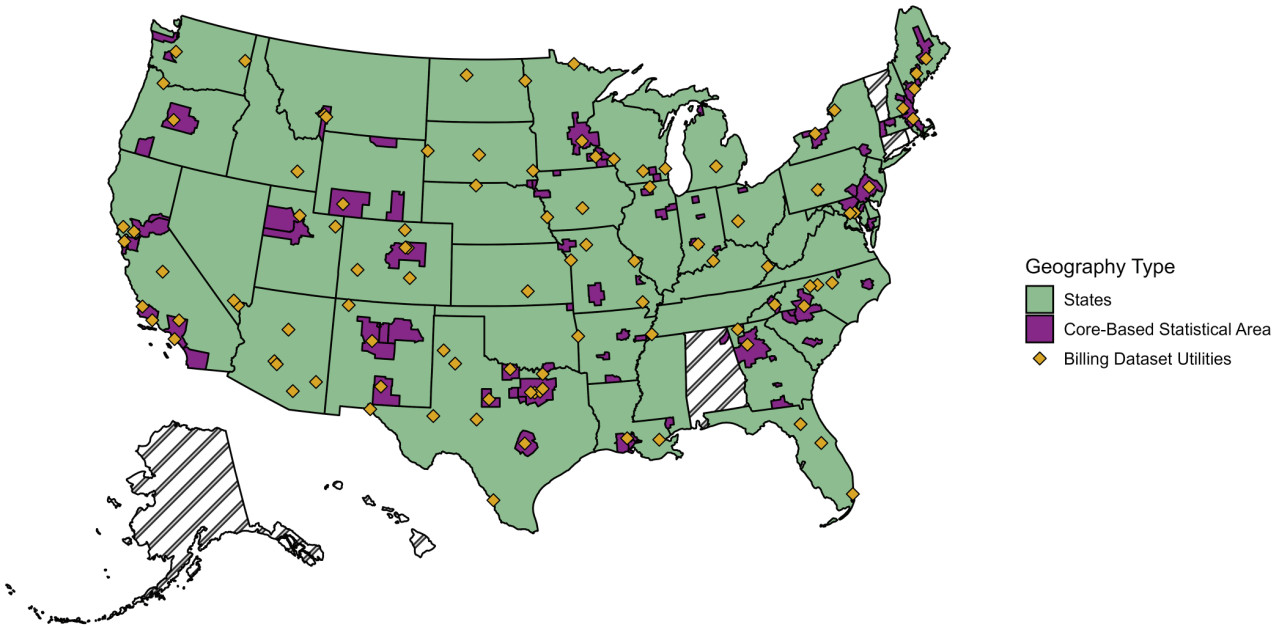
FIGURE 4. Conceptual Diagram of Geospatial Aggregation Process Used to Develop State-Level and National-Level Water Demand Estimates



In this fashion, a CBSA with multiple water utilities would have the average water use metric value multiplied by the population that is not represented by the underlying water utilities and then added to the estimated utility-level water demand to generate a CBSA-level water demand estimate. This process was then repeated at the state level, averaging all CBSAs represented within the state and multiplying this average by the remaining state population, resulting in national-level estimates of current-day water use metrics and demands for all three sectors.[7] In total, the results presented in this study represent water demand estimates for 97 water utilities and 83 CBSAs, in addition to the remaining population within each state (Figure 5).

7 For CBSAs crossing state lines, the population was apportioned by the relative proportion of land area within each state, and this proportion of population was used when calculating population-weighted water use metrics at the state level.

FIGURE 5. Geographic Areas Represented in Current-Day Water Demand and Efficiency Savings Analysis, by Geography Type



Note: Hatched pattern reflects states that are not represented within the Billing and Flume Datasets. For these states, estimated water use metrics reflect the population-weighted average of states within the same U.S. Census Division.

3.2.5 Current-Day Demand Estimates

We estimate that the current-day municipal and industrial water demand across the nation is 57.2 million acre-feet per year (mafy), equivalent to approximately 51.1 billion gallons per day (bgd) or 159 gallons per person per day. When disaggregated by sector, as shown in Table 1, we estimate 25.0 mafy (22.3 bgd) for the residential sector, 19.4 mafy (17.3 bgd) for the CII sector, and 13.0 mafy (11.6 bgd) for utility water loss.

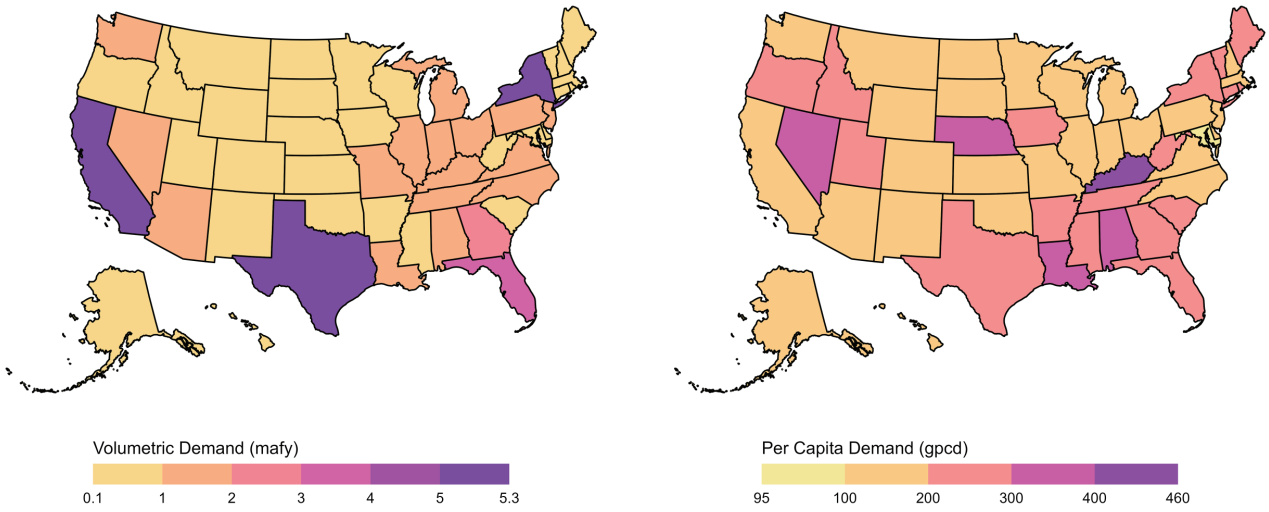
TABLE 1. Current-Day Municipal and Industrial Water Demands, by Water Use Sector

Sector	Volumetric Demand (mafy)	Per Capita Demand (gpcd)	Percentage of Total Municipal and Industrial Demand
Residential	25.0	69.2	43.7
CII	19.4	53.6	33.9
Utility Water Loss	12.8	35.4	22.4
Total	**57.2**	**158**	**100**

State-level estimates of total and per capita current-day demands are illustrated in Figure 6. In general, the largest total demands are found in states with the largest populations, with the five most populous states (California, Florida, New York, Texas, and Pennsylvania) making up 37.2% of

the national population and 36.0% of current-day total demands. However, per capita demands do not show the same correlation with population, and the states with the largest per capita demands (Nevada, Kentucky, Alabama, and Nebraska) have populations ranging from the 15th to the 28th lowest of states. Notably, New York ranks among the largest states in terms of population, total demand, and per capita demand.

FIGURE 6. Current-Day Municipal and Industrial Water Demands as State-Level Volumetric Demand (left) and State-Level Per Capita Demand (right)



For comparison, the United States Geological Survey (USGS) estimated that municipal and industrial water demand in 2015 was approximately 63.2 mafy (176 gpcd) (Dieter et al. 2018), with 43.0 mafy of this total attributed to Public Supply. The most recent estimate (2020) of Public Supply water demand totaled 40.5 mafy, corresponding to an municipal and industrial water demand of 59.5 mafy assuming the same share of municipal and industrial water demand as in 2015.[8] While this is not a complete "apple-to-apples" comparison, the relative similarity in estimates provides a useful benchmark by which to compare changes in water use over the last decade.[9]

3.3 EFFICIENCY POTENTIAL ANALYSIS

Three efficiency scenarios (Basic Efficiency, High Efficiency, and Leading-Edge Efficiency) were developed for each sector. Table 2 provides a general description of each scenario, as well as subsector-level assumptions used to define these scenarios in this assessment.

8 "Municipal and industrial water use" in this study is analogous to the sum of Public Supply, Self-Supplied Domestic, and Self-Supplied Industrial water use categories used by the USGS. The USGS-provided 2020 water demand estimates were not yet available for the Self-Supplied Domestic and Self-Supplied Industrial categories at the time of writing this report. The assumption that Public Supply makes up the same proportion of municipal and industrial water demand in 2015 and 2020 has not been verified and is interpreted only for high-level comparison.

9 The 2015 USGS water demand estimates also represent actual weather conditions for that year, whereas our current-day water demand estimates represent "weather-normalized" water demand for the 2022–2023 reference period (i.e., water demand under average weather conditions).

Efficient indoor residential use was based on the replacement of existing fixtures and appliances that do not currently meet the efficiency performance defined for each scenario with models that meet their respective efficiency performance requirements. Efficient outdoor water use was based on compliance with increasingly aggressive performance benchmarks for landscape efficiency, in terms of supplemental landscape watering needs. CII and utility water loss savings were based on benchmarks of normalized water use metrics developed from existing data in the literature and reported in ENERGYSTAR® Portfolio Manager (for CII) and annual water loss reporting data (for utility water loss).

TABLE 2. General Descriptions and Analysis Assumptions Used to Assess Water Efficiency Potential, by Water Use Sector and Efficiency Scenario

Efficiency Scenario	Basic Efficiency	High Efficiency	Leading-Edge Efficiency
Scenario Description	Reflects Current Federal/ State Standards and/or Common Efficiency Performance	Reflects Improved Efficiency Performance	Reflects Leading Efficiency Performance
Residential Indoor	Current Federal/ State Standards	Average WaterSense/ ENERGYSTAR labeled device performance	Most efficient WaterSense/ ENERGYSTAR labeled device performance
Residential Outdoor	Eliminate overirrigation of existing landscapes	Water use equivalent to landscape with medium-water-use plants and efficient irrigation	Water use equivalent to landscape low-water-use plants and efficient irrigation
Commercial, Industrial, and Institutional	75th percentile of reported efficiency performance	Median reported efficiency performance	25th percentile reported efficiency performance
Utility-Side Water Loss	75th percentile of reported efficiency performance	Median reported efficiency performance	25th percentile reported efficiency performance

3.3.1 Residential Sector

3.3.1.1 Indoor

For the residential sector, we developed estimates of both indoor and outdoor water savings potential. Residential indoor water savings were calculated as the difference between current-day water use and water use if all households were equipped with more efficient appliances and fixtures (Table 3). The Basic Efficiency Scenario assumes all household appliances and fixtures meet current federal standards (originally enacted in 1992 for fixtures, with additional revisions for appliances summarized in Appendix A and Appendix C).[10] The High Efficiency Scenario assumes all household appliances and fixtures meet average water use rates for WaterSense or ENERGYSTAR labeled devices. The Leading-Edge Efficiency Scenario assumes all household appliances and fixtures are leading-edge technologies currently on the market, i.e., WaterSense or ENERGYSTAR labeled devices with the lowest water use rates.

10 Nine states currently have fixture standards that are more efficient than current federal standards (Table A7 in Appendix C); for these states, we assumed federal efficiency standards in the Basic Efficiency Scenario to facilitate interpretation of efficiency savings estimates.

We included low-flow leaks, the persistent/recurring household leaks that are distinct from intermittent large-volume leak events, as part of indoor water use for this study. However these leaks can also occur outdoors in irrigation systems, pools, and water features (DeOreo et al. 2016). Since there are no state or federal efficiency standards for low-flow leaks, we defined efficiency scenario leakage flow rates as the median, 25th percentile, and 5th percentile values estimated from the Flume Dataset for the Basic, High Efficiency, and Leading-Edge Efficiency Scenarios, respectively. A further exploration of the approach and input data used for this analysis is also provided in Appendix A and Appendix B.

TABLE 3. Residential Indoor Fixture and Appliance Performance Values Used for Efficiency Scenarios

Fixture	Performance Units	Efficiency Scenario Performance		
		Basic Efficiency (Current Federal Standard Performance)	**High Efficiency** (Average WaterSense/ ENERGYSTAR labeled device performance)	**Leading-Edge Efficiency** (Minimum WaterSense/ ENERGYSTAR labeled device performance)
Clothes Washers	Gallons Per Cycle	25.0	16.7	13.8
Dishwashers	Gallons Per Cycle	4.93	3.30	2.90
Faucets	Gallons Per Minute	2.20	1.50	0.80
Showerheads	Gallons Per Minute	2.50	2.00	1.00
Toilets	Gallons Per Flush	1.60	1.28	0.790
Low-Flow Leaks	Gallons Per Day	11.0	9.58	8.30

Note: All assumptions used to convert average and minimum integrated water factor to gallon-per-cycle performance for ENERGYSTAR labeled clothes washers and dishwashers are provided in Appendix B.

