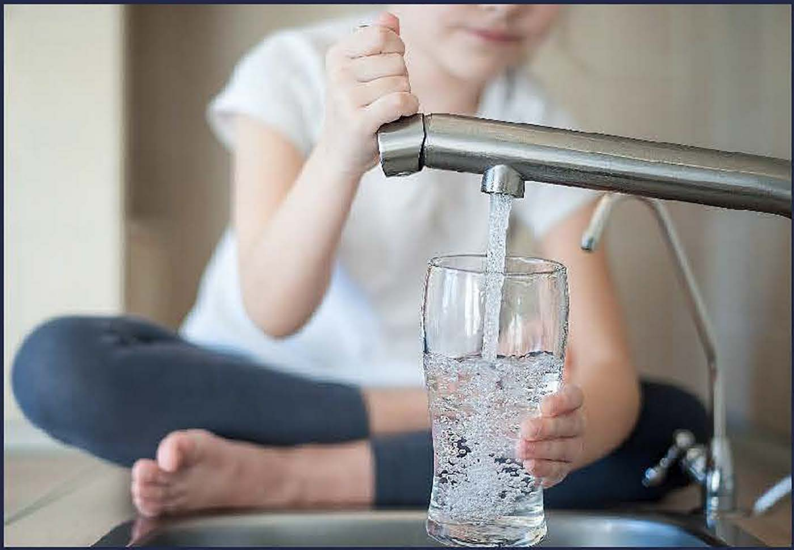
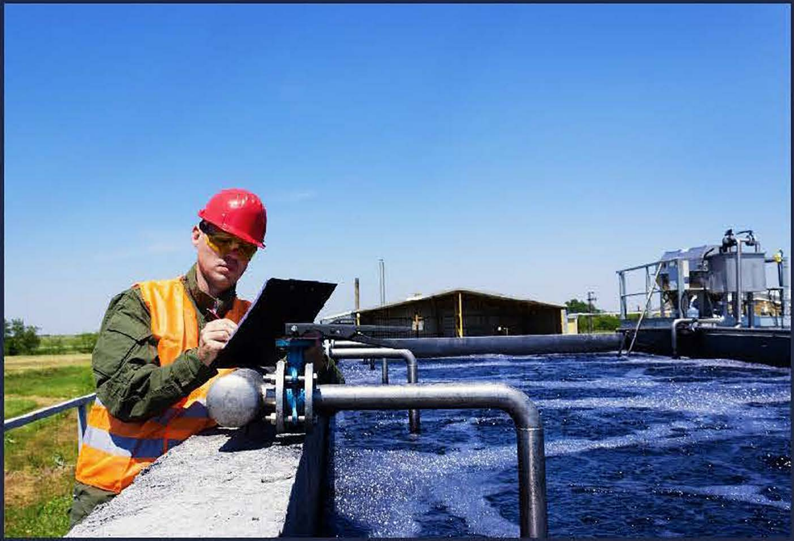
NIAC The President's National Infrastructure Advisory Council





Preparing United States Critical Infrastructure for Today's Evolving Water Crises

August 2023

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About the NIAC

The President's National Infrastructure Advisory Council (NIAC or the Council) is composed of senior executives from industry and state and local government who own and operate the critical infrastructure essential to modern life. The Council was established by executive order in October 2001 to advise the President on practical strategies for industry and government to reduce complex risks to the designated critical infrastructure sectors.

At the President's request, NIAC members conduct in-depth studies on physical and cyber risks to critical infrastructure and recommend solutions that reduce risks and improve security and resilience. Members draw upon their deep experience, engage national experts, and conduct extensive research to discern the key insights that lead to practical Federal solutions to complex problems.

For more information on the NIAC and its work, please visit: https://www.cisa.gov/niac.

Executive Summary

Water crises threaten the security and resilience of our nation's critical infrastructure. This report identifies the challenges we are confronted with and provides recommendations to address them.

The NIAC's **recommendations** include the following:

Aid Infrastructure Owners and Operators

1. Create, incentivize, and enforce standards for water use and quality.
2. Remove barriers to new ways of funding water projects.
3. Invest in innovation to increase storage, access, and management options for the future.
4. Assist low-income and vulnerable populations.
5. Increase national resiliency to drought, floods, and other water-related crises.
6. Invest in the water infrastructure workforce.

Mitigate Cross-Sector Impacts

1. Invest in reliable infrastructure in U.S. river systems to, among other things, improve energy generation capabilities and rehabilitate dams.
2. Modernize and make flood resilient the inland waterways transportation system and coastal waterways.
3. Support adaptive practices and promote smarter irrigation technology so farmers, ranchers, and forest landowners can more efficient and resilient.

Create a **National Water Strategy**

1. Elevate the importance of water in the national consciousness through a public awareness program.
2. Institute either a **Department of Water** or some other entity that stewards water issues at the Cabinet level.

The NIAC concludes that successful mitigation of the risks water crises presents requires a coordinated effort among owners, operators, and local, Federal, and state government. The response must be nuanced, timely and intent on delivering results that strengthen the security and resilience of our nation's critical infrastructure. To achieve the desired outcomes, the NIAC recognizes that innovation, investment, and incentives play a pivotal role in creating long-term gains. This report explores where we are and a better way forward in the form of recommendations and a Federal-level water strategy.

Introduction

On December 27, 2022, The National Security Council (NSC) tasked the NIAC to answer the following questions:

How should the U.S. Federal government help critical infrastructure owners and operators prepare for the rapidly evolving water crisis (including the Colorado River Basin) and what actions should we take now to minimize cross-sector impacts?

As a result of its deliberations, the NIAC:

- Identified eight main areas in which the U.S. Federal government can aid owners and operators of critical infrastructure prepare for the evolving water crisis and six major categories of recommendations associated with them;
- Focused on four critical sectors that are strongly connected to water and provided four recommendations to minimize cross-sector impacts of the evolving water crisis; and
- Proposed the creation of a national water strategy stewarded by a new Department of Water or Cabinet-level entity.

Our nation's water infrastructure and the reliance of water on other critical infrastructure is extremely complex. It is acknowledged that the topics and recommendations in this report are not exhaustive in nature. The NIAC, in its deliberations, focused on what it viewed as possibly the most imminent critical issues.

1. The NIAC's Charge

The NSC tasked the NIAC with the following:

> *How should the U.S. Federal government help critical infrastructure owners and operators prepare for the rapidly evolving water crisis (including the Colorado River Basin) and what actions should we take now to minimize cross-sector impacts?*

2. Subcommittee Activities

The Subcommittee held the following meetings and received the following briefings from Water Agencies, Water Organizations, Water Utility Owners and Operators, Research Centers, and Members of Academia:

February 23, 2023 – Kickoff meeting for the Subcommittee.

March 2, 2023 – Subcommittee meeting focusing on the study topic question. The Subcommittee Chair asked subcommittee members the following questions:

- *Identify a list of issues related to water crisis and water security including the Colorado River Basin.*
- *Provide recommendations on how the U.S. Federal government can help critical infrastructure owners and operators prepare for the rapidly evolving water crisis including the Colorado River Basin.*
- *Identify actions to minimize cross-sector impacts.*

March 9, 2023 – Subcommittee meeting focused on subcommittee member discussion of cross-sector issues related to water supply and potential briefers.

March 16, 2023 – Subcommittee meeting focused on discussion of water supply, water moving and water conserving issues, and potential briefers on these issues.

March 23, 2023 – Subcommittee meeting focused on discussion of water supply issues pertinent to actionable recommendations.

March 30, 2023 – Subcommittee meeting focused on water supply issues pertinent to actionable recommendations. The Subcommittee Chair asked members to provide three names for briefers or three major areas of expertise related to the issue.

April 6, 2023 – Subcommittee briefing from Mr. Del Shannon, President of the United States (U.S.) Society of Dams and Chief Dam Engineer at Kiewit, followed by a question-and-answer session.

April 13, 2023 – Subcommittee briefing from Mr. Michael Lee Connor, Assistant Secretary of the Army for Civil Works, followed by a question-and-answer session.

April 20, 2023 – Subcommittee briefing from Mr. Eddie Belk, Director of Civil Works, U.S. Army Corps of Engineers; and Dr. Robert Webb, Director of the National Oceanic and Atmospheric Administration (NOAA) Physical Sciences Laboratory, followed by a question-and-answer session.

April 27, 2023 – Subcommittee briefing from Dr. Seth Meyer, Chief Economist, and Mr. Brad Rippey, Meteorologist, U.S. Department of Agriculture (USDA), followed by a question-and-answer session.

May 4, 2023 – Subcommittee briefing from Ms. Leslie Meyers, Associate General Manager and Chief Water Resources Executive of the Salt River Project in Arizona, followed by a question-and-answer session.

May 11, 2023 – Subcommittee briefing from Mr. Andrew Lee, General Manager and CEO, Seattle Public Utilities (SPU); Mr. Corey Williams, Member of the Board of Trustees, Water Environment Federation (WEF); Mr. Calvin Farr, General Manager and CEO, Prince William County Service Authority (PWCSA); and Mr. Michael Johnson, General Manager, Birmingham Water Works Board, followed by a question-and-answer session.

