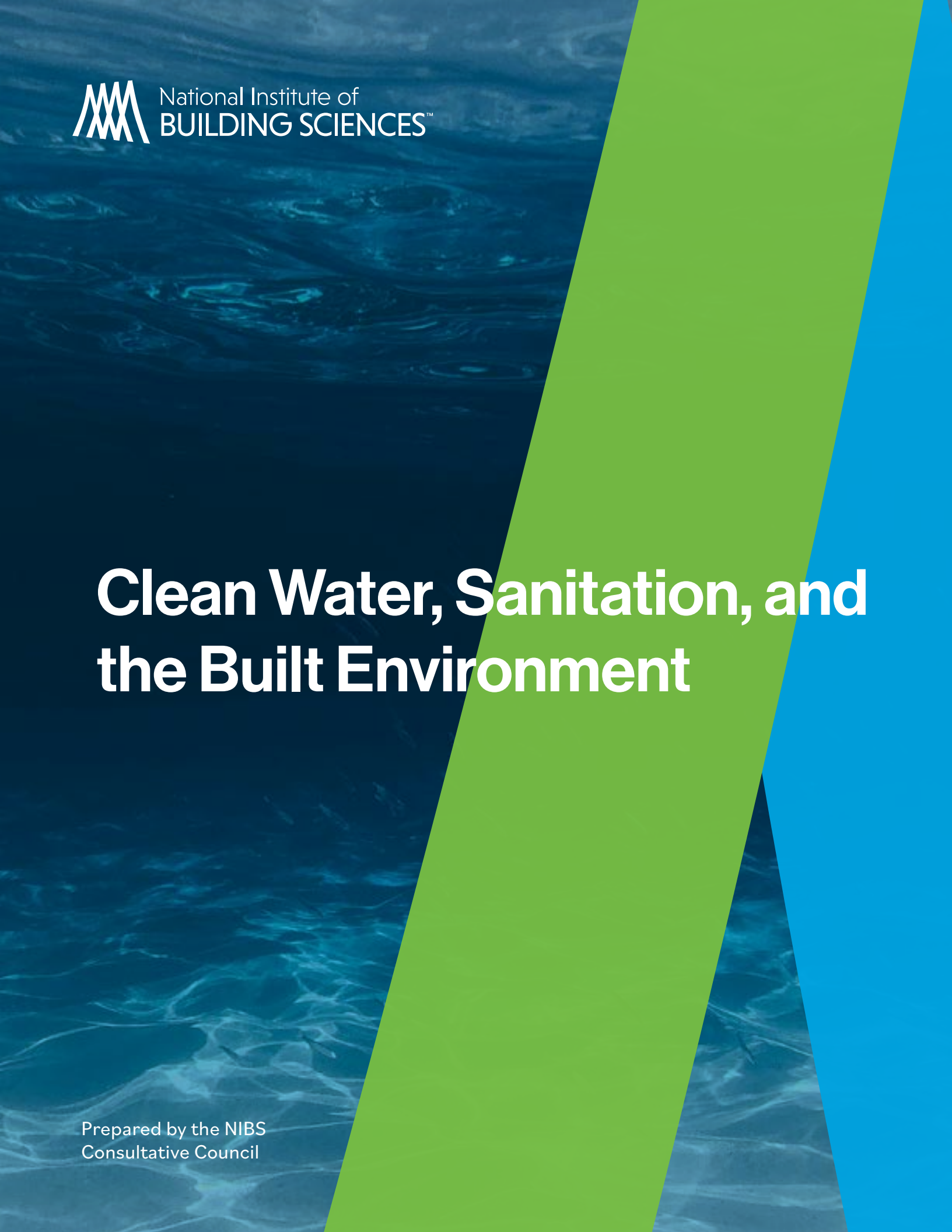
National Institute of BUILDING SCIENCES™

Clean Water, Sanitation, and the Built Environment



Prepared by the NIBS Consultative Council

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Introduction

The National Institute of Building Sciences (NIBS) serves as the unbiased forum for solving common issues and identifying opportunities within the building community. The NIBS Consultative Council assembles high-level building community leaders to make collective recommendations directly to policymakers to improve our nation's buildings and infrastructure. Members of the council include organizations representing consumers, architects, engineers, government officials, contractors, researchers, and housing officials. The goals of the council are three-fold:

- Convene Thought Leaders: bringing together industry leaders and experts from across the built environment to improve our nation's infrastructure and buildings.
- Identify Challenges: assembling experts who identify key issues they believe will be facing the industry in the years ahead.
- Find Solutions: developing and publishing a yearly report that offers solutions to key challenges the built environment faces.

In 2024, the Consultative Council is investigating three critical Access challenges facing the building industry: (1) Clean Water and Sanitation, (2) Housing Affordability, and (3) Safe Schools. For each topic, the Council will evaluate the state of the industry, identify key issues, and make recommendations to industry actors and policymakers to help overcome these challenges. NIBS and the Consultative Council intend to revisit each topic periodically, to track progress and discuss potential new challenges and solutions.

Access to Clean Water and Safe Sanitation: Recommendations Summary

As part of the 2024 Moving Forward Report, the Consultative Council is exploring the topic of "Water and Sanitation Access and the Built Environment," examining key concepts, challenges emerging from climate change impacts and population growth, and considerations that can help to inform decisions about how to plan for, mitigate, and potentially solve water access issues from the perspective of the built environment. This report focuses specifically on the way in which commercial and residential buildings access and use water resources.

The points below summarize the topics and recommendations discussed in this report. Detailed recommendations from the NIBS Consultative Council can be found on page 18. The Council's recommendations supplement other necessary actions to adapt the built environment to a changing climate and make our buildings and communities healthier and more resilient.

- **Data:** Improve and increase data collection efforts regarding water access, quality, and use in households and buildings.
- **Efficiency:** Increase market share for WaterSense and other efficiency programs, expand use of alternate water sources, and bring increased focus to water efficiency as it relates to energy efficiency.
- **Funding:** Continue to increase funding for centralized and decentralized water and sanitation infrastructure, especially for projects in underserved communities, and support strong water treatment standards.
- **Research:** Support implementation of the newly authorized NIST Plumbing Research Program and increase the role of EPA, DOE, and other relevant Federal and industry stakeholders in collecting data on water usage, improving efficiency in system design, and identifying safe alternate water sources for use in the built environment, while maintaining public health and safety, especially in regions facing water scarcity and quality challenges due to climate change.