One consideration for interpreting the findings in this study is the role of behavior in end-use water demands, specifically the relationship between fixture and appliance-use rates (e.g., flushes per day, clothes-washer cycles per day) and end-use performance (e.g., gallons per flush, gallons per wash cycle). While the fixture- and appliance- use rates in this analysis were informed by the Flume Dataset, the broader population might exhibit greater variability in how often and/or how long they use these end-uses within their homes. We assume no changes to user behavior when estimating efficiency savings for this analysis and therefore investigate only the role of fixture and appliance performance in our estimates. While these estimates are appropriate for the national scale of analysis used in this study, individual water utilities could collect more granular use data for their service area to determine localized estimates of fixture-level water demands.

3.3.1.2 Outdoor

For outdoor residential water use, we used a performance-based approach to define the three efficiency scenarios. Strategies for improving outdoor water efficiency vary widely depending on geographic location and climate, water use behaviors, and irrigation technologies. The performance-based approach provides a systematic way to estimate water savings while allowing flexibility in which strategies are employed.

We represented efficiency savings via reductions in the ET Adjustment Factor (ETAF), a dimensionless metric that compares the level of outdoor water use to the supplemental water needs of a landscape while accounting for variations in landscape plant factors, irrigation system efficiency, and net evapotranspiration (Pittenger et al. 2013). Table 4 provides the ETAF values used for each efficiency scenario, as well as representative landscape characteristics that would achieve these values (each scenario allows for other combinations of landscape characteristics beyond the representative landscape provided). Example imagery of these representative landscapes is also provided in Figure 7 as a visual reference.

Outdoor efficiency savings were driven by changes in landscape characteristics and user behaviors (i.e., landscape plant selection, irrigation system efficiency, and behavioral/ cultural factors such as frequency and aesthetic preferences) in relation to the local climate and weather conditions (i.e., precipitation and evapotranspiration) for a household. For each efficiency scenario, we selected ETAF values based on existing landscapes that are achievable today (Table 4).

Strategies for improving outdoor water efficiency vary widely depending on geographic location and climate, water use behaviors, and irrigation technologies.

This approach is relatively agnostic to the specific technologies and plant selections for a landscape and allows for multiple pathways to achieve the desired efficiency improvement. For example, while we use the nomenclature of “low-”, “medium-”, and “high-water-use” plants in this report, we do not prescribe plant selection choices as part of our analysis. In theory, a landscape with climate- and/or regionally appropriate plantings would not require any supplemental watering, except during establishment and extended drought periods and could therefore be implemented as a strategy to achieve ETAF values that are equivalent to one of the defined efficiency scenarios.

The Basic Efficiency Scenario represents the supplemental watering needs for typical turf-grass lawn, with savings potential driven by eliminating any outdoor watering beyond what is needed by the landscape (i.e., overirrigation). Overirrigation can reflect a mismatch between the species of planted turf and species appropriate for the region (i.e., a cool-season turf landscape in a warm-

season turf region) or irrigation behaviors that rely on predefined watering schedules for irrigation systems and/or aesthetic preferences that do not account for actual weather conditions. The High Efficiency and Leading-Edge Efficiency Scenarios therefore represent additional efficiency improvements beyond removing the "surplus" water demand, driven by changes to at least one of the major drivers of outdoor water demands: landscape characteristics, irrigation system efficiency, and behavioral/cultural influences.

TABLE 4. ET Adjustment Factors Used for Residential Outdoor Efficiency Savings Analysis, With Representative Landscape Characteristics Provided for Reference

Efficiency Scenario	Representative Landscape Description*	Plant Factor**	Distribution Uniformity (%)	ET Adjustment Factor	
				Warm-Season Turf Regions	Cool-Season Turf Regions
Basic Efficiency	Turf-Grass Lawn, Amply Watered, Spray Irrigation	0.6 / 0.8	0.7	0.857	01.14
High Efficiency	Medium-Water-Use Plants, Adequately Watered, Spray Irrigation	0.4	0.7	0.571	0.762
Leading-Edge Efficiency	Low-Water-Use Plants, Amply Watered Drip Irrigation	0.3	0.9	0.3	0.444

Notes: * Representative landscape characteristics provide one example of a landscape with the associated ETAF value, but other combinations of landscape characteristics can be used to achieve the same desired ETAF.
** Basic Efficiency Scenario values represent warm-season and cool-season turf regions, respectively.

FIGURE 7. Representative Landscapes for Residential Outdoor Efficiency Scenarios

Current-Day and Basic Efficiency Scenario: Turf-Grass Lawn with Spray Irrigation (Assuming No Surplus Supplemental Watering in Basic Efficiency Scenario)

High Efficiency Scenario: Medium-Water-Use Plants (Mix of Turfgrass and Native Plants), Adequately Watered with Drip Irrigation

Leading-Edge Efficiency Scenario: Low-Water-Use Plants (Minimal Turf, Mix of Native Plantings and Sheet Mulching With Trees and Shrubs), Adequately Watered with Spray Irrigation

For this analysis, we assume that all water use occurring outdoors is attributable to irrigation. However, outdoor water use can also encompass non-irrigation water uses such as pools, water features (e.g., fountains), irrigation system leaks, and car washing. We could not find comprehensive data to characterize the extent of non-irrigation water use, though the 2020 Residential Energy Consumption Survey administered by the U.S. Energy Information Administration suggests that less than 7% of residential homes include pools (U.S. EIA 2024b). This assumption may have the effect of inflating the current-day ETAF and therefore could slightly overestimate outdoor efficiency potential for the relatively small number of households where non-irrigation outdoor water uses occur.

3.3.2 Commercial, Industrial, and Institutional Sector

There are many ways that the CII sector can reduce water use, reflecting the diversity of ways in which water is used in and around CII buildings. Some efficiency measures are similar to those found within the residential sector, such as installing efficient toilets and faucets, while others are customized for specific uses of water that are unique to different subsectors. However, data on water uses and potential water savings for the CII sector is currently limited.

For this analysis, we used a performance-based approach, with efficiency savings driven by increasing reductions in the subsector-level current-day water intensity. In general, efficiency scenario water intensities were selected based on the 75th percentile, median, and 25th percentile values of CII properties reported in the ENERGYSTAR Portfolio Manager Tool, for the Basic Efficiency, High Efficiency, and Leading-Edge Efficiency Scenarios, respectively. In cases where subsector-level water intensities were not found in the Portfolio Manager dataset, we instead used the same summary statistics for literature-derived water intensity estimates.[11] For each scenario, water intensity reductions were only applied to geographies with current-day water intensity values higher than their corresponding efficiency scenario water intensity value.

3.3.3 Utility Water Loss

According to a nationwide assessment conducted by AWE and the Natural Resources Defense Council, 24 states have no requirements for water utilities to report or manage their utility water loss (Burke et al. 2022; Natural Resources Defense Council 2020). This finding suggests a significant potential for efficiency improvements in utility water loss across the United States and highlights the need for a comprehensive analysis to quantify this potential. Strategies to manage the distribution system leakage component utility water loss can range from reactive approaches, such as responding to and repairing reported main breaks and leaks, to proactive approaches, such as active pressure management, routine leak detection and infrastructure inspection, and dedicated infrastructure renewal and asset management programs that aim to repair or replace infrastructure components at high-risk of failure (Figure 8). However, proactive approaches are less common than reactive approaches across water utilities, with just under half of utilities surveyed by the Government Accountability Office in 2016 reporting the use of leak detection technologies as part of a routine inspection and repair program (U.S. GAO 2016). This response rate suggests that the prevalence of more advanced proactive approaches is even lower.

11 Literature-derived water intensities were applied to the Food Service, Industrial, and Places of Assembly subsectors for efficiency scenarios.

FIGURE 8. Examples of Utility Water Loss Management and Leak Reduction Strategies

Leak Response | **Leak Detection** | **Regular Inspection** | **Pressure Monitoring** | **Pressure Management** | **Asset Management**

We used a performance-based approach to estimate the efficiency savings potential for utility water loss, via the Infrastructure Leakage Index (ILI) metric. The ILI is a useful metric for comparing the distribution system leakage — defined as the physical volume of water that enters the distribution system but is lost to leaks and main breaks before reaching customers — across water systems while accounting for differences in system size and characteristics. An ILI value of 1.0 indicates that current leakage volume equals the "unavoidable" real losses, the minimum leakage expected for a distribution system based on its characteristics, meaning the system is operating at maximum efficiency.

However, achieving maximum efficiency is seldom possible. A more realistic benchmark is the economic level of leakage — the point at which the costs of water loss control are balanced by the savings from avoided water loss. While estimating the economic level of leakage is outside the scope of this study, water utilities can conduct such analyses using their own cost data to determine economically efficient water loss management levels. This is an important, though insufficient on its own, step in setting performance goals for efficiency.

To determine efficiency scenario ILI values, we relied on the subset of the Water Loss Dataset with complete observed data for each of the variables needed to calculate ILI: length of water mains, number of service connections, operating pressure, and leakage volume. We applied the 75th percentile, median, and 25th percentile of ILI values from this dataset as the Basic Efficiency, High Efficiency, and Leading-Edge Efficiency Scenarios, respectively (Table 5). For each scenario, we estimated resulting leakage volumes assuming no change in the volume of "unavoidable" real losses or in operating pressure. Efficiency savings potential was calculated as the difference between current-day and scenario leakage volumes.

TABLE 5. Infrastructure Leakage Index Values Used for Efficiency Scenarios, Derived From Observed Data Subset of Water Loss Dataset

Efficiency Scenario	Infrastructure Leakage Index
Basic Efficiency	4.30
High Efficiency	2.60
Leading-Edge Efficiency	1.60

3.3.4 Limitations and Additional Considerations

The analysis methods described in this section rely on several key assumptions that readers should keep in mind when interpreting the estimates of water efficiency potential presented later in this report. First, state-level estimates of per capita current-day demands and efficiency savings — and therefore volume — represent population-weighted averages of observed data from individual communities represented in the Billing, Flume, and Water Loss datasets. The per capita demands and savings for communities within each state likely form a distribution of values that fall above or below their corresponding efficiency scenario values. In cases where state-level current-day demands are more efficient than corresponding efficiency scenario demands, our analysis indicates zero savings as a conservative estimate, though some efficiency potential likely still exists within individual households, businesses, and water distribution systems at the community level. Similarly, community-level efficiency potential will fluctuate around the state-level mean, with some communities having zero efficiency potential and others having greater-than-average potential. Future research efforts should incorporate additional data from water utilities not represented in the Billing, Flume, and Water Loss datasets to better contextualize the variability of efficiency potential for communities within each state.

The residential sector component of the analysis is supplemented by end-use level data for daily use frequency and duration for household fixtures and appliances represented in the Flume Dataset. We assume no change to these behavioral components of indoor water use across all three efficiency scenarios, thereby providing a conservative estimate of efficiency potential. In some cases, fixture use durations for faucets and showerheads can include flow-based uses (e.g., hand washing and showering) and volume-based uses (e.g., filling sink or bathtub basins and cooking pots). For the latter, improved fixture efficiency does not provide water savings. Therefore, our estimates reflect the implicit assumption that savings for faucets come solely from flow-based uses.

For residential outdoor water use, we assume that existing landscapes are predominantly comprised of turf lawns to estimate current-day ETAF values that determine excess supplemental water demand in the Basic Efficiency Scenario. While non-turf lawn landscapes currently exist in communities across the country, their relative proportion is captured in the average ETAF value for each geographic scale represented in our analysis (i.e., water utility, CBSA, and state). Therefore, this assumption simplifies our analysis without overestimating the efficiency potential from reducing current-day ETAF, as savings are generated only by households with higher current-day ETAF values than their corresponding efficiency scenario value, following the same rationale used for state-level savings estimates described earlier in this section.

While a turf lawn landscape could be a counterintuitive representation for the Leading-Edge Efficiency Scenario, the performance-based analysis approach could feasibly result in efficient turf lawn landscapes that feature a combination of reduced landscape area, improved irrigation efficiency, and adjustments to aesthetic preferences — yielding supplemental watering needs equivalent to those of a landscape featuring only low-water-use plants in place of turf. Moreover, our estimates represent the potential water savings in 30-year average weather conditions and therefore do not reflect abnormally wet or dry weather conditions or multi-year climate deviations from historical averages. In these cases, water savings will likely differ due to changes in both outdoor water use behavior and supplemental irrigation needs.

In the CII sector analysis, our estimates of current-day demand do not account for the inherent variability of production/sales and customer traffic that can drive water demand, due to lack of available data for these inputs. For businesses with especially high production or traffic that have enacted aggressive water efficiency improvements, water intensity could still be much higher than the subsector-level estimate, highlighting the difficulty in characterizing CII water efficiency performance with any single metric. Therefore, our estimates efficiency potential assume similar levels of these inputs for all properties within a subsector, as a simplifying assumption to develop preliminary estimates that must be further refined with both supplemental analysis at smaller geographic scales and additional subsector-level metrics of normalized water use (e.g., gallons per customer per year, gallons per production/sales volume per year) that more accurately reflect CII water efficiency performance for each subsector. While our results are most meaningful for subsectors that exhibit a strong correlation between water demand and gross floor area, they can also provide insight into subsectors where these additional normalized metrics provide are more appropriate than — or complement — floor area-based water intensity.

The utility water loss analysis heavily relies on reported water loss audit data from 15 states represented in the Water Loss dataset, primarily located in the southern and eastern United States (Figure A12 in Appendix A). Therefore, estimates for states in U.S. Census Divisions and Regions not found in the Water Loss dataset reflect national averages of per capita current-day utility water loss demands and efficiency potential. Moreover, the Water Loss Dataset contains self-reported data, which rely on the accuracy of each utility's flow-monitoring equipment and billing datasets and can vary in reliability. Inaccuracies in the underlying data can cascade into errors in calculated metrics and water demand and savings estimates. Future research efforts should prioritize additional data collection within unrepresented states to refine our estimates for improved accuracy and to validate or refute the broader spatial trends identified in this report.