May 18, 2023 - Subcommittee briefing from Mr. Ken Jenkins, Chief Water Resource Sustainability Officer, California Water Service (Cal Water); Mr. Scott Wagner, Director Water Resource Manager, Cal Water; Mr. Lester Snow, Chair, Emergency Preparedness Safety & Security Committee, Cal Water; Ms. Erica Brown, Chief Policy and Strategy Officer, Association of Metropolitan Water Agencies (AMWA); Mr. Dale Pierson, Executive Director, Rural Water Association of Utah (RWAU); and Mr. Kurt Pfeifle, Executive Director, South Dakota Association of Rural Water Systems (SDARWS), followed by question-and-answer sessions after each briefer.

May 25, 2023 - Subcommittee briefing from Mr. Jared Mitchem, Regional Vice President, Tennessee Valley Authority (TVA); Mr. James Everett, Manager of the River Forecast Center, River Management, TVA; Mr. Alex Sadler, Training and Development Consultant, TVA Economic Development's Community Development Team; Mr. Wes Kelley, President and Chief Executive Officer, Huntsville Utilities (HSVUTIL); and Mr. Frederick Mucke, Director of Water Operations, HSVUTIL. A question-and-answer session followed, and then the subcommittee met separately to work on report recommendations.

June 1, 2023 – The Subcommittee met to discuss their draft report and recommendations.

June 2, 2023 – The Subcommittee invited the full NIAC to attend a Subcommittee meeting to hear initial details of the draft Water Security Report.

June 7, 2023 – The Subcommittee Chair met with U.S. Bureau of Reclamation Commissioner Camille Touton to discuss the Department of Interior's "Watermaster" role and the Colorado River Basin.

June 8, 2023 – The Subcommittee met to discuss their draft report and recommendations.

June 29, 2023 – The Subcommittee met to discuss their draft report and recommendations.

July 6, 2023 – The Subcommittee met to explore the idea of creating a national water strategy and a U.S. Department of Water in the revised report.

July 14, 2023 – Subcommittee briefing from Mr. David Travers, Director, Water Infrastructure and Cyber Resilience Division (WICRD), U.S. Environmental Protection Agency (USEPA); Mr. Roger Gorke, Senior Policy Advisor, (USEPA), Office of Water, National Drought Resilience Partnership (NDRP) and Western Water; Mr. Curt Baranowski, Environmental Protection Specialist, (USEPA); Ms. Dawn Ison, Geologist, Water Security Division, Emergency Response Team, (USEPA); Mr. Steve Fries, Technical Assistance Lead and Physical Scientist, Creating Resilient Water Utility (CRWU), (USEPA), followed by a question-and-answer session.

July 20, 2023 – The Subcommittee met to discuss their draft report and recommendations.

July 31, 2023 – The Subcommittee Chair met with Mr. Eric Rollison, Assistant Director for Risk Analysis, Resilience, and Recovery at the US Department of Energy's Office of Cybersecurity, Energy Security, and Emergency Response (CESER).

3. Organization of this Report

This report is organized as follows:

Aid Infrastructure Owners and Operators

1. *Challenges in the Evolving Water Crisis for Critical Infrastructure Owners and Operators* details eight problem areas for critical water infrastructure owners and operators.
2. *Recommendations to Aid Infrastructure Owners and Operators* details six recommendations for how the government can help prepare water infrastructure owners and operators for the evolving water crisis.

Mitigate Cross-Sector Impacts

1. *Mitigation of Cross-Sector Impacts Due to the Water Crisis* details five sectors that are impacted by the water crisis.
2. *Recommendations to Mitigate Cross-Sector Impacts* details three ways that the government can help with cross-sector water challenges.

Create a National Water Strategy

1. *Need for a National Water Strategy* describes why a national water strategy is needed.
2. *Recommendations for a National Water Strategy* provides two elements necessary in a national water strategy.

Challenges in the Evolving Water Crisis for Critical Infrastructure Owners and Operators

In 2018, Cape Town, South Africa, a city of over 4 million people, faced the possibility of a “Day Zero,” or the day when taps in a city would run dry. Persistent droughts over the last three years had depleted water in Cape Town’s water storage reservoir. Increasingly harsh measures had reduced water usage by fifty percent, but that had not sufficed. Fortunately, the rains came, and the reservoirs were replenished. “Day Zero” was averted.

Could a “Day Zero” happen in the U.S.? The American West has faced persistent droughts, and cities like Los Angeles, CA and Phoenix, AZ are spending vast sums and crafting innovative strategies to avert a “Day Zero” crisis. Flint, Michigan and Jackson, Mississippi are examples of other water emergencies where a different Day Zero occurred when the drinking water sources were contaminated for a sustained period and caused severe harm to the population. Water access in the U.S. is a slow-rolling crisis filled with a series of headline events but no coordinated response addressing the core or root cause issues identified above.

Water access is central to every aspect of the U.S. economy. Per the United States Geological Survey (USGS), power generation is the biggest user of our nation’s water at 41%; irrigation, at 37%, is the next largest user; public consumption is at 12%; and mining/industrial/technology/manufacturing use composes another 6%. Surface water provides roughly 60% of the public water supply, with the remaining 40% coming from groundwater aquifers.

Delivering water to communities, businesses, and industries in the U.S. is complex. As a member of the subcommittee has said, “all water is local.” However, water is not often located where it is ultimately needed. Large water supply infrastructure such as dams and reservoirs capture precipitation and store water until it is used. Dams and reservoirs also often play a role in flood control and navigation on inland waterways. Canals and other conveyances distribute raw water to where it is treated. Water infrastructure at the local level consists of treatment plants, distribution pipes, pumps, and other drinking water facilities. Federal, state, tribal, county, and municipal governments as well as private entities and public/private partnerships own and/or operate parts of this critical infrastructure. This complexity extends to the framework within the U.S. Federal government that stewards water at the national level (see Appendix A).

The NIAC identified the following eight themes in discussions of how to help owners and operators of critical water infrastructure prepare for the rapidly evolving water crisis:

1. Unsustainable Use of Water

The nation’s current state of water infrastructure and increasing demand for fixed supply of water is unsustainable. Decades of chronic underfunding and underinvestment have impacted the condition, reliability, and resiliency of the nation’s critical water infrastructure. The U.S. government’s share of capital costs on water infrastructure fell from around 60% in 1977 to below 10% in 2020.

The American Society of Civil Engineers’ (ASCE) *Report Card for America’s Infrastructure* 2021 report analyzed the impact of not investing in drinking water and wastewater infrastructure on the gross domestic product, businesses, households, and public health. The report predates the current Federal investment in water infrastructure, namely the Infrastructure Investment and Jobs Act (IIJA).[1] The ASCE report[2] states that in 2019, the total capital spending on drinking water and wastewater infrastructure at the local, state, and Federal levels was approximately $48 billion, while investment needs totaled $129 billion, creating an $81 billion gap for just that year. The IIJA appropriated to the Environmental Protection Agency (EPA) roughly $50 billion on drinking water and wastewater infrastructure improvements over five years (or $10 billion per year). This investment by the Federal government and the American people clearly helps to close the gap in annual water infrastructure investment but does not cover all of the nation's drinking water and wastewater infrastructure investment needs. Sustainable water systems should provide adequate water quantity and appropriate water quality for a given need, without compromising the future ability to provide the required capacity and quality. Attaining a sustainable water supply requires sustained investment at all levels of government.

Yet, U.S. potable water is still among the safest and most reliable in the world. The great majority of Americans have the benefit of clean, inexpensive water on demand. But most of our water supply infrastructure is at or nearing the end of its design life. Extreme weather events prompt more frequent boil orders due to failure of stressed aged water infrastructure. The American Water Works Association (AWWA) estimates that most of the nation's existing drinking water pipes must be repaired or replaced before 2040, necessitating a "replacement era" that will dramatically increase costs to utilities and their customers. ASCE's 2021 *Report Card for America's Infrastructure* gave U.S. dams a "D" grade, and the Association of State Dam Safety Officials (ASDSO) has identified over 15,000 dams that pose a high hazard of failure. The ASDSO also estimated in 2022 that the cost of rehabilitation of non-Federal dams is $75 billion due to decades of deferred maintenance and repair.

The true costs of supplying and treating water (i.e., the "value" of water) are often not reflected in the price the consumer pays. Water utilities have resisted increasing the price of water until recently, and instead covered the increasing cost through reductions in operations and maintenance (O&M). Due to deferred maintenance, about one-sixth of finished water in the U.S. never reaches customers but leaks out of storage and distribution systems. This loss of revenue is borne by the utilities because leaked water cannot be billed since it never reached the user.

The other reason that our nation's current use of water is unsustainable is overreliance on stored surface water and groundwater, particularly in the arid western states. Groundwater can be a sustainable water supply source if the total water entering, exiting, and being stored in the aquifer is conserved at sustainable levels. Similarly, surface water captured from rain and snowmelt and water stored in dammed reservoirs can be used sustainably if the water levels in the reservoirs are maintained at viable levels.