- **Strategy:** Develop a national strategy for providing sustainable water and sanitation services to rural and disadvantaged communities, particularly focused on those that rely on decentralized systems.
- **Workforce:** Increase funding for workforce programs for the water sector, to ensure a pipeline of future workers.

Water Use and the Built Environment

Water is essential to health, safety, hygiene, and productivity. Americans today are facing a water crisis, with over 2.2 million people nationwide surviving without access to running water or sanitation services.[1] Water use in buildings and households is an often underexamined and underappreciated aspect of the water crisis, and of the built environment generally.

According to 2015 estimates, Americans use approximately 322 billion gallons of water per day. Four states--California, Texas, Idaho, and Florida--account for more than one-quarter of all fresh and saline water withdrawn in the US. Water withdrawals are generally broken down into eight categories, as the image below from the United States Geological Survey makes clear:

2015 withdrawals by category, in billion gallons per day

- Public supply **39.0**
- Self-supplied domestic **3.26**
- Irrigation **118**
- Livestock **2.00**
- Aquaculture **7.55**
- Self-supplied industrial **14.8**
- Mining **4.00**
- Thermoelectric power **133**

Source: USGS[2]

Interestingly, American water use has declined since 2010, with overall withdrawals now at levels not seen since the 1970s. Declines from 2010-2015 represented a nearly 9% decline overall in water use. These decreases were primarily driven by declines in thermoelectric power use (18%) -- due to efficiency improvements, environmental protection rules, and closures--and public supply (7%), primarily from appliance improvements.

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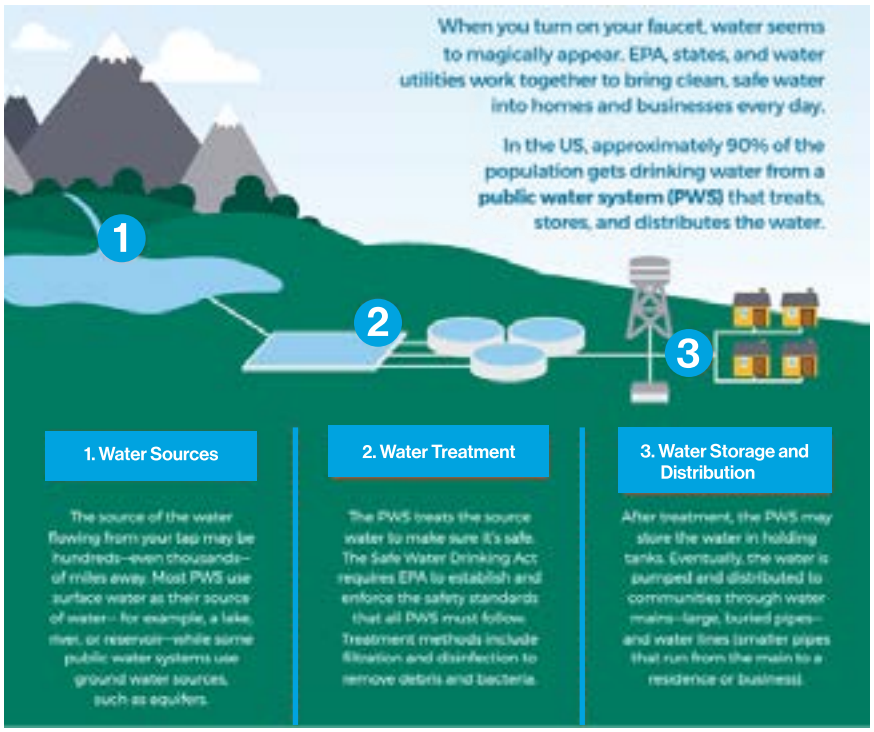
[1] "Close the Water Access Gap." DIGDEEP. www.digdeep.org/close-the-water-gap.

[2] U.S. Geological Survey. "Total Water Use." March 3, 2019. https://www.usgs.gov/mission-areas/water-resources/science/total-water-use?qt-science_center_objects=0#qt-science_center_objects

How Are Buildings Supplied with Water?



Access to clean and safe water is often taken for granted; as the US Environmental Protection Agency (EPA) states, "when you turn on your faucet, water seems to magically appear."[3] However, the systems underpinning water distribution and use in residential and commercial buildings are extremely complex, and standards and enforcement governing their use vary by region, state, and even within localities. More than 300 million Americans, 95 percent of the population, receive part of their water from community water systems.[4] Of the 300 million people served by community water systems, 257 million are served by just 9% of systems. Nearly 91% of systems serve communities of under 10,000 people. The 151,000 public water systems in this country lead to incredible variation in access, quality, and outcomes important to population health and wellbeing.

The primary Federal law governing water access and quality is the Safe Drinking Water Act (SDWA), which was passed in 1974 and subsequently amended in 1986 and 1996.[5] The SDWA tasks the EPA with setting "national health-based standards for drinking water to protect against both naturally occurring and man-made contaminants that may be found in drinking water," and covers every public water system in the US. The SDWA, through amendments in 1996, also provides additional protection for drinking water sources. While the EPA is responsible for setting standards for quality, testing, treatment, and enforcement, direct oversight of water quality is primarily provided by state drinking water programs.

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[3] U.S. Environmental Protection Agency. "How Does Your Water System Work?" https://www.epa.gov/sites/default/files/2017-10/documents/epa-ogwdw-publicwatersystems-final508.pdf

[4] U.S. Environmental Protection Agency. "Population Served by Community Water Systems with No Reported Violations of Health-Based Standards." 2022. https://cfpub.epa.gov/roe/indicator.cfm?i=45#:~:text=Community%20water%20systems%20(CWS)%20are,drinking%20water%20from%20a%20CWS

[5] US EPA. "Regulatory Guidance Information by Topic: Water." Updated March 7, 2023. https://www.epa.gov/regulatory-information-topic/regulatory-and-guidance-information-topic-water

Funding For State Drinking Water Programs

There are multiple Federal programs that provide regular funding to state and local governments to make upgrades to water programs. The Drinking Water State Revolving Fund (DWSRF), a financial assistance program to help water systems and states to achieve the health protection objectives of the Safe Water Drinking Act.[6,7] Funding for the DWSRF is appropriated by Congress, and EPA awards capitalization grants to each state based upon the results of the most recent Drinking Water Infrastructure Survey Needs Assessment. The state is required to provide a 20% match. EPA and state programs have provided over $41 billion for water systems to:[8]

- Improve drinking water treatment
- Fix degrading infrastructure or old pipes
- Improve the source of water supply
- Replace or construct finished water storage tanks
- Other infrastructure projects to protect public health

Additionally, EPA's State Water Infrastructure Finance and Innovation Act program is a Federal loan program for state water and wastewater infrastructure projects.[9] The program was created and funded by Section 4201 of America's Water Infrastructure Act of 2018.