4. Water Efficiency Potential

In this section, we present the results of our analysis of the water efficiency potential in the United States for each of the three efficiency scenarios evaluated. First, we present national water savings estimates for municipal and industrial water use, followed by estimates for each major water use sector: residential, CII, and utility water loss. We then provide estimates of state and regional water savings and discuss major trends and implications for regional, state, and local decision-makers. The full state-level results are provided in Appendix D.

4.1 NATIONAL WATER EFFICIENCY POTENTIAL

Water efficiency has provided significant water savings in communities across the country. Still, we find that widely available technologies and practices can provide additional water savings across the United States. We estimate that total water savings in the Basic Efficiency Scenario, across all sectors, are 14.0 mafy (12.5 bgd), representing a 24.6% reduction from current-day water demand. This represents the total savings if all homes are equipped with appliances and fixtures that meet current federal standards; all homes stop overirrigating existing landscapes; all CII properties have nominally efficient (i.e., 75th percentile) performance compared to similar properties; and all water utilities reduce leakage to the performance level of nominally efficient (i.e., 75th percentile) water utilities.

Additional water savings are possible with readily available technologies and strategies. We estimate total water savings of 23.5 mafy (21.0 bgd), a 41.1% reduction in the High Efficiency Scenario. This estimate represents the total savings if all homes are equipped with minimum-performance WaterSense and ENERGYSTAR labeled devices; landscapes have regionally appropriate, medium-water-use plants and efficient irrigation systems; CII properties are moderately efficient (i.e., median water intensity) compared to similar properties; and water utilities reduce distribution system leakage to the median (i.e., the 50th percentile) loss performance.

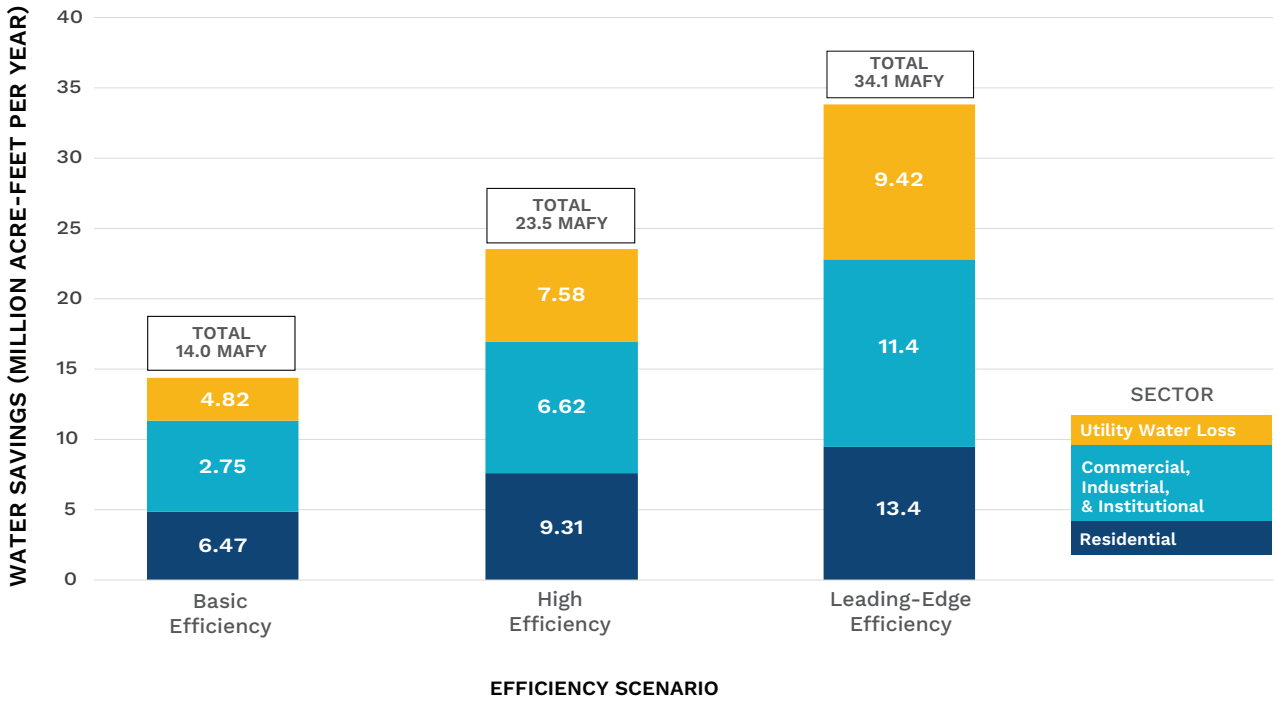
In the Leading-Edge Efficiency Scenario, savings are 34.1 mafy (30.4 bgd), a 59.7% reduction. This represents total savings if all homes are equipped with the most efficient WaterSense and ENERGYSTAR labeled devices available; landscapes have regionally appropriate, low-water-use plants and efficient irrigation systems; all CII properties have a water intensity equivalent to the top 25th percentile of similar properties; and water utilities reduce distribution system leakage to the performance level of the top 25th percentile of utilities.

Significant savings are possible in all sectors. We find that the residential sector offers the greatest potential water savings across all three scenarios (Figure 9). Utility water loss offers greater water savings than the CII sector in the Basic Efficiency and High Efficiency Scenarios, though these rankings invert in the Leading-Edge Efficiency Scenario.

As a percent of current-day water demand, we see the largest percentage reduction for utility water loss across all three efficiency scenarios. Conversely, the CII sector produces the smallest percentage reduction from current-day demand in the Basic Efficiency and High Efficiency Scenarios, and the residential sector sees the smallest percentage reduction in the Leading-Edge Efficiency Scenario.

These trends in current-day demand reduction are consistent with how water efficiency improvements have historically emphasized action for the residential sector, with less emphasis on the CII sector and utility water loss, as a broad trend. Despite producing the largest water savings across all three scenarios, the progress already made in the residential sector leaves less room for additional water efficiency improvements. The Basic Efficiency Scenario highlights the remaining efficiency potential from excessive water use via inefficient fixtures and appliances and overirrigation of existing landscapes. The High Efficiency and Leading-Edge Efficiency scenarios reflect the savings that can be achieved from more aggressive water efficiency improvements, potentially due to more advances in technologies and strategies for water efficiency in the residential sector compared with the CII sector and utility water loss.

FIGURE 9. Municipal and Industrial Efficiency Potential as National Water Savings, by Efficiency Scenario and Sector



4.1.1 Residential Sector

Significant efficiency potential remains in the residential sector, both inside and outside the home. We estimate that residential efficiency potential in the Basic Efficiency Scenario is 6.47 mafy (5.71 bgd), representing a 25.5% reduction from current-day water demand. The savings increase to 9.31 mafy (8.23 bgd), a 37.2% reduction, in the High Efficiency Scenario, and to 13.4 mafy (11.8 bgd), a 53.4% reduction, in the Leading-Edge Efficiency Scenario (Table 6).

We estimate that current-day indoor demands are roughly 20% higher than outdoor demands, and the outdoor efficiency potential is roughly 10% higher than indoors in the Basic Efficiency Scenario. Since the Basic Efficiency Scenario focuses on stopping excess water use, this disparity makes sense, as indoor efficiency efforts have a longer history and are supported by federal regulations and nationwide programs. However, indoor savings increasingly exceed outdoor savings in the High Efficiency and Leading-Edge Efficiency Scenarios. In other words, there is more room for initial improvement in residential outdoor water use, but larger overall efficiency potential indoors. The size of savings opportunities in both settings points to the need for both new and sustained efforts to drive further residential water efficiency across the entire household.

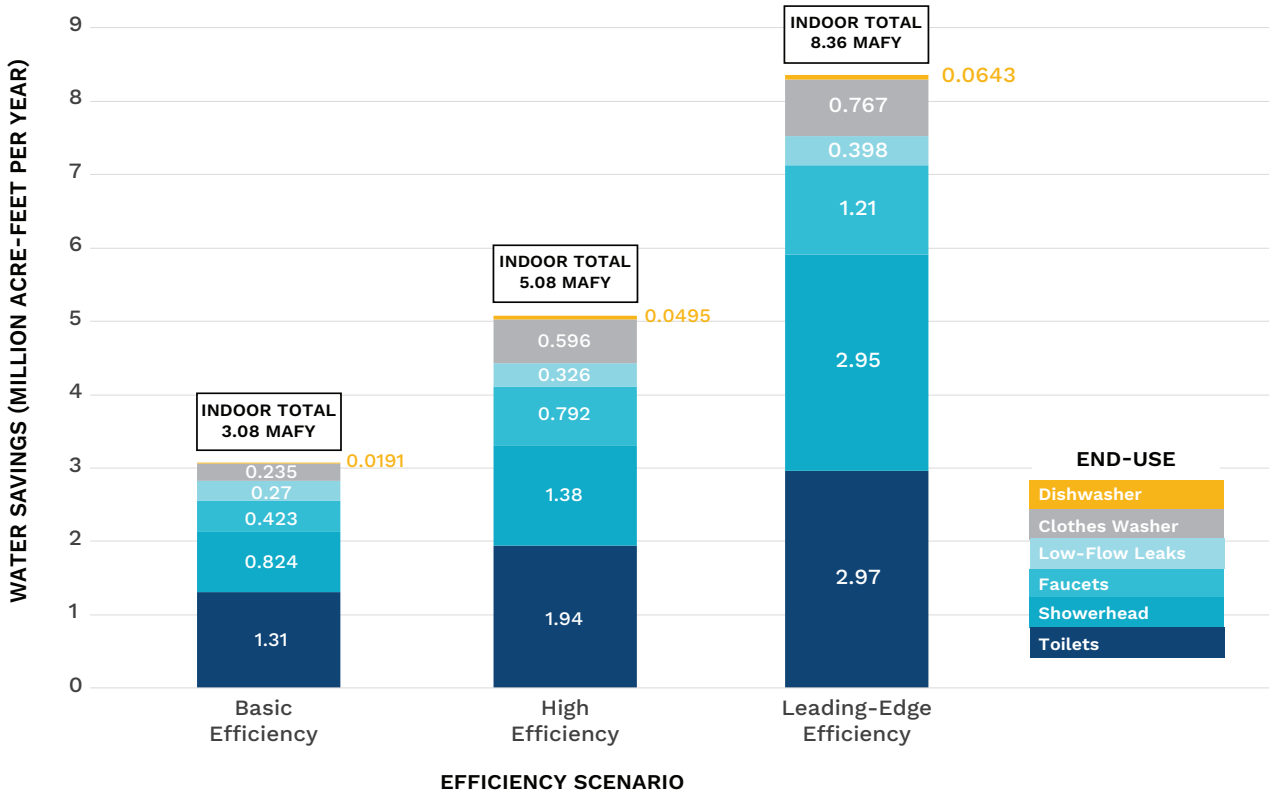
TABLE 6. Residential Efficiency Potential as National Water Savings, by Water Use Setting

	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
	Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
Indoor	13.8	3.08	22.3	5.08	36.8	8.36	60.5
Outdoor	11.2	3.39	30.3	4.23	37.7	5.00	44.6
Total	**25.0**	**6.47**	**25.9**	**9.31**	**37.2**	**13.4**	**53.4**

4.1.1.1 Indoor

There are significant opportunities for saving water inside homes through the adoption of more efficient fixtures and appliances. Across all efficiency scenarios, showerheads and toilets provide the largest water savings by a significant margin, followed by faucets, low-flow leaks, and clothes washers (Figure 10). In contrast, we find that dishwashers have a much smaller efficiency potential (though still non-zero) in each scenario, which could suggest that opportunities for savings exist among a relatively small number of households for this end-use. The share of total indoor savings for each end-use roughly aligns with their corresponding share of current-day total water demand: showerheads and toilets each represent roughly one-third of indoor demand, while faucets, clothes washers, and low-flow leaks each represent about one-tenth (Figure A16 in Appendix D). Therefore, though the savings for showerheads and toilets are vast, the efficiency potential across all end-uses is in proportion with expectations.

FIGURE 10. Residential Indoor Efficiency Potential as National Water Savings, by End-Use and Efficiency Scenario



The savings identified in the Basic Efficiency Scenario represent households with fixtures and appliances that most likely, on average, do not meet current federal standards.[12] The Leading-Edge Efficiency Scenario provides the largest increase in water savings between successive efficiency scenarios (3.28 mafy/2.93 bgd increase from High Efficiency Scenario savings). The resulting national average per capita water demand in this scenario is approximately 14.8 gallons per capita per day, only slightly higher than the approximately 13 gallons per capita per day goal set by the 50-Liter Home Coalition.[13]

While an ambitious target, our findings indicate that this goal is within reach. In fact, in a recent pilot of 31 residential homes in Los Angeles, the 50-Liter Home Coalition found average indoor water demand decreased from approximately 29 to 23 gallons per capita per day after retrofitting these homes with high-efficiency appliances and fixtures, as well as consumer products designed to improve dishwasher and clothes washer efficiency (50L Home Coalition 2024; Brow 2025). Further improvements targeting toilets and low-flow leaks, as well as the adoption of more advanced technologies, could spur further water demand reductions to meet the 14.9 gpcd benchmark estimated in this study.