In the West, population growth and rampant development, decades of drought, overuse of stored surface water, and over-pumping of groundwater have created a critically unsustainable situation. The water levels of the nation's two largest reservoirs, Lakes Mead and Powell, are at record low levels, impacting hydropower production and the ability to operate the associated dams. The Colorado River is a case in point, and its water issues are exacerbated by several factors. The total amount of water that the century-

[1] IIJA investments include $11.7 billion to the Drinking Water State Revolving Fund (DWSRF) and $11.7 billion to the Clean Water State Revolving Fund (CWSRF) to improve water infrastructure, $15 billion to replace lead pipes, and $5 billion to DWSRF and CWSRF, and $5 billion to Water Infrastructure Improvements for the Nation (WIIN) Act grant programs to assist in the removal of emerging contaminates (PFAS) from 2022 to 2026. Other water related IIJA investments include $17.1 billion to the U.S. Army Corps of Engineers for inland waterway infrastructure construction, repair, and operations and maintenance and $16.8 billion to the Bureau of Reclamation for repair of aging water infrastructure and drought resilience.

[2] The remainder of this report does not cover on the nation's wastewater treatment needs but instead focuses on drinking water and water supply.

old Colorado River Compact uses as a base amount is more than the Colorado River can supply. The area is in its 23rd year of drought, so the river's flow is down by about 20% when compared to flows in the 1900s. Yet water usage has dramatically increased over the years and has not been significantly scaled back until the 2023 Colorado River agreement. In this deal, the three Lower Basin states will cut 1 million acre-feet of consumption each year for the next three years. About 75% of the cuts will be compensated for through IRA funds,[3] mostly by paying farmers to reduce irrigation. Even historic water users with senior rights are working to address the drought. The Gila River Indian Community, in an agreement to reduce water usage in exchange for infrastructure and conservation dollars, expects to conserve 600,000-acre feet (or 10 feet) in Lake Mead. This is a strong signal for the desert-based tribe which relies on agricultural usage for much of its land use. Although these agreements will significantly increase water levels in Lake Powell, they are temporary and do not bring the reservoir's water level up to sustainable levels. The rain and snowfall from the atmospheric river events over the winter of 2022-2023 are not adequate to end the drought. Furthermore, much of that stormwater was discharged into the ocean rather than being captured in ways that would contribute to resupplying our water systems. If the megadrought continues, a more sustainable solution must be reached.

Other areas are taking unprecedented steps to solve water scarcity. Arizona is now limiting future development, mostly in the Phoenix area, by denying new Certificates of Assured Water Supply required for new construction in locations that rely on groundwater for water supply. In California, the State Water Resources Board is accelerating permitting of projects that recharge aquifers to capture and beneficially use floodwaters from recent atmospheric river weather events; the state understands that the availability of water has a direct impact on economic development.

Ways to Increase Water Supply Sustainability

Aquifer recharge can return overprescribed aquifers back to health, if they have not been pumped below unrecoverable levels, by injecting water into wells. This can prevent salt-water intrusion into a freshwater aquifer or reduce land subsidence. Aquifer storage is used to store water for later retrieval and beneficial use, much like storage of surface water in dam reservoirs but without losses associated with evaporation. A caveat is the risk of induced seismicity with deep strata injection. The National Ground Water Association posits that aquifers should be considered natural infrastructure and advocates for the conjunctive use of surface and groundwater and for managed aquifer recharge. Examples of conjunctive use in rural Arkansas are the Bayou Meto and Grand Prairie Water Management Projects.

Aquifer health monitoring is traditionally done using point measurements at wells, but the use of remote sensing using satellites and drones also provides additional data. The U.S. National Aeronautics and Space Administration's (NASA) Gravity Recovery and Climate Experiment (GRACE) satellites are now providing information on water movement and water storage on Earth and can help estimate fluxes such as evapotranspiration, providing new ways to monitor changes in groundwater availability.

Dams, reservoirs, underground storage containments, and canals are used in storing and moving surface water. Lining and covering canals in dry regions can minimize water loss through seepage and evaporation, respectively. Project Nexus in the San Joaquin Valley is hoping to reduce water evaporation in existing open channel segments while generating renewable energy (in a state with a 2045 goal of being carbon neutral) by placing solar panel canopies to shade the canals.

[3] These include water-related IRA investments in the creation of a Lower Colorado River Basin Conservation and Efficiency Program

Harvested rainwater and greywater can be used for non-potable purposes such as for landscape use. Reclaimed water (both greywater and blackwater) can be treated to the appropriate quality and used for drinking, irrigation, or industrial purposes. Desalination, because of its expense and high energy use, is not yet considered sustainable, although use of renewable energy and development of technologies to increase its efficiency will eventually increase desalination's attractiveness. Water reuse (water recycling) is the use of municipal wastewater, industrial cooling or process water, agricultural runoff, or produced water from extraction activities such as fracking and mining as source water for potable and non-potable purposes.

An example of a country with a sustainable water program is Israel. To meet its water demands, Israel has a highly integrated water management system that combines desalination, recycling of wastewater, and stormwater capture for aquifer recharge. It is so successful that, even with its arid climate, Israel is now a water exporter. Israel's Ministry of Energy and Water (cabinet-level) carries out water policy, and Israel's national water company, Mekorot, is a government-owned corporation that supplies about 70% of the water needs of the nation. The country's water program also includes nationwide mandates targeted on curbing domestic water usage by encouraging low flow appliances to increase efficiencies in households. Select countries' national water management frameworks can be found in Appendix B.

2. Issues with Water Quality

Raw water quality can be impacted at its source (groundwater, rivers, and reservoirs) and treated (finished) water can be contaminated during distribution from the treatment plant *en route* to the customer. Sources of contamination include fertilizers and pesticides applied to farmland, or runoff from concentrated animal feeding operations,[4] outflows from manufacturing operations, sewer overflows, storm water, the dissolving of chemicals found in rock and soil into groundwater, the dissolving of chemicals such as lead in pipes, pipe joints, and other fixtures into finished water during distribution, and seepage of contamination into leaks in distribution pipes if water pressure is lost. Climate change impacts source water quality because more intense rainfall can increase both the concentration of pollutants and sediment beyond those occurring during normal conditions. Sea level rise can also cause salt contamination of coastal aquifers as well as near-delta riverine freshwater intakes. The risk of the latter can be reduced through the construction of temporary sills at the river bottom below intakes to halt saltwater intrusion.

Recent water quality issues of concern are lead in distribution piping and per- and polyfluoroalkyl substances (PFAS) in source water. The EPA estimates that there are over 9 million lead service lines that are known to be a significant source of lead contamination. According to AWWA, $60 billion is needed to replace lead pipes; the IIJA investment in lead pipe removal is $15 billion, leaving a gap of $45 billion to be paid by utilities and their customers. New EPA regulations setting limits on PFAS in drinking water have recently been proposed due to the impact of PFAS on public health. The proposed National Primary Drinking Water Regulations (NPDWR) will require public water systems to monitor for PFAS and reduce levels if they exceed the proposed limits. Costs for the monitoring, removal, and disposal of PFAS will exceed the additional EPA funding available, requiring utilities and their ratepayers to cover the rest. Such unfunded or underfunded mandates add additional stress to water providers who also must replace aging infrastructure and assure sustainable water supplies. It requires water providers to install new processes and equipment

[4] Congress, the state of Florida, and the U.S. Army Corps of Engineers have been working hard to fund and implement the Comprehensive Everglades Restoration Plan (CERP). The Everglades is a unique network of subtropical wetlands in South Florida that, according to the Everglades Foundation, provides water for one in three Floridians and has been severely impacted by years of excess use of fertilizer by the sugar industry. The Biden Administration announced in 2022 that $1 billion of the IIJA would be dedicated to restoring the Everglades.

such as granular activated carbon filtration or reverse osmosis and ion exchange systems and to have the needed skilled personnel to operate the new processes.

3. Water Inequity and Unaffordability

Water supply infrastructure in the U.S. ranges from large municipal systems serving millions of people to private wells serving a single family. The majority of U.S. residents have access to clean, reliable drinking water, but not everyone. An estimated 0.5% to 1% of U.S. residents do not have piped water; these instances often occur in low income and minority communities (colonias communities in Texas, tribal lands, and Alaskan Native villages). USGS estimates that 15% of the U.S. population relies on individual or shared water systems. These systems are most often in rural areas where water quality testing is limited and are generally subject to few regulations. Most U.S. residents get their water from community water systems. This does not guarantee the water quality or reliability of the system. Just 9% of the community water systems provided water to 80% of the country with the remaining 91% servicing small communities. Small water systems more often service low-income areas.

Ideally the price of water covers the cost of providing it. Many factors impact the ability of providers and their ratepayers to develop and maintain needed water supply capabilities. One factor is the age of the water infrastructure. Many jurisdictions do not account for the full lifecycle cost of building, operating, maintaining, upgrading, and replacing systems. Often water utility owners and operators are unable or unwilling to raise rates to pay for needed investment. Rates can be based on the least cost, which relies on patching and repairing and ignores longer-term problems and consequences. This has negative impacts on water quality and reliability. Low-income and vulnerable communities are more likely to lack access to clean reliable water.