How is Water Used and Controlled in Buildings?

On centralized systems, homes and businesses are connected to public water infrastructure via service lines and (within the building) via premise plumbing, defined as "the portion of a water system, including both hot and cold water, various devices (e.g., hot water heater, HVAC humidifier), fixtures (e.g., showers, faucets), and drains (e.g., sinks, toilets) connected to the main distribution system via service lines."[10] These systems are responsible for providing clean, potable water and removing wastewater through a sanitary drainage system that is connected to a public sewer.[11] Fire protection systems (automatic sprinkler systems, fire pumps, etc.) are also a key component in ensuring building occupant safety and security.

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[6] US EPA. "How the Drinking Water State Revolving Loan Fund Works." Updated November 17, 2023. https://www.epa.gov/dwsrf/how-drinking-water-state-revolving-fund-works#tab-1

[7] Ibid

[8] Ibid

[9] US EPA. "What is SWIFIA?" Updated May 23, 2023. https://www.epa.gov/wifia/what-swifia

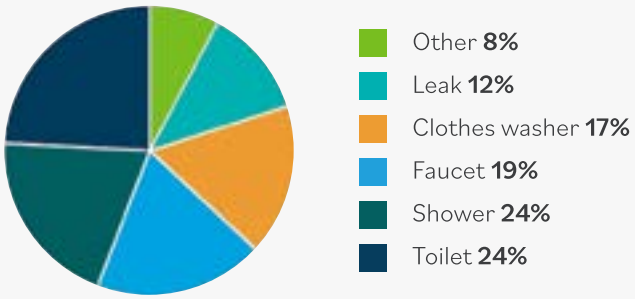
[10] US EPA. "Premise Plumbing Decontamination." Updated March 6, 2023. https://www.epa.gov/emergency-response-research/premise-plumbing-decontamination

[11] National Institute of Standards and Technology. "Premise Plumbing Systems. Updated July 31, 2023. https://www.nist.gov/el/energy-and-environment-division-73200/premise-plumbing-research-nist/current-activities-0

Water use in commercial and institutional facilities, including office buildings and hospitals, accounts for 17% of publicly supplied water use in the US.[12] While water use in commercial buildings obviously differs greatly in volume and by building type, most commercial buildings use water for kitchens, restrooms, laundries, showers, heating and cooling, and landscape irrigation.

According to the US EPA, the average American family uses more than 300 gallons of water per day at home, with roughly 70% of that use occurring indoors, and the remaining 30 percent for landscaping and irrigation.[13] This graphic from a 2016 Water Research Foundation Report details how water is typically used within a residence.

How much water do we use?



Source: Water Research Foundation, Residential End Uses of Water, Version 2. 2016

Within a typical building, plumbing codes set minimum standards and requirements for plumbing systems. This includes requirements for the design, construction, installation, inspection, repair, and alteration of plumbing systems. Plumbing codes are adopted at the state and local levels depending on the jurisdiction. Model plumbing codes used by these jurisdictions are primarily developed by the International Association of Plumbing and Mechanical Officials (IAPMO) or the International Code Council (ICC).

Plumbing design usually depends on collaboration among an architect, civil engineer, plumbing engineer, and (possibly) a mechanical engineer, electrical engineer, and structural engineer, depending on building size and type. These disciplines work together, using relevant codes, to develop a design and piping diagram. Pipe sizing requirements are based on flow rate and velocity limitations calculated using model codes. Plumbing engineers assess water demand for the entire building, and pressure loss through the supply system is calculated. Drain and vent systems are properly sized to remove wastewater and discharge into a public sewer or onsite wastewater treatment system where a public sewer is not available in accordance with model plumbing codes. Fire protection engineers will assess fire protection demand/water supply and design piping sizes and drains for functionality of these systems.

As part of a collaborative design process, architects and engineers work with the building owner to solve multiple challenges for the project to use water wisely, addressing efficiency and consumption while matching water quality to appropriate use. Additional factors that can be addressed during design include resilience for the building, infrastructure and ecosystems, such as how the project's water systems can maintain function during emergencies or disruption, handle rainfall and stormwater responsibly, and contribute to a healthy regional watershed. Design

[12] US General Services Administration. Sustainable Facilities Tool. "Buildings' Water Use." https://sftool.gov/learn/about/183/buildings-water

[13] US EPA, WaterSense. "How We Use Water." Updated April 24, 2023. https://www.epa.gov/watersense/how-we-use-water

considerations for water, as well as additional resources and recommendations, are outlined in AIA's "Design for Water – Framework for Design Excellence" toolkit.[14]

Challenges to Water Access and Water Quality

It is undoubtable that the US has one of the most robust water systems in the world. However, the US Center for Disease Control and Prevention (CDC) estimates that millions of Americans get sick from a waterborne illness each year.[15] Water issues disproportionately fall on poor and marginalized communities and have grown in recent years as funding for water access, quality, and sanitation has lagged. While recent Federal actions to upgrade water infrastructure are a big step forward, more work is needed to better understand water access and sanitation issues.

Water Access and Equity

The CDC defines water access as the "percentage of the population having access to and using improved drinking water sources."[16] In this context, improved drinking water sources are defined by the World Health Organization as "those that are likely to be protected from outside contamination, and from fecal matter in particular,"[17] and include multiple types.