12 Though an alternative cause could be higher fixture/appliance use frequencies and durations than what is represented in the Flume Dataset, which would still produce savings from more efficient fixtures and appliances.

13 The 50-Liter Home Coalitions is a global-scale collaboration sponsored by the World Business Council for Sustainable Development and the World Economic Forum that envisions a whole-home approach to indoor residential water use efficiency (50L Home Coalition n.d.).

Low-flow leaks, the persistent or recurring household leaks that are distinct from intermittent large-volume leak events, reflect an underrepresented source of water savings in terms of strategies enacted to date. We find that low-flow leaks have the fourth-highest water savings across all three efficiency scenarios, ahead of clothes washers and dishwashers. The largest incremental savings opportunity for low-flow leaks occurs in the Basic Efficiency Scenario, representing the difference between typical households and households that receive real-time notification of leak events enabled by continuous home water use monitoring devices (i.e., household represented in the Flume Dataset). The incremental savings between the Basic Efficiency Scenario and the High Efficiency and Leading-Edge Efficiency Scenarios therefore represent continued improvement in leak response time and effort to stop and fix leaks in a timely manner.

Strategies to address low-flow leaks depend on the source of the leak, which can include defective toilet flappers, unsecured pipe fittings and joints, and leaky irrigation systems and outdoor water features. The most effective strategies to reduce leak volume will likely also require some level of continuous monitoring, potentially through advanced metering infrastructure or consumer products that provide real-time feedback to households. A comprehensive effort to realize low-flow leak savings potential should incorporate these types of devices coupled with real-time notification and water use analytics reporting, to identify leak events and notify households in a timely manner, thereby reducing the time between the start of a leak event and when repairs are implemented.

Due to the unpredictable nature and lack of comprehensive data characterizing large leak events (i.e., leaks with flow rates greater than 100 gallons per household per day) that primarily occur due to pipe breaks, we were unable to account for these savings in our analysis. While a relatively small number of households tend to have large leaks, they can represent up to 30% of the total water lost to leaks in the residential sector (DeOreo et al. 2016), thus representing potentially larger efficiency potential than presented in this study.

4.1.1.2 Outdoor

There is significant water savings potential by reducing unnecessary water waste outside of homes, transforming turf lawns into regionally appropriate landscapes, and adjusting behavioral and cultural practices. In the Basic Efficiency Scenario, which focuses on eliminating overirrigation on existing landscapes, we estimate water savings of 3.40 mafy (3.04 bgd), equivalent to a 30.3% reduction from current-day water demand. These savings stem from outdoor water use beyond the supplemental irrigation needs of existing landscapes (mostly occurring during the winter months).

In comparison, water savings in the High Efficiency and Leading-Edge Efficiency Scenarios are 4.24 mafy (3.79 bgd), a 43.4% reduction, and 5.02 mafy (4.48 bgd), a 49.7% reduction, respectively. The incremental water savings for these scenarios (0.840 mafy between Basic Efficiency and High Efficiency Scenarios, 0.780 mafy between High Efficiency and Leading-Edge Efficiency Scenarios) are both much smaller than for the Basic Efficiency Scenario at the national level. This disparity highlights the magnitude of current levels of overirrigation and provides a clear first step in realizing residential outdoor water efficiency potential.

4.1.2 Commercial, Industrial, and Institutional Sector

There is substantial water savings potential across the entire CII sector. We estimate that the efficiency potential for the CII sector, across all subsectors, is 2.75 mafy (2.46 bgd), representing a 14.2% reduction in current-day water demands in the Basic Efficiency Scenario. Volumetric savings increase to 6.62 mafy (5.91 bgd), a 34.1% reduction, in the High Efficiency Scenario, and 11.4 mafy (10.2 bgd), a 58.6% reduction, in the Leading-Edge Efficiency Scenario (Table 7).

Across all efficiency scenarios, office, food service, and healthcare subsectors have the largest water savings, with the largest occurring in the food service subsector in the Basic Efficiency Scenario, roughly 1.6 times larger than the office subsector (the subsector with the next-largest savings). This trend reverses in the High Efficiency and Leading-Edge Efficiency Scenarios, with office overtaking food service, though with a smaller marginal difference than in the Basic Efficiency Scenario.

These three subsectors, as well as accommodation, are the only subsectors that produce savings in the Basic Efficiency Scenario. The lack of savings for the remaining subsectors indicates that these subsectors already have current-day efficiency performance equal to or better than the 75th percentile of similar CII properties reporting their water demand in ENERGYSTAR's Portfolio Manager tool. While this lack of savings could suggest that water use reporting requirements alone might not be sufficient for driving water efficiency improvements in these subsectors, this notion requires further analysis of facility-level water demand pre- and post-enactment of reporting requirements to better understand their efficacy. Moreover, all subsectors except for education and warehousing produce water savings in the High Efficiency Scenario, and warehousing is the only subsector to produce zero savings across all three efficiency scenarios. These trends could suggest that water use reporting requirements are a necessary, albeit insufficient, step to identify and implement appropriate strategies that realize efficiency potential.

Places of assembly, retail, and warehousing represent the three smallest subsectors across all three scenarios in terms of water savings. The relatively small savings in these subsectors could be driven by more limited efficiency potential than in other subsectors, or by a lack of empirical data for properties that have realized their full efficiency potential. Still, the efficiency potential in terms of percent reduction from current-day demand range for these subsectors exceeds 30%, with warehousing being the only exception. The economic savings from demand reduction in these subsectors can provide the motivation for greater water efficiency, despite the relatively small savings volumes observed. Greater understanding of the feasible extent of water efficiency performance in these subsectors requires additional water use reporting data that could reveal a wider range of efficiency performance than observed in this study.

TABLE 7. CII Efficiency Potential by Subsector

Subsector	Employment (millions)	Gross Floor Area (billion square feet)	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
			Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
Food Service	12.1	7.03	3.48	1.65	47.3	2.17	62.4	2.61	75.0
Office	52.4	26.0	4.08	1.03	25.3	2.29	56.0	3.02	74.1
Healthcare	40.7	23.7	3.39	0.0466	1.38	1.01	29.8	1.90	56.1
Accommodation	2.18	7.06	0.992	0.0253	2.55	0.344	34.7	0.557	56.1
Education	1.45	2.32	0.101	0	0	0	0	0.0162	16.1
Industrial	11.8	18.3	1.55	0	0	0.293	18.9	0.833	53.7
Other	5.45	36.4	2.59	0	0	0.400	15.4	1.37	52.8
Places of Assembly	4.82	9.24	0.807	0	0	0.116	14.4	0.406	50.4
Retail	19.9	31.4	2.07	0	0	0.00031	0.0150	0.645	31.2
Warehousing	13.2	40.7	0.340	0	0	0	0	0	0
CII Total	164	202	19.4	2.75	14.2	6.62	34.1	11.4	58.6

Note: Estimates are provided in descending order of national water savings in the Basic Efficiency Scenario. See Appendix A for a detailed description of the analysis methods used to estimate current-day water intensity and volumetric demands for the CII sector.

In terms of percent reduction from current-day water demand, the food service subsector remains the subsector with the largest efficiency potential across all three efficiency scenarios. The food service and office subsectors are the only subsectors where efficiency potential exceeds the CII sector average (though accommodation savings also exceed the CII sector average in the Leading-Edge Efficiency Scenario). This finding highlights the potential outsized impact of efficiency improvements in these subsectors in driving overall CII water efficiency.

The relatively small demand reductions seen for retail, which also has relatively small water savings across all efficiency scenarios, suggest that efforts to improve efficiency performance might require more innovative strategies and technologies that have not yet been developed or widely implemented (though the same caveat discussed for water savings in these subsectors also applies

here). Since most of the indoor water use in the retail subsector is from domestic water use (i.e., bathrooms), adoption of innovative end-use bathroom fixtures with leading-edge performance can provide the means to realize additional savings beyond those presented in this study (Gleick et al. 2003).

4.1.3 Utility Water Loss

In this study, utility water loss represents the volume of water lost to distribution system leakage before reaching the customer. This sector presents a unique opportunity for water utilities to realize water savings using actions under their direct control, to great effect. We estimate the water savings potential for addressing utility water loss is 4.82 mafy (4.30 bgd), equivalent to a 37.7% reduction from current-day water demand. Water savings increase to 7.58 mafy (6.77 bgd), a 59.3% reduction, and 9.42 mafy (8.41 bgd), a 73.6% reduction, in the High Efficiency and Leading-Edge Efficiency Scenarios, respectively (Table 8). The largest incremental water savings would be realized by focusing on water utilities with the highest levels of distribution system leakage and bringing these water utilities in line with the typical water utility's performance represented in the Water Loss Dataset, as represented by the Basic Efficiency Scenario.

TABLE 8. Utility Water Loss Efficiency Potential as National Water Savings, by Efficiency Scenario

	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
	Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
Volume (mafy)	12.8	4.82	37.7	7.58	59.3	9.42	73.6

4.2 STATE AND REGIONAL WATER EFFICIENCY POTENTIAL

While some states and regions have advanced water efficiency for decades, we identified water efficiency potential across every state. In general, the western half of the United States and the Gulf of Mexico region have the largest relative efficiency potential in terms of water savings for residential outdoor water use. Residential outdoor water use is already a significant component of existing efforts to reduce water use in these states, due to recurring water scarcity challenges and long-term drought, resulting in significant efficiency improvements to date that must be sustained and expanded.

In contrast to western states, opportunities for water savings from improved efficiency in the Midwest and along the East Coast are largest for residential indoor water and utility water loss, with additional opportunities for select states in the CII sector. In several of these states — Delaware, North Dakota, South Dakota, Kansas, New Jersey, Michigan, and the District of Columbia — residential indoor efficiency potential is largely driven by low-flow leaks in the Basic Efficiency Scenario, diverging from the national trend of savings concentrated among showerheads and toilets. Utility water loss also shows high efficiency potential in these regions, with per capita savings strongly concentrated in the Southeast, Gulf of Mexico, and Northeast. These findings can motivate additional investigation and more comprehensive water-loss-audit-data collection to validate or refine this trend and determine the underlying causes.

States with the largest efficiency potential tend to fall into two categories: those with the largest populations and those with the largest current-day per capita water demands.

States with the largest efficiency potential tend to fall into two categories: those with the largest populations and those with the largest current-day per capita water demands (Table 9 and Table 10). The most populous states — New York, Florida, California, and Texas — also have the largest water savings potential (Table 9). Other populous states, including Illinois, Georgia, Ohio, and North Carolina, also offer significant water savings potential. While not nearly as large as the top four states, these states each have a population of more than 10 million people and relatively moderate current-day per capita water demands. Several less populated states — Alabama, Kentucky, Louisiana, Tennessee, Washington, Iowa and South Carolina — also show high savings, due to their high current-day per capita demands.

Together, these 15 states represent between 67.1% to 72.1% of national water efficiency potential across the three efficiency scenarios and make up roughly 60% of the United States' population. Moreover, the percent reduction from current-day demand for these states is larger than the average percent reduction for the other 35 states in the United States. This outsized efficiency potential means that focused efforts in these states could help realize most of the water savings available across the country and generate significant water supply benefits at the state level at the same time.

Some states have the highest potential water savings across all three sectors (Florida, Kentucky, and New York) or two of the three subsectors (Alabama, California, Illinois, Ohio, and Texas), explaining their positions among the states with the largest municipal and industrial efficiency potential. In other states, however, water savings are predominantly driven by a single subsector, specifically the residential sector in Iowa, Louisiana, and Washington; the CII sector in Massachusetts, North Carolina, Tennessee, and Utah; and utility water loss in Georgia, Mississippi, New Jersey, and South Carolina. The efficiency potential for each of these single-sector states could be realized through more focused efforts on the sectors driving those savings.

TABLE 9. Top 15 States with Largest Municipal and Industrial Efficiency Potential by Volume

		Current-Day		Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
State	Population (millions)	Volumetric Demand (mafy)	Per Capita Demand (gpcd)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
New York	19.4	5.23	246	2.48	47.4	3.23	61.6	3.97	75.8
Florida	21.1	3.68	156	1.03	28.1	1.72	46.6	2.42	65.7
California	38.5	5.11	118	0.947	18.5	1.81	35.4	2.84	55.6
Texas	28.6	5.24	162	0.855	16.3	1.92	36.7	2.94	56.1
Alabama	4.89	1.68	287	0.771	45.8	1.02	60.9	1.26	74.7
New Jersey	9.08	1.38	138	0.635	45.9	0.784	56.7	0.997	72.0
Kentucky	4.39	1.71	346	0.558	32.6	0.808	47.2	1.08	63.3
Illinois	12.5	1.95	142	0.508	26.0	0.861	44.0	1.21	62.1
Georgia	10.5	2.22	190	0.447	20.1	0.829	37.3	1.29	58.1
Louisiana	4.52	1.22	234	0.424	34.9	0.620	51.0	0.801	65.9
Ohio	11.5	1.85	148	0.343	18.5	0.636	34.3	1.01	54.7
Tennessee	6.78	1.57	202	0.337	21.5	0.638	40.7	0.994	63.4
Washington	7.54	1.27	150	0.320	25.2	0.554	43.7	0.807	63.5
North Carolina	10.2	1.43	130	0.316	22.1	0.584	40.9	0.889	62.2
Iowa	3.10	0.753	221	0.270	35.8	0.365	48.5	0.472	62.7
South Carolina	5.00	0.877	166	0.270	30.8	0.395	45.0	0.530	60.5
All Other States	129	20.8	161	3.80	0.183	7.11	0.342	11.1	0.534
U.S. Total	**323**	**57.2**	**158**	**14.0**	**24.6**	**23.5**	**41.1**	**34.1**	**59.7**

Note: Estimates are provided in descending order of state level water savings in the Basic Efficiency Scenario.