Climate change and water scarcity also impact marginalized and low-income communities disproportionally. In regions where drinking water is obtained from aquifers that are being depleted, large utilities are more likely to have the financial resources required to drill deeper water wells, but adjacent rural or low-income communities are challenged to do so.

4. Fragmentation of Water

As previously mentioned, in the U.S., the over 150,000 public water systems are owned and/or operated by a variety of entities. Roughly 80% of all water utilities are publicly owned and operated by municipalities. Most of these are small with the great majority of publicly owned water systems serving populations of less than 3,300. Community water systems are not typically connected to adjacent systems, unlike electricity and transportation infrastructure which are interconnected into national networks. Small publicly owned water systems are less likely to have the resources to deal with short- or long-term water scarcity, to have access to diverse sources of raw water, and often have limited ability to store treated water for resiliency during short term outages. Each state and jurisdiction also have specific laws regarding access and water rights adjudication that impact water fragmentation.

Water service regionalization occurs when multiple individual water systems consolidate operations, maintenance, and/or financial management. This consolidation can be small scale, such as joint procurement, or complex and large in scope. The objective is to realize operational efficiencies and economies of scale. It can also provide greater financial stability and access to capital. Full scale consolidation requires complex coordination between municipalities, changes in the way water is managed, and often construction of new infrastructure.

Adjacent utility owners and operators can make simple regional agreements for water sharing, which would require interconnection of the utilities' systems. An example of this type of arrangement is Tennessee Valley Authority's (TVA) interconnection with several neighboring rural systems (this agreement is limited to water transfer during emergencies). TVA has access to surface water, while the adjacent systems rely solely on groundwater for their raw water needs. Groundwater availability is diminished during times of extended drought, so TVA will transfer water to their neighbors in a drought emergency. This is not a one-way street: TVA has relied on the water from adjacent systems when either equipment failed or during extended electrical outages.

On a much grander scale, China and India (e.g., India's Dam Rehabilitation and Improvement Project [DRIP]) are creating large scale water grids that are similar to electric grids and interconnected surface transportation systems, which allow inter-basin transfers of raw water. Both countries have comprehensive national water plans or policies (see Appendix B for a list of select countries' national water plans).

California has invested in the California Aqueduct and other infrastructure that allow the intrastate transfer of water from the water-rich Sacramento-San Joaquin Delta in the northern part of the state to the communities in Southern California, while also providing flood control through water storage facilities such as Lake Oroville. However, since water is primarily governed by state law, inter-basin transfers of water is challenging at best.

5. Climate Change

Operators of large water systems often have over one hundred years of historic record to aid them in their long-term operation and planning efforts. Research, using tree ring data, has backfilled past temperature and precipitation information predating the historic record. This has allowed water sector decision makers some degree of certainty in the past. Similarly, traditional hydrologic frequency analysis assumes that climate is stationary, meaning that the statistical properties of hydrologic variables in future time periods will be similar to those in the past time periods, which until recently was an easily defendable assumption.

Weather events over the last two decades indicate that weather has become much more erratic. Examples include last year's atmospheric rivers in California after a record 23-year period of drought and record water levels of the Mississippi River.[5] Hurricanes are becoming increasingly more intense and cause billions of dollars in flood damages. Extreme weather events, exacerbated by increasing temperatures, are contributing to failures of inadequate and poorly maintained water infrastructure, which disproportionately impact economically depressed communities which often include greater percentages of older adults, individuals with disabilities, and people of color. Water losses in the West due to evaporation will increase with rising temperatures. Raw water capture and storage systems must be altered in light of anticipated shifts in precipitation. Drinking water utilities often have 24 hours of water or less in storage, with longer outages leaving communities without potable water. An example is the long duration failure of the water system in Jackson, Mississippi, to provide potable water that was extended due to weather-related issues.

Projects that capture available precipitation, stormwater, or floodwater for aquifer recharge or for replenishing depleted surface water storage must be located where high flows exist. To meet the water-related challenges of climate change, accurate climate predictions and weather forecasting is necessary. NOAA is the agency tasked with providing weather forecasts, as well as severe weather information, aviation weather, historical weather, satellite imagery, coastal charts, and climate records. NOAA also

[5] The Mississippi River saw record highs in 2011, 2018-2019 (extended duration of high water), and 2023, and record lows in 2012, and 2022.

provides tools and resources that engineers use to help make informed decisions about climate risks and vulnerabilities in the design, operation, and maintenance of critical water infrastructure. The Bureau of Reclamation uses NOAA's Water Supply Forecasts for short-term water release planning. NOAA Atlas 14 (and next generation Atlas 15, when published) provides precipitation frequency estimates used in the design and management of the nation's critical infrastructure.

To incorporate climate change into NOAA tools and to provide more accurate, reliable, and timely precipitation forecasts across timescales, from seasonal to decadal, NOAA has recently launched the Precipitation Prediction Grand Challenge Strategy.

6. Workforce Challenges

Water utilities face challenges in recruiting, training, and retaining their workers. About one-third of the current water sector workforce will be eligible to retire in the next ten years. Technologies used in the water sector are becoming more advanced. New water quality regulations such as the limits on forever chemicals and threats such as cybersecurity compromises will require a more specialized workforce. Workforce development will require upskilling and reskilling current employees, enabling re-entry of retirees, and ensuring skill enhancement is equitable. Attracting individuals from disadvantaged communities to a career in water will be key to creating the water utility workforce of the future.

Women are particularly underrepresented in the water sector workforce. Most young people, including women, do not view the water sector as an attractive career path, but, increasingly, young people want to make the world a better place. Employment in the water sector can be made more appealing by promoting that work in this sector can ensure that all Americans have access to safe, sufficient water. Smart system monitoring technologies, advances in treatment processes, and new processes and information system management will provide many opportunities for people entering the workforce to have successful, fulfilling, and exciting careers. The industry must reach out and promote these new exciting career opportunities. Overcoming the reputation of being a stodgy, low-tech, male workforce is one issue, another is that the future water sector workforce requires commensurate compensation with increased skill sets.

The NIAC's 2023 *Cross-Sector Collaboration to Protect Critical Infrastructure* report noted that the ability to attract information technology (IT) talent varies significantly between industries. Specifically, it is easier for industries where IT is part of their core business to attract highly skilled talent compared to industries where it is a necessary component but not the core function of the business. Without additional investment in technologies routinely employed in other infrastructure and employees, water utilities will be hard pressed to find the skilled employees needed to meet their cybersecurity needs, additionally utilities must protect customer data and maintain secure control of all processes within their systems. This problem is exacerbated for the public sector, which must compete for talent with the private sector.

7. Barriers to Innovation and Implementation of New Capabilities

There are many new, innovative approaches to delivering safe and sustainable water. Innovative digital water management includes the use of artificial intelligence (AI), the internet of things (IoT) sensors that detect leakage, and advanced meters that enable remote asset management and improve decision making. Precision farming practices conserve irrigation water by utilizing drones and sensors to monitor irrigation, water quality, and soil moisture. Innovative materials such as modular adsorbents, electrode-based reactors, photocatalysts and nanoparticles are being researched for water applications. Desalination research includes solar-powered reverse osmosis technology and floating wave-powered desalination plants. Ultraviolet (UV) disinfection, an alternative to chlorine disinfection, can eliminate the risk to the public associated with the transport of chlorine on our transportation systems.

The use of novel delivery methods and water treatment technologies can address efficiency, energy usage, and structural delivery. A promising water delivery model is distributed water, which is analogous to distributed energy. The use of digital technologies to accelerate the creation of “actionable information” allows water systems to become more efficient and addresses the critical need for robustness. Currently these advances are mostly used in industrial, agricultural, and energy production where water is a raw material input or where water costs drive users to become more efficient with the water that is available. Additionally, using technology to monitor water systems from external and intentional threats is an important consideration for the safety of users.

New public-private partnership O&M services and financing models are emerging, such as integrated solutions or design-build-own-operate and maintain (DBOOM) services.[6] Industrial users are embracing third-party investors for O&M as well as direct ownership of water assets. The trend is also accelerating for municipal systems. By entering long-term contracts with service providers, water facility operators can reduce costs and improve efficiencies. Industrial operators are also starting to change their mindset from viewing wastewater as a compliance cost to viewing it as a reliable and sustainable water source.

More enterprises engaging in NetZero or Zero Liquid Discharge goals and objectives coupled with overall Environment, Sustainability, and Governance (ESG) mandates will undoubtedly drive proactive water usage savings and efficiencies.