DigDeep, a non-profit focused on water access in the US, defines residential safe water access as having three primary components:

1. Safe, reliable, running water
2. A tap, toilet, and shower in the home
3. A safe system for removing and treating wastewater

Per DigDeep's analysis, more than 2.2 million people in the US live without running water and basic indoor plumbing. This gap in water access can be explained primarily by certain communities being "left behind" during major infrastructure investment booms, as well as funding that has not been appropriately targeted to affect the communities hardest hit. This access gap has significant impacts on human health, wealth, and well-being, as well as severe consequences for our national economy. Each year that the water access gap remains open, the US loses an estimated $8.6 billion per year in GDP. Parsed out by household, each American family facing these challenges loses nearly $16,000 every year, sometimes more than their annual income.[18]

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[14] American Institute of Architects. "Design for Water – Framework for Design Excellence." https://www.aia.org/design-excellence/aia-framework-for-design-excellence/water

[15] U.S. Center for Disease Control and Prevention. "Waterborne Disease in the United States." Updated January 4, 2023. https://www.cdc.gov/healthywater/surveillance/burden/index.html

[16] U.S. Center for Disease Control and Prevention. "Assessing Access to Water and Sanitation." Updated March 24, 2022. https://www.cdc.gov/healthywater/global/assessing.html

[17] World Health Organization. "Improved sanitation facilities and drinking-water sources." https://www.who.int/data/nutrition/nlis/info/improved-sanitation-facilities-and-drinking-water-sources#

[18] "Draining — DIGDEEP." DIGDEEP, www.digdeep.org/draining.

Water equity and environmental justice loom large in consideration of all aspects of water quality, access, and scarcity. Water inequality exists on both sides of the building enclosure and needs to be addressed in the context of existing environmental justice laws. Executive Order (EO) 12898 defines environmental justice as the "fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."

DigDeep's study also uncovers significant disadvantages for impoverished communities, rural communities, and communities of color. Native American households are 19 times more likely than White households to lack access to clean running water and sanitation, and Black and Latino households are twice as likely as White households. Access to indoor plumbing is correlated with household income, educational attainment, and unemployment rates. Households without running water are likely to be stuck in a cycle of poverty, as yearly income is spent on accessing alternative water sources (i.e. bottled or trucked-in water) or forced to be dispersed for water insecurity-related medical issues, like increased health risks from unregulated water sources.

On the public supply side, while water inequality may be more glaringly apparent on the world stage, an extensive 2021 analysis by The Guardian newspaper of the public water systems in the US crossed with US Census data shows water inequality rampant in this country as well. Public water systems not in compliance with Federal regulations were assigned violation points. The study found that geography, race, and income all affect access to clean water. **The study further indicated that areas made up of 25% or more Latino population violated the standard at twice the national rate.** The worst performing of the public water systems provide water to 25 million people, some 5.8 million of whom are Latino. Interestingly, violation points in rural counties surpass metropolitan counties by 28 percent. Compounding the problem are severe under-reporting by county water managers of EPA violations and lack of transparency in reporting, spurring public mistrust in both the process and the water supply.

The study also indicates that water quality testing usually occurs only at the water source. This limited method of testing does not account for the pollution from chemicals, such as lead, that come from the building's plumbing as the water travels to the tap. This method of testing also does not detect corrosion, such as microbiologically induced corrosion.

"Overall, rigorous enforcement of federal and state standards coupled with adequate testing is the key to curbing water inequality," according to Save the Water,™ a 501(c)(3) non-profit organization dedicated to conducting research and raising public awareness about water contamination and its health impacts. "This is especially true for local water authorities in areas where Federal and state oversight is lacking."

Decentralized Access to Water and Sanitation

Many homes and buildings rely on decentralized access to water and sanitation services. According to the US Geological Survey, more than 43 million people—about 15 percent of the U.S. population—rely on domestic (private) wells as their primary source of drinking water. The quality and safety of water from domestic wells are not regulated by the Federal Safe Drinking Water Act or, in most cases, by state laws. Instead, individual homeowners are responsible for maintaining their domestic well systems and for monitoring water quality.[19]

Further, it was reported that in 2021 only 84.5% of occupied housing units (108,574,000 housing units) are connected to public sewer and 15.2 % of occupied housing units (19.5 million housing units) used septic tank systems or

[19] https://www.usgs.gov/mission-areas/water-resources/science/domestic-private-supply-wells

cesspools).[20] But industry experts do not view these data as accurate and that the true number of households that rely on decentralized wastewater systems is significantly higher.[21]

Many of the households that rely on decentralized water and sanitation access are located in rural or disadvantaged communities. These households are significantly more likely to have very limited resources to maintain, repair, or to replace their onsite water and wastewater systems. As a result, many of these homes have failing or inadequate water and sanitation infrastructure and face significant health challenges.[22] Poor access to water and sanitation represents a public policy failure and it impacts human health, dignity, and quality of life.

The number of decentralized systems continues to grow each year. According to the National Association of Homebuilders, about 10% of new single-family homes started in 2022 were served by individual wells and 18% had private septic systems. These shares, however, vary widely across the nine Census divisions with the corresponding shares reaching 38% and 46% in New England – the highest occurrence rates in the nation.[23]

In 2005, EPA created a Memorandum of Understanding (MOU) to improve the overall performance and management of decentralized wastewater systems through facilitated collaboration among EPA, state and local governments, and industry practitioners. These MOU partners have effectively worked together to facilitate information exchange on system technology, collaborate to support training efforts, and promote public awareness on the management of decentralized wastewater systems.[24]

Rising Water Costs

Across the US, water is getting increasingly expensive. The New York Times recently noted that average water and sewer bills have increased by approximately 50% over the last decade, with additional increases forecasted.[25] These rate increases, which are likely to fall disproportionately on poor and disadvantaged communities,

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[20] U.S. Census Bureau (2021e). 2021 American Housing Survey (AHS) - AHS Table Creator. [WWW Document]. Available at: https://www.census.gov/programs-surveys/ahs/data/interactive/ahstablecreator.html?s_areas¼00000&s_year¼2021&s_tablename¼TABLE2&s_bygroup1¼1&s_bygroup2¼1&s_filtergroup1¼1&s_filtergroup2¼1 (accessed 18 November 2022).