We observe significant shifts in which states have the largest efficiency potential when examining the percent reduction from current-day demand (Table 10). Both large population and high per capita demand appear to heavily influence the water efficiency potential in New York and New Jersey, suggesting that a wider range of strategies can support efficiency improvements in these states. Conversely, seven of the states with the largest water savings — California, Texas, Georgia, Tennessee, Ohio, North Carolina, and Washington — do not appear among the states with the largest percent reductions. For these states, water savings are likely more influenced by the overall population. Six states — Maine, Mississippi, Alaska, Nebraska, and Hawaii — as well as the District of Columbia show some of the largest percent demand reductions but have some of the lowest water savings. These states require further analysis to better understand the potential drivers of their efficiency potential.

The efficiency potential in states with disproportionately high per capita demands may indicate one or more of the following: a significant proportion of residential fixtures and appliances that do not meet current federal standards (or are used more frequently or for longer durations than expected), residential outdoor water use beyond the optimal supplemental water needs of existing landscapes, and/or higher normalized water use than that of the nominally efficient commercial building (for CII) or water utility (for utility water loss).

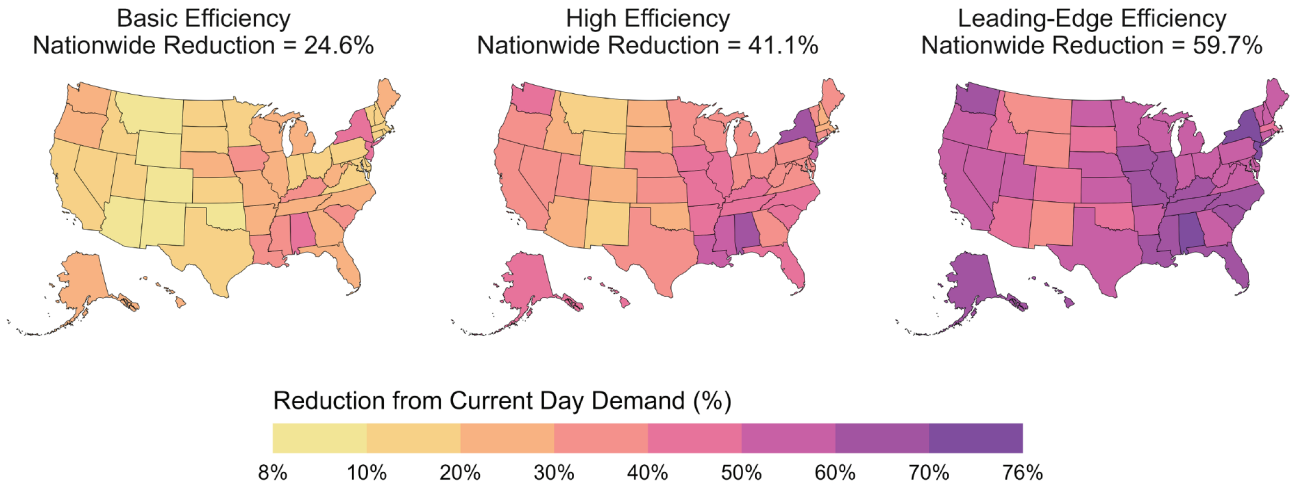
TABLE 10. Top 15 States With Largest Municipal and Industrial Efficiency Potential by Percentage Reduction

		Current-Day		Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
State	Population (millions)	Volumetric Demand (mafy)	Per Capita Demand (gpcd)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
New York	19.4	5.23	246	2.48	47.4	3.23	61.6	3.97	75.8
New Jersey	9.08	1.38	138	0.635	45.9	0.784	56.7	0.997	72.0
Alabama	4.89	1.68	287	0.771	45.8	1.02	60.9	1.26	74.7
Iowa	3.10	0.753	221	0.270	35.8	0.365	48.5	0.472	62.7
Louisiana	4.52	1.22	234	0.424	34.9	0.620	51.0	0.801	65.9
Mississippi	2.86	0.694	209	0.236	34.0	0.348	50.1	0.459	66.2
Kentucky	4.39	1.71	346	0.558	32.6	0.808	47.2	1.08	63.3
South Carolina	5.00	0.877	166	0.270	30.8	0.395	45.0	0.530	60.5
Alaska	0.706	0.123	158	0.0350	28.4	0.0501	40.7	0.0749	60.8
Florida	21.1	3.68	156	1.03	28.1	1.72	46.6	2.42	65.7
Hawaii	1.41	0.251	158	0.0700	27.9	0.117	46.5	0.165	65.8
Illinois	12.5	1.95	142	0.508	26.0	0.861	44.0	1.21	62.1
District of Columbia	0.641	0.0872	121	0.0225	25.8	0.0394	45.2	0.0578	66.3
Washington	7.54	1.27	150	0.320	25.2	0.554	43.7	0.807	63.5
Nebraska	1.91	0.570	278	0.139	24.3	0.220	38.7	0.303	53.3
All Other States	129	20.8	161	3.80	0.183	7.11	0.342	11.1	0.534
U.S. Total	**323**	**57.2**	**158**	**14.0**	**24.6**	**23.5**	**41.1**	**34.1**	**59.7**

Note: Estimates are provided in descending order of state level percent reduction from current-day demand in the Basic Efficiency Scenario savings.

States in the eastern half of the United States, particularly in the Southeast and Midwest regions, have some of the largest efficiency potential, as measured by a percent reduction from current-day demand (Figure 11). These regions have historically been considered "water abundant" and do not face the same water supply constraints as the western half of the country. At the same time, stressors such as increasingly intense and frequent droughts and extreme weather events can challenge their existing water supplies' ability to meet demands and threaten long-term water resilience. In addition to increased water demands from continued population growth, states such as Illinois, Minnesota, New York, Ohio, and Virginia are also seeing increasing economic activity in new highly water-intensive industries, including advanced manufacturing, hydrogen production, and data center cooling (Gardner 2024; Heilweil 2023; Neese et al. 2025; Rydzewski 2024; Walker 2025). If these states are not equipped to face these challenges, heightened efforts to improve water efficiency could provide an additional pathway to support long-term water resilience. We discuss the sector-level drivers of these water savings through the lens of state and regional trends in the following sections of this report.

FIGURE 11. Municipal and Industrial Efficiency Potential as State-Level Percent Reduction from Current-Day Demand



Municipal and industrial water efficiency potential in the United States varies widely across geographic areas and sectors, though there is a general trend toward the greatest water savings in the most populous states. The per capita savings and percent reduction from current-day demand metrics provide additional insight into states with disproportionately high current-day water demands and outsized opportunities for savings compared to their relative populations. While the findings presented in this study provide a high-level summary of efficiency potential that can inform national- and state-level efforts, additional investigation is required to validate or refine these estimates to inform how water utilities, water supply planners, and decision-makers should prioritize efforts and investments to improve water efficiency within their communities.

4.2.1 Residential Sector

The states with the largest residential efficiency potential, in terms of water savings, closely align with the states with the largest municipal and industrial efficiency potential (Table 11) and are largely driven by overall population.[14] The link between population and water savings becomes more distinct with increasing efficiency levels, with the top five positions in Table 11 occupied by the five most populous states — New York, California, Texas, Florida, Texas, and Illinois — in the Leading-Edge Efficiency Scenario.

TABLE 11. Top 15 States with Largest Residential Efficiency Potential

State	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
	Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
New York	2.30	1.34	58.3	1.54	66.9	1.77	76.9
California	3.36	0.706	21.0	1.24	36.8	1.86	55.3
Florida	1.80	0.601	33.4	0.840	46.7	1.15	63.7
Alabama	0.583	0.393	67.4	0.437	75.0	0.491	84.2
Louisiana	0.516	0.258	50.0	0.295	57.2	0.344	66.7
Illinois	0.891	0.257	28.8	0.366	41.1	0.505	56.7
Kentucky	0.539	0.247	45.7	0.284	52.6	0.335	62.1
Washington	0.723	0.244	33.7	0.355	49.1	0.469	64.8
Texas	2.25	0.226	10.0	0.550	24.4	0.969	43.0
Iowa	0.391	0.173	44.3	0.202	51.8	0.237	60.7
North Carolina	0.565	0.162	28.8	0.231	40.9	0.348	61.7
Georgia	0.720	0.150	20.8	0.214	29.7	0.336	46.7
Tennessee	0.491	0.142	28.8	0.222	45.2	0.314	63.9
Nevada	0.645	0.123	19.1	0.188	29.1	0.263	40.8
Oregon	0.503	0.112	22.2	0.152	30.2	0.213	42.3
All Other States	8.74	1.34	0.153	2.20	0.252	3.75	0.430
U.S. Total	**25.0**	**6.47**	**25.9**	**9.31**	**37.2**	**13.4**	**53.4**

Note: Estimates are provided in descending order of state level water savings in the Basic Efficiency Scenario.

The states with municipal and industrial efficiency potential driven largely by the residential sector — Iowa, Louisiana, and Washington — each have among the highest current-day residential per capita demands, driven by either high indoor or outdoor per capita demands (Appendix D). The efficiency potential for Iowa and Louisiana is found indoors, while the bulk of efficiency potential

14 The only exceptions to this trend are Washington and Iowa, which rank eighth and tenth, respectively.

for Washington is generated outdoors.[15] These states can therefore realize most of their residential efficiency potential by prioritizing efforts on the appropriate component of residential water use. Moreover, residential efficiency potential in these states represents the largest source of municipal and industrial water savings across sectors, emphasizing the potential impact of focusing efforts on the residential sector.[16]

Following the national-level findings, residential indoor water savings are highest for either showerheads or toilets in nearly every state and across efficiency scenarios (Table A14 in Appendix D). The only exceptions to this trend occur in the Basic Efficiency Scenario for six states — Delaware, North Dakota, South Dakota, Kansas, New Jersey, and Michigan — and the District of Columbia. Low-flow leaks typically provide the largest source of savings in these states, except in Delaware and New Mexico, where faucets provide the largest savings.

Of the states that have enacted standards that are more efficient than the current federal standard for indoor appliances and fixtures, only Massachusetts has zero efficiency potential in the Basic Efficiency Scenario.[17] This finding is somewhat counterintuitive but potentially could be explained, in part, by higher fixture utilization (e.g., longer average shower or faucet use duration) and a larger prevalence of out-of-date fixtures that have not yet been replaced in the remaining states with more efficient standards than the current federal standard. Efforts to realize the residential indoor efficiency potential in these states require further analysis at the water-utility level to better understand the extent to which these factors exist throughout the state or within select communities.

The residential outdoor efficiency potential, in terms of water savings, somewhat follows the same population-driven geographic trends as seen for municipal and industrial and total residential efficiency potential. However, savings are concentrated among relatively few states, with the 10 largest states, in terms of water savings, making up over 50% of the total efficiency potential (Table 12).

15 Indoor water savings make up 85%–86% and 70%–77% of total state-level residential savings across efficiency scenarios, for Iowa and Louisiana, respectively. Outdoor water savings for Washington make up 73%–95% of total state-level residential savings across efficiency scenarios.

16 Residential water savings make up 50%–55% of municipal and industrial savings for Iowa, 43%–60% of municipal and industrial savings for Louisiana, and 58%–64% of municipal and industrial savings for Washington.

17 The states with more efficient standards than the current federal standards for at least one fixture are: California, Colorado, Georgia, Hawaii, Illinois, Maine, Maryland, Massachusetts, Nevada, New Jersey, New York, Oregon, Rhode Island, Texas, Utah, Vermont, and Washington, as well as the District of Columbia.