These and other advances would significantly contribute to ensuring access to safe and sustainable water resources nationwide; however, there are barriers to the use of novel methods in the water sector, not the least of which is the risk of regulatory noncompliance when trying something new. Other barriers include lack of personnel needed to institute new processes, equipment, and procedures; limited or no funds devoted to investment in new equipment; and hesitancy in adopting new methods because of limited availability. There are issues in scaling from research quantities to production quantities of new materials and equipment. Some new technologies simply must be proven and their efficacy validated through bench and full-scale studies. Barriers to partnerships with private entities to deliver drinking water include the municipal owner’s (the mayor) fear of loss of control. The removal of these barriers could enable a golden age of technology in water, as envisioned in Appendix C.

[6] For instance, the 20,000 resident city of Alice, Texas, recently entered into a partnership with Seven Seas Water Group, a private company owned by Morgan Stanley Infrastructure Partners, to convert brackish groundwater into drinking water without taxpayers investing upfront capital. As another example, Ridgewood Infrastructure LLC and IDE Technologies Ltd. entered a unique public-private partnership project with the city of Fort Lauderdale, Florida to construct and operate a 50-million gallon-per-day water treatment plant using state-of-the-art technology to replace an aging facility built almost 70 years ago. The private parties will fund 25% of the project costs and assume all the risks of construction and O&M over a long-term contracted basis. Finally, as a measure of how water utilities can be combined into a more efficient and collaborative system akin to regionalization, Central States Water Resources Inc. (CSWR) has acquired water utilities in 12 states. CSWR now services more than 300,000 customers in its network and is transforming how water utilities work by using technology and innovation to quickly assess and invest in infrastructure.

8. Emergency Management

Rising incidents of water crisis creates the need for holistic emergency management. Water is a lifeline sector that serves communities, industries, and businesses daily and has the power to bring them back to normal after a disaster, which makes quickly restoring water services highest priority.

As stated previously, community water systems are not typically connected to adjacent systems, unlike electricity and transportation infrastructure, which are interconnected into national networks. The connection of a water system to adjacent systems can allow for transfer of water during emergency situations. With climate change and increasing water scarcity as well as high intensity precipitation events, the number of significant water crises has dramatically increased. For example, Hurricanes Laura and Delta in 2020, both affecting Southeast Louisiana, impacted water supply for over 300 utilities. Hurricane Fiona in 2022 impacted the power grid in Puerto Rico and the lack of power made the water systems throughout the island inoperable. New Orleans lost power for 31 days in 2021 due to Hurricane Ida that had a cascading impact to the city's water system.

Other natural hazards are exacerbated by water-related issues. The recent Lahaina wildfire in Maui, Hawaii, the deadliest wildfire in the U.S. in over 100 years, was compounded by inadequate fire protection water pressure. Lahaina's water system,[7] relying on a limited supply from surface water and groundwater, was compromised due to persistent drought conditions combined with population growth.

Recommendations to Aid Infrastructure Owners and Operators

Subcommittee members proposed a range of recommendations in six major categories where the U.S. Federal government can help owners and operators of critical water infrastructure prepare for the water crisis:

1. Create, incentivize, and enforce standards for water use and quality.

- Promote, at the state, tribal, and local levels, that new development (agricultural, commercial, housing, and industrial) demonstrates access to a sustainable water supply.
- Streamline the permitting process, which can take eight to 10 years for complex projects.
- Incorporate regulatory "teeth" into source water protections as opposed to relying on water treatment at the backend.
- Set reasonable timelines for compliance with new regulations for water quality, particularly those new standards that require adding entirely new processes and equipment.
- Support the National Groundwater Monitoring Network and fund cooperative groundwater quantitative and qualitative data collection.

2. Remove barriers to new ways of funding water projects.

- Incentivize sustainable investment strategies at the regional and local levels to diversify and have strong interconnectivity with adjacent districts.

[7] Most communities' fire hydrants and other fire protection systems are connected to the drinking water distribution system.

- Remove barriers to privatization, concessions, and other nontraditional models of funding community water systems in conjunction with each state's development of best practice approaches to using these nontraditional finance models in the water sector.
- Allow access of privately-owned water providers to Water Infrastructure Finance and Innovation Act (WIFIA) and U.S. Federal grant programs.
- Support and incentivize regionalization of water systems by reviewing state capacity development policies to ensure beneficial regionalization and modifying current grant allocation formulas to actively promote beneficial consolidation of water systems. "Safe harbor" from regulatory penalties should be given to those systems that absorb troubled systems for a reasonable time period.

3. Invest in innovation.

- Provide funding and construct infrastructure to retrieve water from underground storage (from on-farm recharge, injection of treated wastewater, etc.).
- Invest in grant programs or other techniques to promote advanced asset management of water utilities, such as the use of leak detection technologies, and encourage reinvestment of cost savings into new or upgraded facilities.
- Fund NOAA's Precipitation Prediction Grand Challenge Strategy and NASA's Earth Science remote sensing tools (particularly the interface between space observations and local data needs).
- Furnish high speed computational systems to allow for accurate decadal weather forecasting and related modeling that incorporate the effects of climate change.
- Enable water suppliers to try innovative products and practices by minimizing the risk in innovation while maintaining compliance and capacity.
- Provide funding for research in AI and how it can be used as a tool in water resource management.

4. Assist low-income and vulnerable populations.

- Identify and assist at-risk communities where water security can be decimated by non-record weather events (e.g., Jackson, Mississippi's August 2022 extended loss of potable water).
- Expedite Native American water rights settlements in lieu of adjudication.
- Make permanent and increase the funding for programs that aid water customers with delinquent accounts and low-income assistance programs; provide the aid directly to water utilities.
- Assist low-income communities in preventing loss of treated water from leaking pipes and restoring efficiencies to at-risk water systems through Federal investment.
- Address water over-allocation and inequities in water entitlements.
- Invest in critical water infrastructure in those communities which may have outdated systems or no systems.

5. Increase national resiliency to drought, floods, and other water-related crises.

- Promote cooperation and transparency between government and non-government entities, including local authorities, and help states and cities adjust and adapt to extended drought conditions, intense precipitation, and flooding.
  - Conduct cross-sector and regional water crises drills to ensure cooperation and response during extreme events.
  - Eliminate silos between Federal, state, and other agencies.

- Enable the ability to upgrade existing water infrastructure such as reservoirs to increase water storage capacity.
- Allow operational flexibility of Federal water assets to take advantage of wet and dry years.
- Ensure that protocols and processes are in place to face natural and man-made disasters and disruptions in water supply.
  - Create and implement a water industry national standard in cybersecurity that is affordable and attainable by all utilities.
    - Invest in cybersecurity systems at water plants and on military bases.[8]
  - Facilitate connectivity of adjacent water systems for water sharing during emergency situations.
- Streamline the Federal Emergency Management Agency (FEMA) emergency process and promote FEMA's hazard mitigation planning process to state, tribal, and local governments.
  - Recommend that FEMA include the Water Sector as an Emergency Support Function under the National Response Framework.
  - Encourage FEMA to allow post-disaster mitigation funding for nontraditional emergencies and to increase funding for the Disaster Relief Fund (DRF).
- Remove barriers to inter-basin transfers of water.
- Leverage regional water systems.
  - Provide interconnections to maximize use of available water – move water to where it is needed (regional systems act as raw water wholesalers to local water treatment facilities).
- Promote circularity through water reuse, the use of greywater, underground storage, and the recharge of aquifers through onsite retention of stormwater and other available water.
  - Implement desalination projects (especially on the Gulf Coast).
- Organize large-scale conservation efforts by developing national conservation goals and by integrating Federal, state, tribal, and local conservation programs to ensure the nation's conservation goals are met.
- Incentivize homeowners to install water-saving fixtures and appliances by increasing the limit on Federal tax credits.
  - Increase the limit on tax-free "cash for grass" programs.

6. Invest in the water infrastructure workforce.

- Expand workforce development and training programs such as the EPA's Innovative Water Infrastructure Workforce Development Grant Program to find and train the next generation of water facility operators.
- Broaden the EPA's America's Water Sector Workforce Initiative to include workforce needs across the entire water sector.
- Focus on diversity and inclusion to create a pipeline of workers. Half of all Americans do not have a post-high school credential, so remove barriers such as lack of access to funding (i.e., Pell Grants), childcare, transportation, and workforce housing.

[8] The lawsuit in March 2023 initiated by certain states against the EPA ruling that requires water authority to upgrade their cybersecurity system is the type of disagreement that needs to be settled out of court and further supports the NIAC's recommendation for a comprehensive water strategy and a Department of Water. The main objection made by those states was that it would be too costly to suppliers who will then need to pass on the cost to consumers. In addition, their objection was a lack of staffing, training, and expertise to evaluate cybersecurity programs. These are precisely the issues the NIAC aims to address in our recommendation.