[21] Jillian Maxcy-Brown; Mark A. Elliott; Bennett Bearden. "Household level wastewater management and disposal data collection in the U.S.: the history, shortcomings, and future policy implications." Water Policy. World Water Council. September 2023. https://iwaponline.com/wp/article/25/9/927/97569/Household-level-wastewater-management-and-disposal

[22] Capone D, Bakare T, Barker T, Hutson Chatham A, Clark R, Copperthwaite L, et al. "Risk factors for enteric pathogen exposure among children in Black Belt Region of Alabama, USA." Emerg Infect Dis. 2023 Dec [date cited]. https://doi.org/10.3201/eid2912.230780

[23] Fu, Jing. "New Homes Built with Private Wells and Individual Septic Systems in 2022." NAHB. October 2023. https://eyeonhousing.org/2023/10/new-homes-built-with-private-wells-and-individual-septic-systems-in-2022/

[24] US EPA. "EPA's Decentralized Wastewater Partnership." Updated January 18, 2024. https://www.epa.gov/septic/epas-decentralized-wastewater-partnership

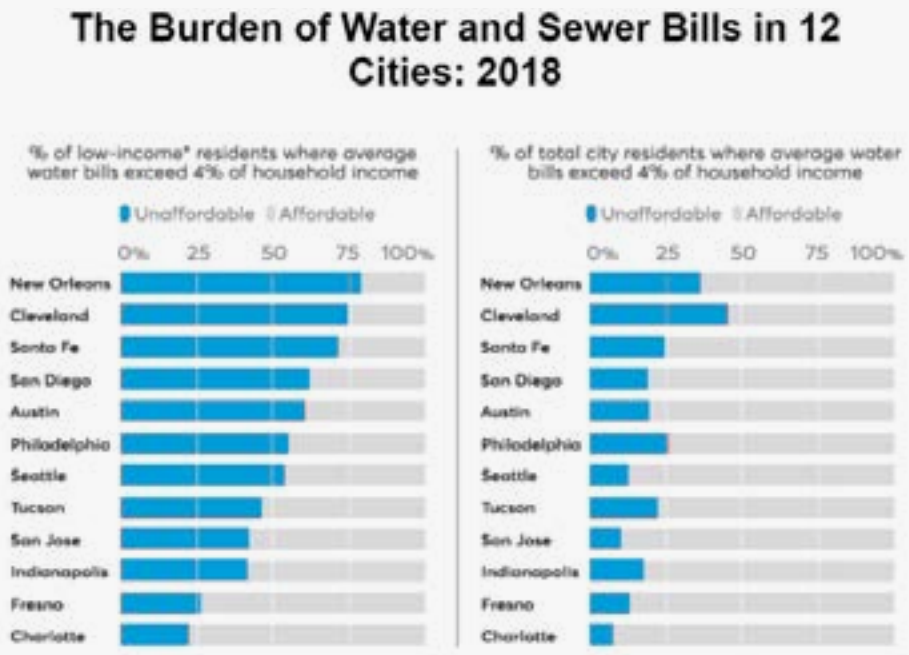
[25] Carrns, Ann. "Water Bills Are Rising. Here's What to Do About It." The New York Times. July 14, 2023. https://www.nytimes.com/2023/07/14/your-money/water-bills-tips.html

are driven by several factors:

- Increasing costs resulting from climate change, especially ongoing drought conditions and increased rates of wildfires in the American Southwest.
- Delayed rate increases from the COVID-19 pandemic.
- Inflation and supply chain disruptions impacting service upgrades.

According to McKinsey, water bills contribute significantly to many household budgets. In 2019, nearly 20 percent of American households were paying more than 4.5 percent of their income on water bills, a level considered unaffordable.[26]

The rising unaffordability of water is also not spread evenly. Certain cities and metro areas have been harder hit than others, and in all cases the burden falls heaviest on poor and low-income residents. The image below from the Guardian/Consumer Reports highlights the growing burden of accessing potable water on the nation's poor:



Source: Guardian/Consumer Reports[27]

[26] Bielenberg, Aaron et. al. "US water infrastructure: Making funding count." McKinsey and Company. November 24, 2012. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/us-water-infrastructure-making-funding-count

[27] Lakhani, Nina. "Millions of Americans Can't Afford Water, as Bills Rise 80% in a Decade." The Guardian. July 10, 2020. https://www.consumerreports.org/money/personal-finance/millions-of-americans-cant-afford-water-as-bills-rise-80-percent-in-a-decade-a8273700709/

Water Efficiency and Reuse

Water consumption in the US has actually declined over the last 10 years, in part driven by the increased efficiency of water products in homes, businesses, and the water system generally. The primary government program supporting water efficiency is WaterSense, a voluntary labeling program sponsored by the US EPA. WaterSense-labeled products and services are "certified to use at least 20 percent less water, save energy, and perform as well as or better than regular models." [28]

According to a study commissioned by Plumbing Manufacturers International, equipping homes and non-residential commercial facilities with WaterSense-labeled products could save Americans nearly $26.4 billion annually.[29] The market for WaterSense-labeled products continues to grow over time as the figure below makes clear. The increases in market share for WaterSense-labeled products are driven primarily by the replacement market.[30]

WaterSense Products	2015 market penetration	2019 market penetration
Tank-type residential toilets	7.0%	16.8%
Bathroom sink faucets	25.4%	40.1%
Showerheads	28.7%	45.4%
Flushing urinals	Not included	1.8%
Flushometer-valve toilets	Not included	2.0%

The WaterSense program has been incredibly successful, but funding for the program is not on par with other issues related to efficiency, such as energy. Continuing to improve market penetration of WaterSense products will improve water access via increased efficiency, reduced energy demand, and better managed cost control for the end user.

Additionally, increasing pressures on water resources have led to greater water scarcity and a growing demand for alternative water sources. Onsite water reuse is one solution that can help communities reclaim, recycle, and then reuse water for non-drinking (and limited potable) water purposes. Onsite water reuse systems capture and treat water sources generated from within or surrounding a building, such as rainwater, wastewater, greywater, or stormwater. The treated water is then reused onsite or locally.[31]