TABLE 12. Top 15 States with Largest Residential Outdoor Efficiency Potential

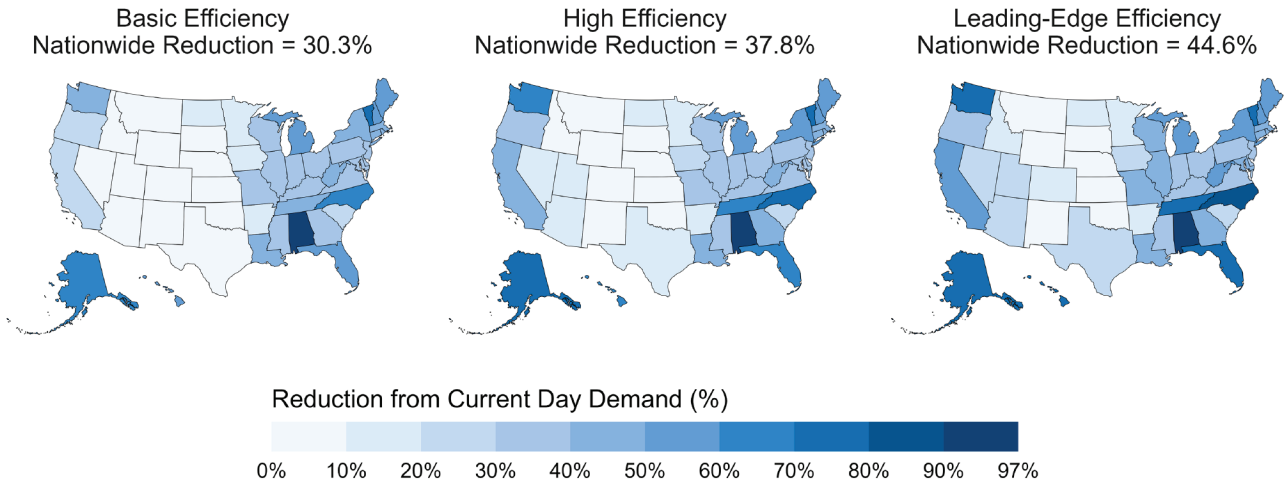
State	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
	Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
Florida	1.01	0.549	54.1	0.658	64.9	0.741	73.0
California	1.86	0.512	27.6	0.766	41.3	1.00	54.0
Washington	0.467	0.230	49.4	0.304	65.1	0.344	73.8
New York	0.500	0.227	45.4	0.268	53.5	0.291	58.2
Alabama	0.230	0.218	94.8	0.222	96.5	0.224	97.4
North Carolina	0.240	0.157	65.6	0.184	76.8	0.198	82.6
Georgia	0.357	0.136	38.2	0.147	41.1	0.159	44.6
Illinois	0.309	0.103	33.5	0.113	36.5	0.125	40.5
Tennessee	0.209	0.102	48.9	0.131	62.8	0.151	72.1
Oregon	0.354	0.101	28.5	0.115	32.5	0.135	38.1
Louisiana	0.170	0.0768	45.2	0.0773	45.6	0.0790	46.5
Kentucky	0.211	0.0723	34.4	0.0780	37.0	0.0830	39.4
Virginia	0.197	0.0691	35.1	0.0703	35.7	0.0740	37.5
Michigan	0.129	0.0689	53.4	0.0690	53.5	0.0691	53.6
Ohio	0.198	0.0664	33.5	0.0664	33.5	0.0664	33.5
All Other States	4.77	0.703	0.147	0.961	0.201	1.26	0.264
U.S. Total	**11.2**	**3.39**	**30.3**	**4.23**	**37.8**	**5.00**	**44.6**

Note: Estimates are provided in descending order of state level water savings in the Basic Efficiency Scenario.

Some states in Table 12 have disproportionately large water savings compared to their population (Table A21 in Appendix D). These states — Alabama, Kentucky, Louisiana, Oregon, and Tennessee — are primarily located in the West Coast and Southeast regions of the United States and are also among the largest states in terms of percent reduction from current-day demand (Figure 12). In these states, the Basic Efficiency Scenario generates the largest additional savings when moving from one scenario to the next most efficient one. This trend indicates that reducing existing overirrigation of landscapes in these states drives most of their efficiency potential, particularly at the beginning and end of the typical irrigation season, where average monthly precipitation exceeds average monthly evapotranspiration and no supplemental watering of landscapes is needed. Alabama sees the largest overall demand reduction across efficiency scenarios, with estimates ranging from 94.8% to 97.4%. This disproportionately large demand reduction suggests that almost all the outdoor water use in the state represents overirrigation of existing landscapes in typical weather conditions. However, this finding does not include periods of drought or unseasonal weather that deviate from historical trends, where additional outdoor water use is needed to preserve or maintain the health of landscape vegetation.

This residential outdoor efficiency potential could either be further concentrated among select communities within each state or across the broader state population. In the former case, the per capita savings for individual communities with relatively high outdoor water demand would be much higher than the state-level and national-level averages presented in this report. State-level efforts to realize this efficiency potential will require further investigation to better characterize the spatial variability in residential outdoor water use. This information would support water utilities and state efforts to prioritize efficiency improvements in these communities in a more cost-effective manner than a statewide effort that would affect communities with little savings potential.

FIGURE 12. Residential Outdoor Efficiency Potential as State-Level Percent Reduction From Current-Day Demand



Another subset of states with high residential outdoor efficiency potential, in terms of percent reduction from current-day demand, is concentrated in the Northeast and Midwest regions of the United States. Much of the savings for these states occurs in autumn and winter, driven by reductions in overirrigation during these months. Though northern states such as New York and Illinois both appear in Table 12 and are not generally associated with wintertime outdoor water use, landscape and irrigation data from the Flume Dataset indicate that some level of outdoor irrigation occurs throughout the year and therefore present an unexpectedly large efficiency potential. The Flume Dataset also identify this year-round watering trend in other northern states including Michigan, Minnesota, New York, Pennsylvania, and Massachusetts. However, it is possible that the bulk of outdoor water used during winter months in these areas occurs only in select communities, rather than a statewide trend. While additional research is needed to verify this phenomenon, these findings point to a clear opportunity to realize the potential of outdoor residential water efficiency across the country.

4.2.2 Commercial, Industrial, and Institutional Sector

Overall, the states with the largest water savings span the United States and do not follow any clear spatial trends. However, they show some correlation with gross floor area, with several exceptions (Table 13). In the states with both the largest water savings and the largest gross floor area — Texas, Florida, California, New York, Georgia, North Carolina, Ohio, and Illinois — efficiency potential is more likely due to the overall scale of CII water use being driven by the economic activity within each state, as opposed to being driven by especially high values of water intensity for individual subsectors.

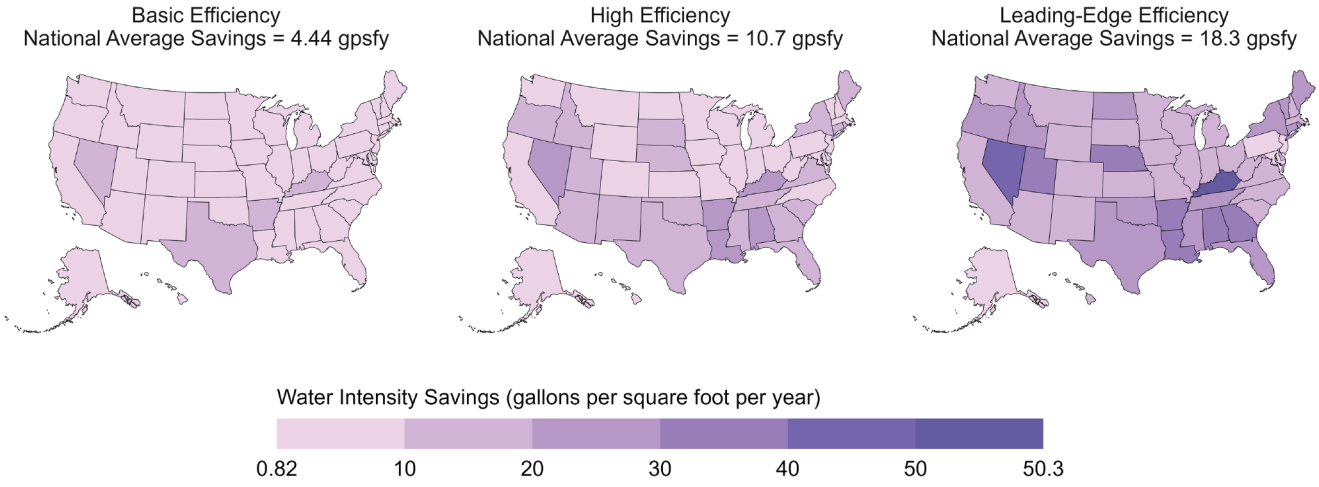
TABLE 13. Top 15 States with Largest CII Efficiency Potential

State	Employment (millions)	Gross Floor Area (billion square feet)	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
			Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
Texas	13.9	15.1	1.73	0.472	27.2	0.806	46.5	1.14	65.6
Florida	10.4	10.8	1.27	0.234	18.4	0.543	42.7	0.839	65.9
California	19.1	26.4	1.34	0.213	15.9	0.518	38.6	0.857	63.9
New York	11.0	11.8	1.45	0.204	14.1	0.534	36.9	0.918	63.4
Georgia	4.90	5.63	1.02	0.116	11.3	0.341	33.3	0.609	59.4
Nevada	1.41	2.46	0.503	0.104	20.7	0.211	41.9	0.322	64.0
Kentucky	2.11	2.50	0.733	0.0778	10.6	0.209	28.5	0.385	52.6
Louisiana	2.17	2.47	0.406	0.0711	17.5	0.152	37.3	0.237	58.4
Alabama	2.18	2.45	0.513	0.0685	13.3	0.169	33.0	0.282	55.0
North Carolina	4.83	5.51	0.506	0.0669	13.2	0.160	31.5	0.284	56.1
Utah	1.57	2.61	0.368	0.0651	17.7	0.149	40.6	0.253	68.7
Ohio	6.14	7.64	0.778	0.0648	8.33	0.184	23.6	0.372	47.9
Virginia	4.56	4.50	0.422	0.0588	13.9	0.140	33.2	0.234	55.4
Oregon	1.88	2.86	0.312	0.0565	18.1	0.112	36.1	0.195	62.4
Illinois	7.11	9.31	0.507	0.0537	10.6	0.155	30.6	0.286	56.4
All Other States	70.7	90.0	7.53	0.825	0.109	2.24	0.297	4.15	0.551
U.S. Total	**164**	**202**	**19.4**	**2.75**	**14.2**	**6.62**	**34.1**	**11.4**	**58.6**

Note: Estimates are provided in descending order of state level water savings in the Basic Efficiency Scenario

The remaining seven states — Nevada, Kentucky, Louisiana, Alabama, North Carolina, Utah, Virginia, and Oregon — have large subsector water intensities but relatively small CII floor area, with Kentucky having the highest CII average current-day water intensity of any state (Figure 13). The subsectors with the largest efficiency potential in terms of both water savings and percent reduction from current-day demand in these states follow national trends, namely the food service, office, healthcare, and accommodation subsectors. Therefore, while CII efficiency potential varies widely across subsectors, these findings suggest that there is a consistent trend of CII efficiency potential being concentrated in these subsectors across the country.

FIGURE 13. CII Efficiency Potential as State-Level Water Intensity Savings (gallons per square foot per year) by Efficiency Scenario



As noted previously, these findings do not account for the relative levels of building-level productivity, non-employee occupancy, and water-intensive end-uses, such as water-based cooling and landscaping, that also influence CII water demand. Additional research to account for these factors could provide insight into the consistency of these findings at the building level. For example, water utilities should collect data to develop a local database of cooling tower prevalence and CII landscape characteristics to better characterize CII efficiency potential within their service area.

Despite significant efficiency opportunities, improving overall CII water efficiency is challenging due to the wide variability in water intensity and end-uses across and within subsectors. Within a subsector, overall productivity/sales, business operations, foot traffic, and other factors can lead to vastly different water intensities, regardless of efficiency level. While further research is needed to better understand this variability, these findings suggest that significant CII water efficiency opportunities could be realized by targeting high-demand subsectors, such as food service, office, healthcare, and accommodation.

4.2.3 Utility Water Loss

Consistent with the broader municipal and industrial trends, the greatest water savings for reducing utility water loss are found in states with large populations and/or high per capita leakage (Table 14). These states are predominantly found across the eastern half of the United States, particularly along the East Coast. New York and New Jersey rank among the top three for total water savings and for percent reduction from current-day demand across all scenarios (Table 14 and Figure 14).[18]

TABLE 14. Top 15 States with Largest Efficiency Potential From Utility Water Loss Reduction

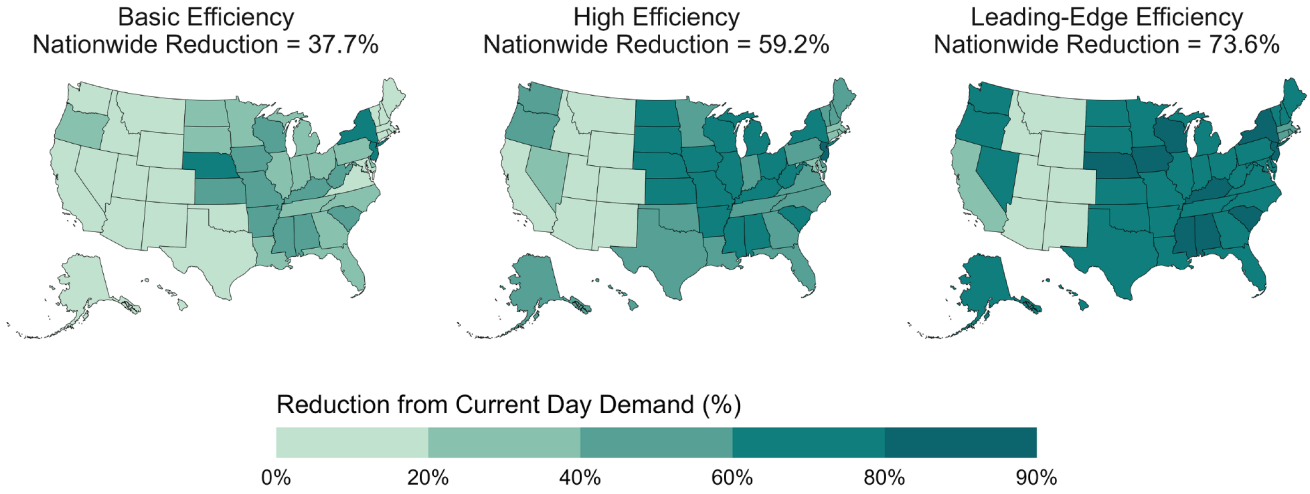
State	Current-Day	Basic Efficiency		High Efficiency		Leading-Edge Efficiency	
	Demand (mafy)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)	Savings (mafy)	Reduction from Current-Day (%)
New York	1.49	0.935	63.0	1.15	77.5	1.28	86.2
New Jersey	0.765	0.578	75.5	0.644	84.2	0.690	90.2
Alabama	0.584	0.309	52.9	0.418	71.5	0.482	82.5
Kentucky	0.439	0.234	53.3	0.315	71.8	0.363	82.6
Florida	0.612	0.200	32.6	0.333	54.5	0.433	70.8
Illinois	0.556	0.198	35.6	0.340	61.1	0.423	76.0
Ohio	0.504	0.192	38.1	0.315	62.5	0.388	77.0
South Carolina	0.315	0.183	58.2	0.235	74.7	0.266	84.4
Georgia	0.477	0.181	37.9	0.274	57.4	0.346	72.6
Mississippi	0.304	0.161	52.9	0.217	71.5	0.251	82.5
Tennessee	0.458	0.158	34.5	0.258	56.3	0.332	72.4
Texas	1.26	0.156	12.5	0.566	45.1	0.831	66.2
Michigan	0.354	0.132	37.4	0.220	62.1	0.271	76.7
Missouri	0.285	0.125	43.6	0.188	65.9	0.225	79.0
Wisconsin	0.231	0.109	47.1	0.157	68.0	0.186	80.3
All Other States	4.17	0.970	0.233	1.95	0.468	2.65	0.636
U.S. Total	**12.8**	**4.82**	**37.7**	**7.58**	**59.2**	**9.42**	**73.6**

Note: Estimates are provided in descending order of state level water savings in the Basic Efficiency Scenario

The Southeast and Appalachia regions of the United States have the largest potential for per capita savings from reducing utility water loss (Figure 14). This trend is likely influenced by the relative age of water distribution infrastructure across the country, with eastern states tending to have older infrastructure that is more prone to leaks and failure. While this notion is not necessarily universally applicable across all eastern United States water utilities, it is generally supported by these findings and warrants further investigation.