Mitigation of Cross-Sector Impacts Due to the Water Crisis

The DHS OCIA Sector Resilience Report includes a measure of the dependency on water of U.S. critical infrastructure. It was determined that a four- to eight-hour loss of water substantially impacted the functioning of all other critical infrastructure. A graphical depiction of this interdependency is shown in Figure 1.[9]

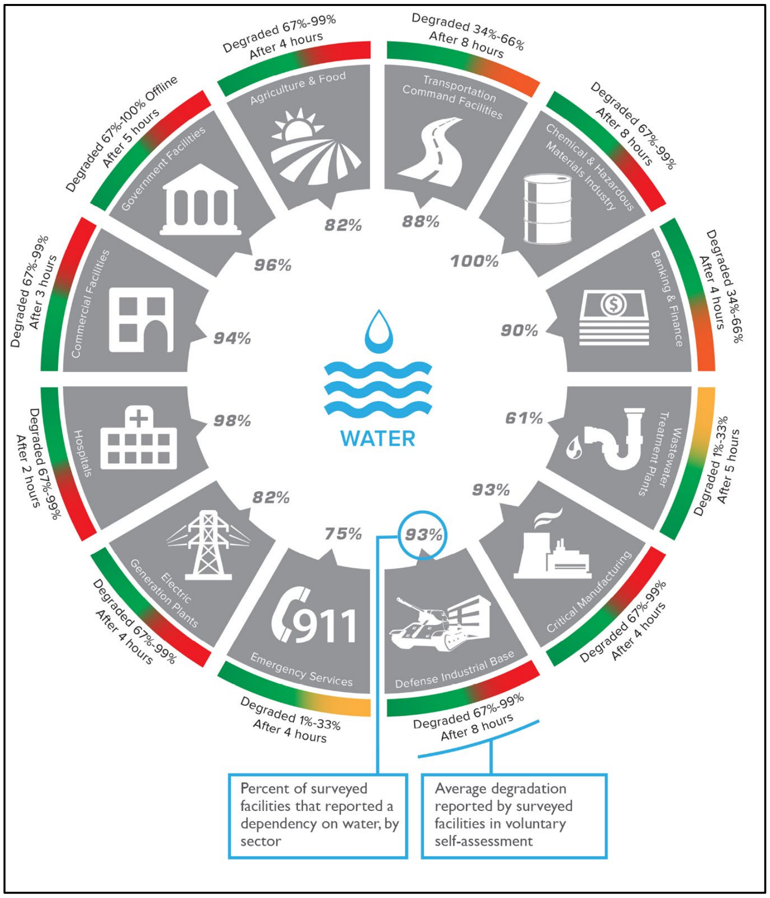

Figure 1: Critical Infrastructure Dependence on Water and Potential Function Degradation following Loss of Water Services (2016)

The ASCE's *Failure to Act: Economic Impacts of Status Quo Investment Across Infrastructure Systems* 2021 report assessed how the conditions of U.S. infrastructure systems affect the nation's economic performance. Our nation's economic health relies on reliable delivery of clean water and electricity and on low transportation costs to offset higher wages and production costs when compared to our international competitors. By 2039, water service disruptions are estimated to cost water-reliant businesses a cumulative $2.9 trillion decline in U.S. gross domestic product (GDP) due to underinvestment, and failing drinking water

[9] This figure was drawn from the NIAC's 2016 Water Sector Resilience report with the following explanation: The information provided in the graphic is based on a limited sample of 2,661 voluntary facility assessments conducted between January 2011 and April 2014 (DHS OCIA, *Sector Resilience Report*, 2014).

infrastructure results in a cumulative $7.7 billion in associated health care costs. This analysis has not been adjusted for the impact of IIJA investments.

In this section, the NIAC focused on four sectors that depend on water: energy, agriculture, inland waterway transportation, and flood control.

1. The Energy Sector

Water and energy are inextricably tied to one another. The water/energy nexus is critical for the production and delivery of each to the other. Recognizing this nexus and its importance with respect to economic development must be part of any recommendation and ultimate solution.

Energy production heavily relies on water for generating electricity and is the biggest user of water. However, the generation of electricity does not consume an appreciable amount of water but returns the vast majority to the system after use. In all thermal power plants, whether fueled by fossil, nuclear, or solar, boiled water turns a steam turbine that generates electricity. About 90% of all U.S. power plants are thermal, 6.2% are hydropower, and 3.4% are photovoltaic solar. A moderate amount of water used for cleaning reflective surfaces of solar panels, particularly if located in areas of little rain, is consumed. The amount of water used for the cooling of power-generating equipment has been increasing due to increasing temperatures, particularly due to increased nighttime temperatures. Thermal and hydropower plant efficiency and generation capacity is reduced by drought conditions. Drought or low water river conditions also impact the supply chain for fuel availability and delivery.

The U.S. power grid is almost entirely privately owned, as opposed to the nation's water assets which are not interconnected and are most often municipally owned. Hydropower and fossil fuel generation, unlike solar and wind generation, are dispatchable. Dispatchable generators can adjust their power output according to need and thus are reliable, flexible, and predictable sources of electricity. For solar and wind generation to be successful, the sun must shine (during the day) and the wind must blow (most often at night) – these sources of power generation are not dispatchable. As states transition to carbon neutrality, the decommissioning coal-burning plants is under consideration. Water insecurity, especially in western, environmentally progressive states, is causing the older fossil fuel assets to remain in place, since hydropower generation is being reduced during periods of water scarcity. With time, renewable energy will become a higher percentage of the total electricity provided. Until electric storage technologies become more robust and come online, dispatchable generation will become increasingly important because it fills the generation gaps that occur at sunrise, at sunset, on windless nights, and on cloudy days.

New sources of energy can also be big consumers of water. Green hydrogen uses clean energy to electrolyze water, thus consuming water in converting it to hydrogen and oxygen. The other types of hydrogen production are less green, but most use steam in the chemical process of creating hydrogen. Water will play a key role in attaining carbon neutrality, further increasing the strain on the nation's water resource infrastructure.

Conversely, as much as 40% of operating costs for drinking water systems can be for energy. The pumping of raw or finished water is energy intense. One of the largest cost and capital components is the actual delivery of water through underground infrastructure which, as stated, is in poor shape.

2. The Agriculture Sector

Agriculture is the second biggest *user* of water, behind the energy sector. Energy, however, is not a big *consumer* of water – agriculture is the biggest *consumer* of water both nationally and globally.[10] The U.S. is a major agricultural producer and is considered the breadbasket for the world. The Midwest grows the majority of the nation's corn and soybeans, while California is the "fruit and vegetable basket" of the country, growing nuts, seeds, citrus and other fruits, and vegetables. The U.S. produces about 30% of all corn and 35% of all soybeans grown globally, and it provides 55% of the world's almonds and 37% of its pistachios. So, it is not surprising that agriculture is the second biggest user of water and the biggest consumer of water. According to the USDA, the top five states ranked by irrigated acres are Nebraska (14.8%, increasing), California (13.5%, decreasing), Arkansas (8.4%, increasing), Texas (7.5%, decreasing), and Idaho (5.9%). The listed percentage is of the total irrigated land. The same USDA report indicates whether irrigated acreage is increasing or decreasing over the last decade. These regional trends reflect how changing water availability related to competing water demands, the effects of drought, and depletion of groundwater has influenced the distribution of irrigated farmland.

Corn and soybean yields have steadily increased over the last two decades, partially due to the increase in irrigation of these crops and despite being sensitive to extreme heat. Roughly 90% of corn and soybean acreage is insured, decreasing a farmer's financial risk. However insured farmers do not have the incentive to engage in costly climate adaptation as insurance compensates them for potential losses.

More than half of irrigation water (55%) comes from surface water, and 45% of irrigation water is from groundwater[11]. Surface water irrigation is most common in the western states where Federal reclamation policy and state investment in irrigation infrastructure make surface water accessible to irrigated land. The types of crops that are irrigated have shifted, with corn, soybeans, and alfalfa being increasingly irrigated. Groundwater withdrawal for irrigation is usually managed by local irrigation organizations. Irrigated agricultural production supported by groundwater use is concentrated over three aquifer systems (the Central Valley, High Plains, and Mississippi Embayment), with unsustainable ground water depletion increasing over the last thirty years. Regions pumping at particularly unsustainable rates are the southern part of the Central Valley Aquifer (Tulare Basin) and the Southern High Plains in Texas. Irrigation withdrawals of surface water from Lake Mead and Lake Powell are major contributors to the depletion over the last two decades of these stored water assets.

3. The Inland Waterways: Transportation

The nation's inland transportation system relies on water. The Mississippi River's inland waterways overlay America's (and arguably the world's) most productive farmland, providing the U.S. an agricultural competitive edge. It is the only transportation system with the capacity to handle moving the projected increase in agricultural, energy, and manufacturing products to the coast for export. This is dependent on the reliability of the inland waterways transportation system to move bulk freight. Over 92% of the nation's agricultural exports and 78% of the world's feed grains and soybean move by barge on the inland waterways annually, often closing the gap between total U.S. imports and U.S. exports. Exported U.S. farm products play a vital role in global food security and stability.

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[10] *Using* and c*onsuming* water have different definitions in this context. Energy generation uses (needs) a lot of water but almost 100% passes through and is not consumed. Electric generation needs water to flow *through* turbines, so the water is used to generate electricity, but it goes right through the system and back into the river. Agriculture *uses* less water but the water that it uses is also mostly consumed.