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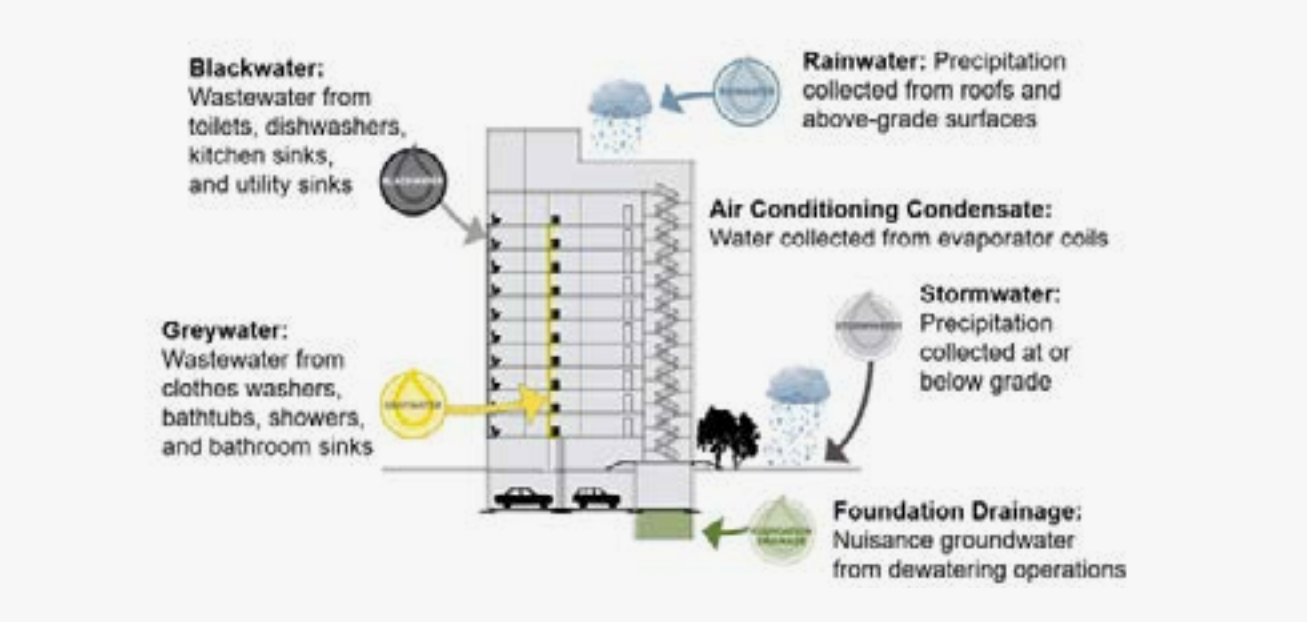
[28] EPA. "About WaterSense." June 6, 2023. https://www.epa.gov/watersense/about-watersense

[29] GMP Research, for Plumbing Manufacturers International. "2019 WaterSense Market Penetration." June 2019. https://www.safeplumbing.org/files/safeplumbing.org/documents/misc/2019-WaterSense-market-penetration-study.pdf

[30] Ibid.

[31] US EPA. "Onsite Non-Potable Water Reuse Research. Updated February 2023. https://www.epa.gov/water-research/onsite-non-potable-water-reuse-research

Recycling water on site or nearby reduces the energy needed to move water longer distances or pump water from deep within an aquifer. Tailoring water quality to a specific water use also reduces the energy needed to treat water. For example, the water quality required to flush a toilet is less stringent than the water quality needed for drinking water and requires less energy to achieve. Using recycled water that is of lower quality for uses that don't require high quality water saves energy, money, and chemical inputs by reducing treatment requirements.[32]



Lack of Data

Data on water access and water quality in buildings is not collected by the Federal government in a comprehensive, systematic way and fails to provide an adequate picture of the state of water and sanitation usage, access, and quality in the US. Multiple Federal surveys provide questions related to water, but in totality the information gleaned from US communities (especially lower-income and minority communities) does not provide enough information on those without access to clean and safe drinking water and sanitation. In addition, data collection is not done on a consistent enough basis, leading to significant gaps in knowledge that make it virtually impossible to assess changes over time.

According to DigDeep, the decennial census "used to collect detailed information on household water and wastewater access, but the questions about wastewater were removed after 1990."[33] The last question on water and sanitation in the American Community Survey was removed by the Census Bureau in 2016, so data is actually becoming more

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[32] WateReuse. "How Can Water Reuse Support the Environment." https://watereuse.org/educate/types-of-reuse/environmental-restoration/

[33] Roller, Zoe, et. al. "Closing the Water Access Gap in the United States: A National Action Plan." DigDeep. 2019. https://static1.squarespace.com/static/5e80f1a64ed7dc3408525fb9/t/6092ddcc499e1b6a6a07ba3a/1620237782228/Dig-Deep_Closing-the-Water-Access-Gap-in-the-United-States_DIGITAL_compressed.pdf

inaccurate, unreliable, and problematic for communities that still face the most acute water insecurity issues. Additionally, questions related to water usage were dropped from the 2018 Commercial Building Energy Consumption Survey.[34] Another area where the effect of water shortages is apparent but not well studied is fire protection systems.[35] A coordinated Federal and state and local effort to better understand water use in households and other buildings is needed.

In 2017, Lawrence Berkeley National Laboratory (LBNL) issued a report with support from EPA's Office of Water.[36] The report found that despite water shortages caused by drought and unmet (and growing) water infrastructure needs, little is known on the national scale of water demand within each economic sector. LBNL reviewed federal government water data collection efforts by the US Geological Survey (USGS), US Department of Agriculture (USDA), and the US Energy Information Administration (EIA). These efforts in their current form were found to be intermittent and too narrowly focused when examining water usage in the built environment. It further looked at the utility of non-national studies, which were limited by collection frequency, sample size, and geographical coverage. Ultimately, LBNL concluded that collecting and publishing national water demand data, with a level of detail similar to that in the EIA surveys, would allow for the development of metrics to gauge the water use and efficiency in buildings across economic sectors in the same manner the EIA survey instruments have enabled energy metrics and analysis.

There have been positive developments made in this area. In 2022 Congress passed the CHIPS and Science Act of 2022. This legislation included the formal creation of a National Institute of Standards and Technology (NIST) program, in consultation with EPA, for premise plumbing research – a federal policy recommendation that NIBS included in previous Moving Forward reports. With the formal authorization of this program, Congress still needs to provide NIST with adequate resources to support the research needs that NIST has identified in partnership with industry stakeholders. NIST should also be empowered in its coordination with other Federal stakeholders, including EPA and DOE, to carry out this important research agenda.