18 The other "large population" states (Florida, Illinois, Ohio, and Georgia), while not appearing among the states listed in Table 21, are all in the top half of states in terms of percent reduction from current-day demand, with reductions ranging from 32.8% to 38.2%.

FIGURE 14. Utility Water Loss Efficiency Potential as State-Level Percent Reduction From Current-Day Demand by Efficiency Scenario



These findings provide a compelling justification for additional efforts to better track and manage leakage nationwide, as the cost to maintain existing infrastructure and manage utility water loss are likely to increase as infrastructure assets age and require replacement, all else being equal. These findings are especially useful demonstrating the need for increased funding from state and federal sources to address utility water loss, especially for smaller water utilities that are less likely to have the organizational capacity and/or resources to effectively manage leakage.

5. Case Examples

In this section, we build on the results of the national assessment by discussing three case examples that represent the next frontier of water efficiency strategies, going beyond the water efficiency potential identified in this study. The first two examples (reducing structural waste and certification for whole-home water efficiency) are best suited for the construction of new buildings; however, some of the principles could be implemented in the retrofit and/or redevelopment of existing buildings.

5.1 REDUCING STRUCTURAL WASTE

Indoor water efficiency has traditionally focused on fixture and appliance performance to reduce end-use water demands without reducing the level of service. While these improvements are effective, the design and layout of the hot and cold plumbing systems within a building can also drive excess water use. This excess water use, also known as "structural waste," happens when pipes are larger than required for the desired level of service or through hot-water pipe layouts that pass through non-preferred environments (such as outside air or under the foundation slab), or add extra distance between the water heater and hot water end-uses including showerheads, faucets, clothes washers, and dishwashers (Lohr 2022a; 2022b; 2022c; Lutz 2011).

These structural waste sources reduce water efficiency and user experience either by supplying an end-use with higher-than-desired flow rates (for oversized plumbing) or by requiring longer wait times for water to reach its desired temperature (Lutz 2011; Lutz et al. 2014; Sherman 2015). Structural waste can also increase the residence times of water within the plumbing system, increasing the risk of waterborne pathogens (Bédard et al. 2018; Clements et al. 2023; Lautenschlager et al. 2010; Nisar et al. 2020; Schück et al. 2023) and the energy use required to heat water that cools and is subsequently sent to the drain (Chen et al. 2021; Hendron et al. 2009; Lutz 2005; Omaghomi 2018).

Beyond structural waste, behavioral factors during hot-water events, such as showers and some faucet uses, can waste 20–30% of the total event volume (Lutz 2005; 2011). This "behavioral waste" typically occurs when users are waiting for water to reach the desired temperature before stepping into the shower or using the water coming from the faucet. Behavioral waste can be mitigated by adopting technologies designed to restrict fixture flows while water temperature reaches the desired level, such as temperature-actuated flow-reduction tub-spout inserts and inline showerhead flow-reduction devices. To enable the integration of these devices into plumbing and building codes, the

International Association of Plumbing and Mechanical Officials (IAPMO) also developed and released the Tub and Shower Flow-Reduction Systems Standard (IGS 244-2021), which details performance specifications and testing requirements for these devices (IAPMO 2021).

As indoor water demands continue to decrease, building officials and plumbing codes have not updated their design assumptions for building plumbing systems accordingly, with many relying on standards developed in the 1940s (Lohr 2022b). This lag between fixture performance and industry practices presents a clear opportunity to align plumbing design principles with modern rates of water use. To drive industry-wide innovation, IAPMO has conducted research and released several resources for plumbing and mechanical professionals to design premise plumbing systems that reflect modern water efficiency trends while maintaining level of service during peak demands and prioritizing public health (IAPMO 2024; Mayer et al. 2020). The 2023 edition of the IAPMO Water Efficiency and Sanitation Standard for the Built Environment (WE-Stand) provides a comprehensive framework, including design standards, model legislation and code language, and support tools for communities to update their existing plumbing and building codes to reflect the latest advancements in water efficiency, conservation, and on-site reuse (IAPMO 2024; Lutz 2011; Lutz et al. 2014).

As indoor water demands continue to decrease, building officials and plumbing codes have not updated their design assumptions for building plumbing systems accordingly, with many relying on standards developed in the 1940s.

To facilitate analysis and design of plumbing systems to meet this standard, IAPMO has also released the Water Demand Calculator® tool, which allows designers to analyze the impact of adapting plumbing designs to the WE-Stand framework, providing key metrics such as annual estimated water savings, monetary savings from reduced plumbing system costs, and monetary savings from reduced utility bills (Arup US, Inc. 2023; Becking et al. 2023; Feng et al. 2023). The Water Demand Calculator has been adopted at both state and local levels, with case studies estimating that water savings range from 250 to 1,500 gallons per dwelling annually by reducing structural water waste, in addition to the monetary and energy benefits previously discussed.[19] These findings point to significant savings potential by rethinking the assumptions that have guided plumbing design for decades and providing a way for communities to build on their existing water efficiency improvements or enhance new efforts beyond end-use-based approaches.

19 At the time of writing, the IAPMO Water Demand Calculator has been adopted for either voluntary or mandatory use in: Castle Rock, CO; King County, WA; the Metropolitan North Georgia Water Planning District, GA; and the State of California.

5.2 CERTIFICATION FOR WHOLE-HOME WATER EFFICIENCY

The U.S. EPA first launched the WaterSense program in 2006 with the goal of creating a standardized resource for consumers to identify and purchase high-performing and water-efficient products, ranging from fixtures to landscape irrigation controllers (U.S. EPA 2024b). Since then, the program's offerings have expanded to include the first national certification for whole-home water efficiency, WaterSense Labeled Homes. Since the launch of Version 2 of the WaterSense Labeled Homes program in 2022, certification under this program requires only a relatively simple mandatory checklist (including use of WaterSense labeled plumbing fixtures and adherence to a basic leak detection protocol) and achieving water use performance at least 30% more efficient than typical new construction homes with similar characteristics (U.S. EPA 2023b).[20] While these requirements are relatively easy to implement, the benefits are immense.

In a pilot study of 160 homes in Las Vegas, Nevada, WaterSense labeled homes saved an average of 4,000 gallons per household each year (a 45% reduction from typical household water demand). In the zHome neighborhood in Issaquah, Washington, the first full community of WaterSense labeled homes built in the United States, households saved an average of 53,000 gallons per household each year, translating to a 70% reduction in water demand compared to typical homes and $600 per year in avoided water and energy costs for the homeowner (U.S. EPA 2025b). Despite some claims of unsatisfactory performance of high-efficiency or "low-flow" products, over 86% of residents in this community strongly agreed that they were satisfied with their WaterSense labeled home performance, and satisfaction had increased since the survey of the same community conducted 10 years prior (U.S. EPA 2025b).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Additional case studies have also investigated the energy and monetary savings resulting from these homes. In a case study consisting of 219 WaterSense labeled homes in the Oak Shade and Durango communities in Menifee, California, households saved an average of 61,000 gallons per year of water and 2,420 kWh per year of energy (U.S. EPA 2024a).[21] Depending on the mix of energy sources, coupling water efficiency with renewable energy in the home can support decarbonization efforts by reducing carbon emissions from the household. It also reduces energy use for the water utility by reducing energy used to transport, treat and distribute/collect water and wastewater.

20 The 30% efficiency improvement requirement can also be satisfied by the implementation of one or more optional recommended practices that include other indoor and outdoor end-uses (appliances, water softeners, hot water systems, metering, landscapes, irrigation systems and controllers, and pools/water features) (U.S. EPA 2023a)

21 In 2022, the U.S. Energy Information Administration estimated that the average home uses approximately 10,800 kilowatt-hours of energy per year (U.S. EIA 2024a).

The WaterSense Labeled Homes program has demonstrated a record of success both for individual households and for water utilities, while providing an easy-to-understand certification for prospective homeowners and home builders that allows flexibility in achieving water and energy sustainability goals. As new communities emerge and existing communities expand and/or replace existing building stock, this program provides a way to integrate water supply into land-use planning practices to support long-term water resilience.

5.3 PROACTIVE STRATEGIES FOR WATER LOSS CONTROL

Utility water loss remains an elusive source of municipal and industrial water demand, largely due to the concealment of the majority of water distribution infrastructure underground. At the same time, utility water loss can also be a major cost for the water utility in the form of lost revenue. In this study, we estimate that utility water loss makes up approximately 22.6% of current municipal and industrial water demand. Still, less than half of the states currently have standards or regulations requiring the quantification and/or reduction of water loss (Burke et al. 2022). Strategies to manage the distribution system leakage component of utility water loss have historically relied on reactive approaches focused on timely repair of water main breaks and reporting. While these strategies remain a critical component of water loss management programs, advanced technology and support tools — advanced leak detection, active pressure management, advanced metering infrastructure, and dedicated asset management and renewal programs with predictive capability — have recently emerged to provide more proactive means for water loss management and control.

Advanced leak detection techniques encompass a suite of technologies that aim to provide higher-resolution and/or real-time data for a water distribution system that can be used to identify and

repair infrastructure leaks faster and more accurately than through visual inspection and customer reporting alone (Trachtman 2019). The U.S. Department of Energy provides a list of technologies for small, medium, and large facilities that can be adopted to support existing leak detection efforts (U.S. DOE, n.d.), including a mix of active (e.g., hand-held imaging devices and acoustic sensors) and passive (e.g., in-pipe continuous monitoring sensors, satellite and drone imagery, ground-penetrating radar) approaches. While additional research to characterize the effectiveness of each technology is ongoing, these strategies can support existing leak detection efforts and improve understanding of the extent of water loss within a water utility's service area.

Like the effects of excess pressure on premise plumbing discussed previously, some water distribution systems operate at higher pressures than necessary to deliver water to customers at the desired level of service, often to serve high-elevation customers and/or accommodate peak demand periods (European Commission 2015; LeChevallier et al. 2014), but this can increase the likelihood of infrastructure failure (Sturm et al. 2015; Trachtman 2019). Active pressure management — monitoring and adjusting system pressure in real-time as part of regular operations or by identifying high-pressure regions of a distribution system and installing pressure relief valves to better regulate service pressure — can reduce leakage from over-pressurized distribution systems and extend the life of infrastructure. In some cases, water utilities implementing active pressure management saw a payback period of less than two years, driven by the savings in reduced leakage and operational expense (LeChevallier et al. 2014), providing a clear business case for cost-effective water loss reduction.

Effective water loss management also requires a long-term funding strategy to maintain and replace the thousands of infrastructure assets making up a utility's distribution system (AWWA 2022; U.S. EPA 2010; U.S. EPA et al. 2017). In AWWA's 2022 water utility benchmarking survey, less than 30% of respondents reported minimal or no implementation of asset management activities within their organization (AWWA 2023). When asked if they had implemented an optimized asset management program that "strikes a balance among performance, risk, and cost to support infrastructure renewal and replacement decisions" with additional criteria provided to assess performance, the response rates indicating minimal to no implementation increased to between 50% and 75% (AWWA 2023). This disparity in responses points to a role for emerging analytical tools to support decision-making for asset renewal and replacement, often using both physical modeling and data-driven approaches to leverage existing water utility data to more accurately predict the current condition and likelihood of failure of individual assets, thereby better targeting proactive maintenance efforts (Delnaz et al. 2023). While the underlying prediction techniques are still developing, water utilities should consider the use of these tools when establishing or enhancing their existing asset management programs to improve system performance and the long-term sustainability of their infrastructure.