[11] P.J. Ruess, "Irrigation by Crop in the Continental United States from 2008 to 2020." (*Water Resources Research 2022*)

The inland waterways system also supports industries that rely on rivers, indirectly contributing to job growth in the agriculture, manufacturing, and energy sectors, while directly supporting towboat operators and skilled labor trades. The inland waterways navigation system, along with railways and highways, provides a multimodal network that enables freight movement and reduces congestion along roadways and rail lines. This integrated transportation system enhances the overall efficiency and effectiveness of the nation's logistics infrastructure. In addition, barge transportation has a significantly lower carbon footprint than other modes of transportation and reduces highway congestion.

The Mississippi River and its tributaries connect inland ports that rely on barges to move freight to and from deep draft Gulf Coast ports. The system includes over 12,000 miles of navigable waters, made navigable by systems of locks and dams. Locks act as marine elevators, allowing barge traffic to move through a dam. Dams, often authorized for a single purpose (water supply) or a dual purpose (navigation and flood control), play an important role in managing both high and low water conditions. Other features include levees, floodwalls, channel stabilization, floodways, dikes, and other structures.

The average age of U.S. dams is 60 years, and many waterway assets have reached the end of their design life. Single locks present a single point of failure for movement of barge traffic and are not sized for today's barge tows so that tows must break into two parts to traverse locks on the system. The IIJA provided $2.5 billion for construction and major rehabilitation of inland water projects although there is a $6.8 billion backlog of construction projects and an estimated $13 billion funding needs for complete modernization. Projects along the inland waterways system yield a substantial return on investment due to the movement of bulk commodities and reduction in flood damages. The inland water system is managed by the U.S. Army Corps of Engineers.

4. The Inland Waterways: Flood Control

Climate change has challenged inland waterways. In the past twelve years, the Mississippi River system has seen several years of historic record flows alternating with record low water flows caused by climate variability. Low water flows threaten navigation, requiring releases from dam reservoirs, an increase in dredging due to sediment carried by the energy of the river at high discharge, and a reduction of freight loaded on barges to reduce barge draft. Record high discharge often causes riverine flooding of communities, industry, and farmland and causes economic damages associated with record flooding as well as damages to the system itself.

Enhancing the infrastructure of the inland waterways' navigation system improves natural disaster resilience. The waterways serve as alternative transportation routes should roads, railways, or pipelines become inaccessible or compromised. In natural disasters and major flood events, the system's levees and dams are used to manage floodwaters and are damaged in the process. Emergency Supplementals, appropriated by Congress, are used for recovering from major disasters such as major floods, wildfires, and hurricanes. The use of supplemental funds most often are limited to repair of damaged Federal assets and measures to increase resiliency are not allowed. The exception was the Third Emergency Supplemental for damages from Hurricanes Irma, Harvey, and Maria and wildfires in the West which allowed funding of mitigation and resiliency projects.

5. Other Sectors

The communication and information and technology sectors rely on dependable supplies of freshwater for cooling data centers. Microchip manufacturers need significant amounts of water. Extractive industries, such as mining and fracking rely on water in extraction processes, and the manufacturing and chemical sectors rely on water for their system processes. The need for water requires the understanding of water-related risks. Most big corporations inadequately manage their water risks, but uncertainties related to climate change are driving industries to incorporate water risks into their valuation models and investment decisions. This can encourage sustainable practices such as using recycled greywater for cooling purposes by a corporation but can also lead to loss of business opportunities in a community because of water reliability issues. Investors now search for competitive advantages and may review corporate operations for water-related risks. Specialized tools are being used to help a company determine a location's true value for water as opposed to the price paid for water (which is often not reflective of actual costs of supplying clean water to a site). Investors want to determine how much they are underpaying for the risk that they are exposed to. An example is that California just passed climate risk disclosure legislation – the first in the nation – to help make water risks, and the steps being taken by stakeholders to minimize those risks, more transparent.

Recommendations to Mitigate Cross-Sector Impacts

Subcommittee members proposed a range of recommendations to mitigate cross sector impacts of the evolving water crisis:

1. Invest in reliable infrastructure in U.S. river systems to provide for energy generation needs.

- Support the rehabilitation of dams and reservoirs through increasing funding of grant programs, such as FEMA's Rehabilitation of High Hazard Potential Dams Program, and through revising or deviating from policies that remove barriers to the rehabilitating existing dams and reservoirs that serve public health and safety.
- Maintain hydropower generation through incentives and programs such as DOE's Maintaining and Enhancing Hydroelectricity Incentives and IIJA's Hydroelectric Production Incentives.
- Monitor drought and river levels.
    - Increase the number of point measurement such as river gauges.
- Increase drought prediction and forecasting capabilities so that electric utilities can estimate future conditions.
- Create a unifying entity that allows for more coordination between electric assets upstream and downstream about each other's water usage that balances the need for sharing data with security concerns (similar to the Water Information Sharing and Analysis Center).
- Provide more structural assessments of water versus energy demand to aid in system efficiency and delivery through the Energy Information Administration.
- Remove barriers to the placement of hydropower on existing U.S. dams when placement is feasible (some dams are authorized for flood control or another single purpose and can be equipped relatively easily for additional power generation through the installation of turbines and the associated facilities).
- Invest in interdisciplinary and applied research.
    - Promote the use of reclaimed wastewater for thermoelectric power cooling needs.
    - Increase efficiency of cooling technologies to offset energy demands from increasing temperatures because of climate change.

2. Modernize and make flood resilient the inland waterways transportation system.

- Integrate multiple benefits as opposed to a single benefit into feasibility studies and investigations for new inland waterways projects, and always address flood risk.
- Allow supplemental appropriations to be used to fund mitigation and resiliency post disaster.
    - Increase FEMA's Building Resilient Infrastructure and Communities (BRIC) funding.
- Use forecast-informed reservoir operations (FIRO) strategies to better respond to atmospheric episodes by either retaining or releasing water from reservoirs per forecasted weather.
- Incorporate modern information systems into flood control/risk management.
- Update water control manuals and operating rules of large inland waterway infrastructure to better handle climate variability.
- Continue to invest in the modernization of the U.S. Army Corps of Engineers (USACE) assets (e.g., dredges, survey vessels, new survey technologies) that are critical for maintaining operational waterways during water crisis events (e.g., for quick response to actual and emerging high or low water flow along the Mississippi River).
- Develop a prioritized investment plan for locks and dams with focus on the highest priority transportation (both current and future) needs along the marine highways. Replace aging locks with larger dual locks on the Mississippi and Ohio Rivers when justified by usage.
- Increase national dredging capacity due to increased dredging needs driven by climate change, sea level rise, and new/emerging industrial needs such as offshore wind and increased use of green infrastructure. Strike the best balance between supporting a robust private fleet and ensuring sufficient USACE-owned assets.
- Leverage the water power available at dams along rivers to support clean energy power/fuel needs for decarbonized marine operations on the rivers.
- Fund programs monitoring and forecasting snowpack related to potential flooding on the Mississippi and Missouri Rivers, Ohio Valley, and into the Great Lakes region.

3. Support adaptive practices and promote smarter irrigation technology so farmers, ranchers, and forest landowners can better deal with climate variability.

- Incentivize the planting of less water-intensive crops by farmers in areas of water scarcity.
- Support drip irrigation and other ways to apply irrigation of water efficiently.
- Promote USDA's Climate Hubs which, in conjunction with partner entities, offer strategies, management options, and technical support to farmers, ranchers, and forest landowners to help them adapt to climate change.
- Reform crop insurance to incentivize climate adaption by farmers.
- Develop a comprehensive, objective national drought index. Include reservoir levels, aquifer status, in-situ soil moisture measurements to validate model predictions, potential moisture stored in snowpack, and a measure of the temporal distribution of precipitation.
- Prioritize drinking water over agriculture water during drought emergencies; agriculture water used for drinking purposes should be compensated post-disaster.

Need for a National Water Strategy

Water is an essential and primary need of every American, yet most Americans take water for granted. Because water infrastructure and water suppliers have a long track record of reliable service with few major disruptions, the infrastructure that delivers water often goes unnoticed by the public and is undervalued by decision-makers. Local water suppliers are dealing with aging, obsolete infrastructure, a challenged and shrinking workforce, and compliance with regulations of increased scope. Existing water treatment processes cannot remove PFAS. These new regulations require upgrades to water treatment facilities, during a time of supply chain issues, regardless of whether the utility is large, well-managed, and financially secure or a small provider of water to a marginalized community. Our raw water supply is being threatened by changes in weather patterns. Erratic precipitation and the associated uncertainties in long- term forecasting and hydrologic modeling make the retrofitting and remodeling of major water supply infrastructure of Federal interest a challenge. Access to water is crucial to energy production, food security, and bulk freight transportation, as well as to large domestic military bases (which impacts national security).