Water Quality

Minimum water quality standards for public water systems, defined by the Safe Water Drinking Act and EPA regulations, include guidelines for quality, testing schedules, and testing methods. These actions have, on average, made notable improvements in the use efficiency and quality of US water systems.[37]

While EPA and other government agencies provide standards and regulations governing supply, there are also

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[34] U.S. Office of Management and Budget. "2018 CBECS Supporting Statement A 03-26-19." March 26, 2019. https://omb.report/icr/201812-1905-004/doc/88419203

[35] Charter, Virginia R., et al. "Water Supply & Climate Change: The Impact of Water Stress on Fire Protection Systems." SFPE Foundation. December 2022. https://higherlogicdownload.s3.amazonaws.com/SFPE/c2f91981-c014-4bec-97f4-1225586937ac/UploadedImages/Water_Supply_and_Climate_Change_Report_2022.pdf

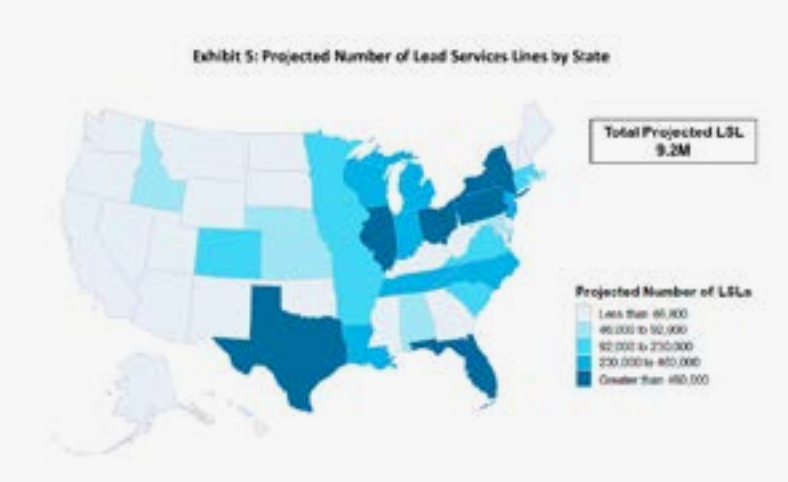
[36] Dunham, Camilla; Fuchs, Heidi; Stratton, Hannah. "Benefits of a National Survey on Water Demand." Lawrence Berkeley National Laboratory. December 2017. https://eta-publications.lbl.gov/sites/default/files/lbnl-2001085.pdf

[37] Persily, Andrew et al. "NIST Technical Note 2088: "Measurement Science Research Needs for Premise Plumbing Systems." National Institute of Standards and Technology. May 2020. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2088.pdf

[38] Ibid.

numerous standards that maintain water quality standards for buildings. Within the building, water quality concerns fall into three main categories: metallic, chemical, and biological.[38] Two examples of these standards are:

- ASHRAE/NSF 514: Prevention of Injury and Disease Associated with Building Water Systems
- ASHRAE 188: Legionellosis: Risk Management for Building Water Systems



According to the US EPA, there are an estimated 9.2 million lead service lines in the US, with the highest concentration in the Midwest, Texas, and Florida.[39] Replacing these lines should be a priority. The Bipartisan Infrastructure Law did allocate additional funding for the replacement of lead service lines in the Drinking Water State Revolving Fund.

The recent COVID-19 pandemic brought the issue of water quality within buildings to the fore. Buildings that sat unused for long periods of time faced issues of stagnant water, which can introduce and/or optimize the growth of pathogens (such as Legionella bacteria) or cause harmful changes in water chemistry that may cause corrosion or leaching of metals, both of which can be harmful to occupant health.

Aging Infrastructure

America's water distribution infrastructure, which supplies potable water to our homes and offices, is under tremendous stress. As noted by the University of Michigan Water Center, "the useful life-cycle of much of the water and sewer infrastructure is coming to an end."[40] Water main breaks are currently a constant feature of a strained infrastructure system, with nearly 250,000-300,000 breaks per year, the equivalent of water break every 2 minutes.[41] Some of the older systems in the US, which include some of the larger systems supplying major population centers, utilize pipes and other infrastructure that were laid at the end of the 19th century. The CDC data shows that Legionnaires' Disease cases in most states have doubled in the five-year period from 2014-2019. Furthermore, the CDC reports 96% of those cases were individual and sporadic, meaning they were not contracted in a cluster of related cases tied to a specific building, equipment, or plumbing fixtures. Instead, they were individual isolated

[39] US EPA. "Fact Sheet: 7th Drinking Water Infrastructure Needs Survey and Assessment." April 2023. https://www.epa.gov/system/files/documents/2023-04/Final_DWINSA%20Public%20Factsheet%204.4.23.pdf

[40] University of Michigan Graham Center for Sustainability. "Water and Sewer Infrastructure Funding and Gap." April 2022. https://graham.umich.edu/system/files/pubs/Water-Sewer-Infrastructure-Funding-Gap.pdf

[41] American Society of Civil Engineers. "Chronic Underinvestment in America's Water Infrastructure Puts the Economy at Risk." August 26, 2020. https://www.asce.org/publications-and-news/civil-engineering-source/society-news/article/2020/08/26/chronic-underinvestment-in-americas-water-infrastructure-puts-the-economy-at-risk

cases contracted in homes, businesses, healthcare facilities, etc. This indicates systemic issues with the source water supplied to the buildings and a need to reevaluate and improve the stringency of requirements of the Safe Drinking Water Act and to address aging and neglected distribution infrastructure.

A lack of investment in updating infrastructure carries substantial costs. Per McKinsey, nearly 14-18% of treated potable water is lost through leaks, with some systems reporting losses of 60%.[42] According to ASCE, leaking pipes lost the equivalent of $7.6 billion worth of treated water in 2019, with that loss rate projected to double over the next 20 years. ASCE further notes that businesses and homes most reliant on water will spend $250 billion in 2039 on water service disruptions.[43] Coupled with increasing threats from drought, natural hazards, and climate change, the nation's aging water infrastructure is projected to be a significant threat to the nation's public health, as well as to the budgets of America's families.

While recent Federal legislation has dramatically increased the available funds for water infrastructure improvements, funding for water infrastructure improvements and upgrades does not match the current need, at any level. As noted by McKinsey, this is especially true in light of new regulations from the EPA to limit or remediate certain man-made chemicals in the water system.[44]

Workforce

Per Brookings Institute, in 2016 there were 1.7 million workers across 212 occupations involved in designing, constructing, and operating the nation's water infrastructure.[45] As with workforce across much of the building sector, the water supply and plumbing industry is facing a shortage of skilled workers, as well as a lack of workers in the pipeline. In its annual "State of the Water Industry" survey, the American Water Works Association found that an "Aging workforce/anticipated retirements" ranked sixth out of 20 Water Sector Challenges.[46] As noted by the US EPA, more than one-third of the water industry workforce is expected to retire in the next 10 years, indicating the critical need to invest in the nation's water workforce. It is also important that the next generation of workforce be properly trained for adaptation and deployment of the latest in best practices and technological innovations that are prescribed in the most up-to-date model codes and industry standards when delivering solutions to communities in the decades ahead.