6. Conclusions

Water efficiency is an essential tool to support long-term water resilience. Communities and businesses across the country have made meaningful water efficiency improvements over the past several decades. Without these efforts, water supply challenges would likely have been much worse. As water supply disruptions and uncertainty become more severe, water efficiency strategies remain a critical tool that is often more cost-effective, less environmentally damaging, and faster to implement than centralized water supply options. Beyond the direct water supply benefits, improving efficiency also supports water affordability, reduces energy use and greenhouse gas emissions, and supports ecosystem protection. There is still significant potential for greater water efficiency across all sectors of municipal and industrial water use, and realizing this potential requires both new and sustained efforts to build on the improvements made thus far.

In this study, we estimate that the efficiency potential from reducing excess water use (i.e., Basic Efficiency Scenario) is 14.6 mafy, equivalent to a 25.5% reduction from current-day demand. By adopting residential fixtures, appliances, and landscapes and improving the efficiency levels of CII properties and utility water loss to those reflected in the High Efficiency Scenario, savings increase to 23.5 mafy, a 40.9% demand reduction. Finally, improving efficiency levels to reflect the leading technologies and practices across all sectors (i.e., Leading-Edge Efficiency Scenario) can generate 34.4 mafy of water savings, representing a 59.9% reduction in current-day water demand. Across all three scenarios, water savings are highest in the residential sector, though the gap between sector-level savings closes significantly as efficiency levels increase.

Beyond the direct water supply benefits, improving efficiency also supports water affordability, reduces energy use and greenhouse gas emissions, and supports ecosystem protection.

Most of the states with the largest municipal and industrial efficiency potential also have the largest water savings across multiple subsectors. However, there are cases where water savings in a single subsector drive large municipal and industrial efficiency potential: residential for Louisiana and Washington, CII for North Carolina and Tennessee, and utility water loss for Georgia and South Carolina.

More broadly, residential savings opportunities are the highest in states with either the largest populations (and therefore current-day water demands) or the highest per capita demands. Residential indoor efficiency potential is largest for toilets and showerheads, highlighting the need for continued efforts to identify and retrofit older, less-efficient models with high-efficiency models for these end-uses. Water utilities that wish to promote early retirement of currently installed devices before the end of their service lives typically rely on incentives or can enact policies requiring fixture retrofits upon resale. Toilets and showerheads can have some of the longest service lives of residential fixtures and appliances (Berhanu et al. 2017), leading to lower turnover rates and potentially longer lag times between the implementation of regulations and observed savings. At the same time, fixture and appliance efficiencies continue to improve, leading to more unrealized savings potential if regulations do not update accordingly. Therefore, areas that have experienced higher population growth (and subsequently new home construction) are more likely to have more efficient fixtures installed on average, and thus lower indoor per capita demand. Conversely, areas with lower population growth would see higher average per capita demands. These areas can still achieve meaningful savings by regularly updating fixture efficiency regulations and implementing policies that require retrofit of fixtures upon resale, though it would take longer to see commensurate levels of saturation.

Moreover, larger urban water utilities typically have more resources available to enact conservation programs and provide incentives for adoption of more efficient fixtures than their smaller counterparts. For reference, the U.S. EPA estimates that 90% of the roughly 48,000 community water systems in the United States serve 10,000 or fewer people (U.S. EPA 2025a), representing around 15% of the total population. These systems require more effort to direct resources to customers via water utility-level conservation and rebate programs due to the disproportionate number of entities that would need to act. These figures also do not account for self-supplied domestic water users, another 10% of the population based on our analysis, who would not be eligible for these programs.

In the CII sector, subsector-level water savings are largest for offices, food service, and healthcare. Utility water loss efficiency potential is largest in the eastern half of the United States, potentially due to the relative age and condition of water distribution infrastructure compared with the western United States, particularly in southeastern states.

The three efficiency scenarios investigated in this study represent increasingly aggressive actions that can be taken to realize water efficiency potential in every state. This framework provides a benchmark for states and water utilities to compare their current efficiency levels and identify opportunities for both across-the-board and focused efforts to secure deeper demand reductions in each sector. The case examples presented also highlight additional strategies that fall outside of traditional approaches for improving efficiency, including updating existing plumbing design principles for modern water use rates (structural waste), incentivizing wide-ranging technology improvements across the home (WaterSense Labeled Homes program), and employing innovative techniques to better identify and respond to water waste (proactive water loss control).

While full adoption of the technologies and strategies represented by each efficiency scenario is not always feasible, our estimates provide a resource that can be refined to account for local contexts and used to inform water supply planning and management efforts. Water utilities and states can utilize these estimates to identify the feasible water efficiency potential within their jurisdictions.

7. Recommendations

Water efficiency is a proven strategy for augmenting and diversifying water supplies, while simultaneously supporting population growth and a vibrant economy, reducing water and wastewater costs, adapting to and mitigating climate change, improving water affordability, and maintaining healthy freshwater ecosystems. Over the last several decades, communities across the United States have made important water efficiency gains. This study identifies additional potential to save water through existing technologies and practices. In this section, we offer recommendations to help realize the untapped potential of water efficiency through changes in policies, programs, and investments.

Expand funding and financing opportunities for water efficiency programs. Water efficiency improvements are typically the cheapest and fastest way to meet water needs. Yet, water utility investments in water efficiency are less than investments in new water supplies, such as recycled water and desalination. To accelerate water efficiency improvements, new funding and financing strategies are needed.

- State and federal agencies should increase funding, including through grants and low-interest loans, for local water efficiency and water loss control programs to levels consistent with other water supply investments. These funding opportunities should be targeted specifically to, and dedicated exclusively for, water efficiency programs.
- Local agencies should, where possible, employ debt financing, such as municipal bonds or state revolving fund loans, for water efficiency investments, a common practice for funding other centralized water supply options.
- State and federal agencies should provide small and underserved communities with dedicated planning and implementation grants for water efficiency programs.

Increase financial and non-financial water efficiency incentives for customers. Incentives are effective strategies for promoting the adoption of water-efficient technologies, practices, and behaviors. These incentives can take many forms. For example, the WaterSense program is a powerful public-private partnership that provides a simple way for customers to identify high-performing water-efficient products and services while driving innovation in American manufacturing. Likewise, financial incentives, such as tax credits and discounts, can motivate customers to purchase efficient products and support new business opportunities.

- The federal government should maintain the U.S. EPA's waterSense program to support customer choice in high-performing products and services.

- Utilities should offer customer incentive programs for water efficiency measures and enhance education and outreach efforts for households and businesses. These programs should be accessible to low-income and multi-family households through, for example, direct-installation programs and partnerships with local nonprofit and community groups.
- Water and energy utilities should partner to offer customer incentives for measures that save both water and energy, increasing the pace and lowering the cost of achieving water and energy savings.
- States and the federal government should create personal tax exemptions for water efficiency rebates and create individual and business tax credits for water efficiency investments, as is done for energy efficiency investments.
- States, cities, and counties should provide funding to repair household leaks and install WaterSense labeled devices for low-income households in states, tribes, and territories, through programs like the Community Block Development Grants or the Plumbing Repair and Efficiency Assistance Program proposed by the AWE.
- Water utilities — in partnership with non-governmental organizations and others — should provide education programs and technical support for residents and businesses, including training on the proper installation and maintenance of regionally appropriate landscapes and audits for non-residential buildings.

Provide water efficiency incentives to retailers, installers, and manufacturers. While most water efficiency incentives target individual customers, they can also be designed to target those further upstream, such as retailers, installers, and manufacturers. These upstream and midstream incentives are more commonly employed in the energy sector but could also be used to advance water efficiency.

- Regional entities, industry associations, and states should develop financial incentives targeted at installers and manufacturers to promote the development and adoption of cost-effective and more efficient technologies and practices.
- State, local, and regional agencies and non-governmental organizations should support workforce training and development. This can include providing educational programs and technical support for retailers and installers, as well as training for landscape professionals to properly install and maintain sustainable landscapes.

Update standards and codes. Standards and codes have been cost-effective strategies for saving both water and energy and lowering utility bills for households and businesses. The Energy Policy Acts of 1992 and 2005 established maximum water use rates for a variety of plumbing products and appliances sold in the United States. Accelerating efficiency improvements requires broad adoption of these standards and codes to reflect updated, innovative technologies and practices.

- State and local governments, especially those with high outdoor water demand, should adopt standards that support the development of water-efficient landscapes for residents, businesses, and institutions, such as limiting turfgrass or irrigated areas, promoting the use of native and drought-tolerant plants, requiring efficient irrigation systems, and incentivizing rainwater harvesting.
- States should update standards and codes to require the use of WaterSense labeled devices, which save water and meet high performance criteria.

- States and municipalities should adopt IAPMO's Water Efficiency and Sanitation Standard or similar code amendments to local and state building and plumbing codes. These standards provide minimum requirements for water use in the built environment that reflect modernized design assumptions and provide model guidelines to facilitate adoption of innovative water efficiency and reuse technologies and practices.
- States and municipalities should amend their plumbing codes to require IAPMO's Water Demand Calculator for estimating peak demand and provide training on its use for inspectors, installers, and design professionals. Right-sizing plumbing saves water by reducing structural water waste, lowering construction costs, and improving water quality.
- States and municipalities should adopt IAPMO's Tub and Shower Flow-Reduction Systems Standard (IGC 244-2021) for local and state building and plumbing codes. This standard provides a means for residential and commercial buildings to reduce behavioral water waste for fixtures that use hot water, while saving energy and reducing customer utility bills.

Reduce water distribution system leakage. Leaks in the water supply and distribution system result in a loss of both water and revenue. Reliable water loss data are limited, in part because adequate monitoring systems are not in place or because available data are not collected and consolidated. However, available data suggest there are significant opportunities to reduce distribution system leakage. Capturing these savings requires monitoring and reporting, as well as the adoption of performance standards, as has been done in some states.

- States should require monitoring and reporting of non-revenue water, including distribution system leakage, by water utilities and provide technical assistance to water utilities that require additional capacity to perform this monitoring. Reported data should be collected and validated using industry-approved methodologies, such as the American Water Works Association's *M36 Water Audits and Loss Control Programs* manual and the Water Research Foundation's Level 1 *Water Audit Validation Manual*.
- States should adopt water loss reporting and performance standards that include regular validated audits, individualized performance goals, and public reporting of progress toward those goals.
- State and federal agencies should provide small and underserved communities with dedicated planning and implementation grants to manage utility water loss and reduce distribution system leakage.

Adopt universal metering and conservation-oriented water and sewer rates. Water and sewer rates play an essential role in communicating the value of water and promoting the wise use of water resources. Universal metering combined with well-designed rate structures can support multiple objectives, including the financial viability of the water utility, efficient allocation of water, water affordability, and environmental sustainability.

- State and local entities should install water meters for all customers. To help defray the cost of universal metering, states should provide funding for meter installation in existing developments.
- State and local entities should install sub-meters for new landscape irrigation systems and multi-occupant buildings, including multi-family residential, mixed use, and multi-tenant commercial buildings

- Water managers should adopt progressive rate structures that encourage conservation, such as tiered rate structures or increasing block price scheduling, to motivate customers to use water efficiently while supporting the financial viability and sustainability of water and wastewater utilities.

Expand data collection and monitoring. Limited data and information are available on water use, the various end-uses of water, or the appliances. Consistently reported data collected at regular time intervals are needed to inform decisions about water efficiency opportunities and challenges, as well as projections of water demand, water availability, and investment needs.

- National organizations, in partnership with researchers and water managers, should develop guidance and a standardized framework for the collection and reporting of utility-level water demand data for adoption by state and local water agencies. Such a standard should account for the range of metrics currently used to evaluate water use, such as surface water and groundwater withdrawals, water distribution system input, billed/unbilled consumption, and consumptive/non-consumptive water use. The standard should also provide a consistent framework to calculate standardized water use metrics that allow for benchmarking and comparison across geographic scales.
- National organizations, in partnership with researchers and water managers, should develop and disseminate guidance to calculate and report common water-use metrics, such as gpcd and peak demand ratio, to facilitate regional efforts to better manage water supplies and customer demand across shared water sources.
- States and/or local governments should conduct end-use saturation studies, potentially in combination with ongoing energy studies, for homes, businesses, and institutions, to help identify which water uses hold the greatest savings opportunities.
- States and/or local governments should adopt the taxonomy of buildings specified in the U.S. EPA's ENERGYSTAR Portfolio Manager to classify CII customers.
- Larger water suppliers, for example, those with a population exceeding 100,000, should require large building owners to benchmark and report water use through the ENERGYSTAR Portfolio Manager tool and take action to improve water efficiency.

Fill critical research gaps. There remain outstanding research questions that must be addressed for effective implementation of water efficiency measures. Agencies across all levels of government, academics, water utilities, and community-based organizations have a role to play in filling these gaps.

- A national effort — comprised of diverse stakeholders — is needed to develop a strategy for advancing water efficiency across the United States, as was accomplished in the Water Reuse Action Plan and the National Action Plan for Energy Efficiency.
- Researchers and others should examine CII water use and end-uses within specific subsectors to better understand the drivers and more accurately estimate water use for sites and across service areas.
- Researchers and others should examine behavioral and other strategies to encourage greater adoption of water efficiency improvements.
- Researchers and others should examine emerging technologies and trends, such as the use of air or direct cooling for data centers, to help plan for and potentially mitigate impacts on water systems.

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