Finding, hiring, and retaining qualified professionals continues to affect many trades, including plumbing. In

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[42] Bielenberg, Aaron et. al. "US water infrastructure: Making funding count." McKinsey and Company. November 24, 2012. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/us-water-infrastructure-making-funding-count

[43] American Society of Civil Engineers. "Chronic Underinvestment in America's Water Infrastructure Puts the Economy at Risk." August 26, 2020. https://www.asce.org/publications-and-news/civil-engineering-source/society-news/article/2020/08/26/chronic-underinvestment-in-americas-water-infrastructure-puts-the-economy-at-risk

[44] Bielenberg, Aaron et. al. "US water infrastructure: Making funding count." McKinsey and Company. November 24, 2012. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/us-water-infrastructure-making-funding-count

[45] Kane, Joseph W.; Tomer, Adie. "Renewing the water workforce: Improving water infrastructure and creating a pipeline to opportunity." Brookings Institute. June 2018. https://www.brookings.edu/articles/water-workforce/

[46] American Water Works Association. "State of the Water Industry 2023." https://www.awwa.org/Portals/0/AWWA/ETS/Resources/2023-SOTWI-Full-Report.pdf

construction, builders report a 55% shortage of plumbers available for work training. The US Bureau of Labor Statistics estimates there will be 42,600 plumber, pipefitter, and steamfitter vacancies in the country each year between now and 2032.[47] This lack of skilled labor is straining current plumbers on multiple fronts, from demanding longer hours to having to decline work opportunities because they don't have the bandwidth to complete the jobs.

Recommendations from the Consultative Council

Data: The Federal government must coordinate and consolidate how data on water access, use, and quality in buildings is measured. Current Federal data-gathering efforts regarding water are irregular and uncoordinated, with primary efforts at measuring water access and quality in buildings mainly driven by the EPA's surveys of drinking water systems. A more comprehensive effort to understand water systems and water use in buildings is needed, with input from multiple Federal agencies, and must be provided on a consistent and regular basis. The White House should convene a multi-agency working group to develop and implement a coordinated water data strategy including funding needs. Congress should appropriate funding to support this strategy.

Efficiency: The WaterSense program should be expanded, with a focus on improving water efficiency for those with the least access to water-efficient products. This includes ensuring that when promoting "Efficiency," water is given similar imperative as energy. In addition, water needs to be better integrated into, or given increased focus by, Federal efficiency efforts, emphasizing how it relates to energy efficiency. This also includes expanding the use of alternate water sources in Federal buildings, including rainwater, stormwater, and greywater. In addition, better understanding the interplay of energy efficiency, carbon reduction strategies, water efficiency, and current plumbing codes and standards is critical to ensuring safe water for occupants.

Funding: In addition to recent legislation providing additional funding for water infrastructure, including the Infrastructure Investment and Jobs Act, the Federal government must continue to increase its share of funding to water infrastructure projects. McKinsey estimates that, despite recent increases in funding, a 22 percent gap remains between the capital required to properly update America's water infrastructure and the funds available. Additionally, funding should be provided to ensure and increase equity and affordability among the most vulnerable. While funding should be made available to all systems, targeting funding to improve water access and quality for lower-income and traditionally marginalized communities should be made a priority. Many existing funding mechanisms are currently focused on the capital costs for installing the water and wastewater systems; there also needs to be consideration for

[47] U.S. Department of Labor. "Plumbers, Pipefitters, and Steamfitters." Occupational Outlook Handbook. Last Modified September 6, 2023. https://www.bls.gov/ooh/construction-and-extraction/plumbers-pipefitters-and-steamfitters.htm

the long-term sustainability of systems that are installed. Many of the systems will serve low-income residents who are unable to afford the ongoing operation and maintenance expenses, which could potentially prevent long-term access to clean drinking water and safely managed sanitation. Congress and the Administration should prioritize the following programs and initiatives through funding commensurate with their impacts:

- WaterSense
- Drinking Water State Revolving Fund (including potential reduction in match requirements for disadvantaged jurisdictions and a focus on long-term operations and maintenance of systems)
- NIST Plumbing Research Lab

Prioritizing Research: In 2019, the National Institute of Standards and Technology developed a list of prioritized research required for overcoming technical research knowledge gaps for providing plumbing systems to provide access to clean water.[48] The Council supports actualizing the research outlined in the report through the effective implementation of the recently authorized NIST Plumbing Research Act. This includes supporting NIST in developing an appropriate Roadmap with goals and funding to see the research through. It also includes strengthening NIST's coordination with DOE, EPA, and other Federal agencies, as well as state and local actors, and private industry in carrying out this research agenda. Congress and the Administration should prioritize research as identified in the roadmap through appropriations and budgets.

Strategy: Currently, there is no national strategy working towards providing universal access to clean drinking water and effective sanitation to many communities. The Council supports the development of a national strategy for providing sustainable water and sanitation services to rural and disadvantaged communities, including those that rely on decentralized systems. EPA should lead (with Congressional approval as needed and with the engagement of other relevant agencies) development of a national strategy for sustainable water and sanitation services in rural and disadvantaged communities. This should be linked to EPA's existing decentralized wastewater initiative.

Updated Regulations: Increased rates of waterborne illness, like Legionnaires' Disease, over the last decade indicate a need to reevaluate Federal water treatment standards in the Safe Drinking Water Act and make adjustments as needed. Frequent water line breaks and disruptions can compromise the water entering all types of buildings and necessitate the testing of water further downstream in the distribution system than water providers have typically done. The Federal government should support communities in the regular update to plumbing codes and related standards and support their effective implementation, providing technical assistance and grant funding (similar to funding provided for energy code adoption and implementation through IIJA and BIL).

Workforce: Federal and state and local governments should work together to invest in the water workforce. This includes plumbers and other individuals who work to ensure water access and quality both within the larger systems as well as within the building itself. This includes investment in attracting new skilled workers into the water sector, as well as continued education and training for the current workforce to ensure that today's workers are up-to-date on the latest technologies and practices. For example, EPA should expand the Water Industry Workforce Initiative to increase the scope and breadth of the program and continue to attract top talent into the building water workforce.[49]

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[48] Persily, Andrew et al. "NIST Technical Note 2088: "Measurement Science Research Needs for Premise Plumbing Systems." National Institute of Standards and Technology. May 2020. https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2088.pdf

[49] US EPA. "America's Water Workforce Initiative: A Call to Action." https://www.epa.gov/sites/default/files/2020-11/documents/americas_water_sector_workforce_initative_final.pdf

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