The regionalization of water will require Federal action. We need to elevate water as a national priority. The People's Republic of China (PRC) has the Ministry of Water Resources as a department within China's Central People's Government responsible for managing water resources in PRC, an $800 billion annual water budget, and a Five-Year National Water Security Plan. The U.S. has an outward facing Global Water Strategy, but no five-year or long-term national strategy. Water resources are managed by a variety of Federal agencies, with little coordination among them. EPA enforces water quality requirements through the Clean Water Act and the Safe Drinking Water Act; the Department of Interior has oversight of the data-gathering U.S. Geological Survey and the Bureau of Reclamation, which is responsible for large water infrastructure and hydropower in the western U.S.; the Department of Defense, through the U.S. Army Corps of Engineers, manages the inland waterways east of the Rocky Mountains with a focus on flood control and navigation. The Departments of Energy (DOE), Transportation (DOT), and Commerce have varying water related programs and interests. Examples include DOE's Water Conservation Program and DOT's Water Management Policy. This fragmentation of responsibility at the Federal level makes it difficult to ascertain the country's water needs and strategically prepare the nation for a water-secure future.

A regularly updated national water strategy would identify challenges to the nation's water assets, unify the efforts of all Federal agencies, and partner with state, tribal, and local governments so that the national water resources can provide for the country's needs today and in the future by developing required goals and measures while balancing the competing priorities and interests of other sectors.

Recommendations to Create a National Water Strategy

Subcommittee members proposed two major recommendations regarding a National Water Strategy:

1. Elevate the importance of water in the national consciousness through a public awareness program.

- In the 1970s, the famous advertisement depicting a Native American crying because of pollution skyrocketed the environmental movement into public awareness. While this ad became controversial and has since been retired, at the time of its release, it was an influential advertisement campaign. There is a need for national consciousness and corporate, governmental, and individual accountability of the need to conserve, reuse, and recharge water. There also must be broader recognition that having assured access to water in the United States in the future will require additional investments.

2. Institute either a Department of Water or some other entity that stewards water at the Cabinet level.[12]

- Create a Department of Water (DOW) to ensure America's economic prosperity, security, and quality of life by working with state, local, tribal, and territorial governments and stakeholders to deliver safe, efficient, sustainable, and equitable water, wastewater, and stormwater systems responsive to changing climate, hazards, and threats, including physical and cyber threats. The DOW would be charged with the following:
  - Create and implement both a near-term and a long-term national strategic plan for water infrastructure.
  - Develop national policies and standards that would ensure adequate and sustainable water supply through conservation, aquifer replenishment, cross-regional cooperation, and water storage.
  - Partner with states, regions, and neighboring nations to develop standards for water use that would promote resiliency and balance between supply and demand.
  - Work with the Biden Administration and Congress to develop policies and laws that would resolve water governance issues, including water rights disputes and water allocations.
  - Develop budget requirements necessary to ensure safe and plentiful water through lead pipe replacement, dam safety and repairs, and inland waterway upgrades, etc. Establish national priorities for funding and implementation consistent with the national water strategy.
  - Establish priorities and associated budget requirements necessary to increase the resilience of the water system to physical and cyber threats.
  - Work with public water system owners to identify necessary infrastructure upgrades and determine funding plans that include local investments, national subsidies, and water rate increases, when necessary.
  - Institute policies and budgets necessary to ensure equitable access to water, wastewater, and the benefits of stormwater.
  - Collaborate with related agencies and programs to ensure cross-government alignment.
  - Develop a public affairs strategy to promote public awareness and commitment to water management, including the public's role in water conservation.
  - Fund stakeholders in watershed modeling to support public actions and investments.
  - Develop and fund a world-class research and development program in water supply and resilience that would include new approaches to water access (desalinization), automated management schemes, new approaches to PFAS elimination, cyber security, and/or new uses of artificial intelligence, etc.
- As a step toward establishing a new DOW, designate a water advocate in every regulatory agency that interacts with water and charge them with developing a near-term national water strategy. Appoint a U.S. Special Presidential Envoy to advance the creation of a DOW.[13] The Envoy should explore other options to a DOW such as expanding DOE to include water. However, the DOE stewards energy, which is another critical infrastructure sector; expanding the scope of DOE to include two of the most critical infrastructure segments will diminish the DOE's capacity of focus on

[12] The 2016 NIAC *Water Sector Resilience* report noted that although energy and transportation both merited a cabinet level agency, there was no U.S. federal Department of Water.

[13] The Biden Administration has named 36 Special Envoys including one for climate change.

energy (just as the nation's electrification policy is being put in place, possibly hampering the nation's transition to clean electrified technologies). Appendix D includes a brief history of the creation of DOE and DOT, which are examples of fairly recent cabinet-level departments.

Call to Action

Following receipt of the NSC's tasking, and over the course of five months, the NIAC pulled its network of resources from across the critical water infrastructure industry to share challenges faced in the evolving water crisis. The result is this report's identification of **14 challenges** as well as **12 recommendations** which the U.S. Federal government can use to help critical owners and operators prepare for the rapidly evolving water crisis. The NIAC urges the President to consider these recommendations for immediate and long-term implementation to improve the nation's critical water infrastructure resilience, security, and accessibility through increased investments, standards, and attention.

Appendix A: Water Missions of U.S. Federal Agencies Mentioned in this Report

The following agencies have been mentioned in this report due to their involvement in water interests.[14]

U.S. FEDERAL AGENCIES	MISSIONS
Executive Departments (Cabinet)	**Missions of the 15 Executive Departments with Water-related Oversight**
Department of Defense	Provides the military forces needed to deter war and to protect the security of the U.S.
Department of Interior	Protects America's natural resources, offers recreational opportunities, conducts scientific research, conserves and protects fish and wildlife, and honors the U.S. government's responsibilities to the American Indians, Alaskan Natives, and to island communities
Department of Agriculture	Develops and executes policy on farming, agriculture, and food
Department of Commerce	Creates the conditions for economic growth and opportunity
Department of Transportation	Ensures a fast, safe, efficient, accessible, and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people
Department of Energy	Advances the national, economic, and energy security of the U.S.
Department of Homeland Security	Protects the American people from a wide range of foreign and domestic threats
Independent U.S. Federal Agencies	**Missions of High-level U.S. Federal Agency with Water-related Oversight**
Environmental Protection Agency (Cabinet, non-Dept)	Protects human health and the environment
National Aeronautics and Space Administration (non-Cabinet)	Explores the unknown in air and space, innovates for the benefit of humanity, and inspires the world through discovery
Tennessee Valley Authority (non-Cabinet)	Generates safe, clean, reliable and affordable power for the region's homes and businesses
U.S. Federal Entity (under: Dept/etc.)	**Mission of Subcomponent of Executive Dept with Water-related Oversight**
U.S. Geological Survey (DOI/ORDA)	Provides reliable scientific information to describe and understand the Earth; minimizes loss of life and property from natural disasters; manages

[14] This table is not exhaustive but is meant to illustrate how many entities in the U.S. government have water-related responsibilities. A more expansive list of U.S. federal agencies involved in water interests can be found on the Water Education Foundation's (WEF) website.

U.S. FEDERAL AGENCIES	MISSIONS
	water, biological, energy, and mineral resources; and enhances and protects our quality of life
Bureau of Reclamation (DOI/ORDA)	Manages, develops, and protects **water** and related resources in an environmentally and economically sound manner in the interest of the American public
U.S. Army Corps of Engineers (DOD/DA)	Delivers vital engineering solutions, in collaboration with our partners, to secure our Nation, energize our economy and reduce disaster risk (see Civil Works)
Water Power Technologies Office (DOE/EERE)	Enables research, development, and testing of emerging technologies to advance marine energy as well as next-generation hydropower and pumped storage systems for a flexible, reliable grid
Office of Water (EPA)	Ensures drinking **water** is safe, restores and maintains oceans, watersheds, and their aquatic ecosystems to protect human health, supports economic and recreational activities, and provides healthy habitat for fish, plants and wildlife
National Oceanic and Atmospheric Administration (DOC)	Provides daily weather forecasts, severe storm warnings, climate monitoring to fisheries management, coastal restoration, and the supporting of marine commerce
U.S. Federal Emergency Management Agency (DHS)	Helps people before, during and after disasters
Maritime Administration (DOT)	Fosters and promotes the maritime industry of the U.S. to meet the nation's economic and security needs

Appendix B: Governmental Entities in Other Countries That Address Water

COUNTRY	GOVERNMENT TYPE, CABINET-LEVEL ENTITY	NATIONAL WATER STRATEGY?	HIGH-LEVEL ENTITY MANAGING WATER
Australia	Federal/Parliamentary, Ministry	National Water Initiative	Ministry of the Environment and Water
PRC (China)	Unitary/Authoritarian, Ministry	National Water Security Plan	Ministry of Water Resources
Germany	Federal/Parliamentary, Ministry	National Water Strategy	Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
India	Federal/Parliamentary, Ministry	National Water Policy	Ministry of Water Resources
Israel	Unitary/Parliamentary, Ministry	Master Plan for the National Water Sector	Ministry of Energy (formerly Ministry of National Infrastructure, Energy and Water Resources
South Africa	Federal/Parliamentary, Ministry	National Water Resources Management Strategy	Ministry for Water and Sanitation

Appendix C: Revolutionizing Water through Game-Changing Technologies

The U.S. may be at the brink of a golden age of technology in the water sector. This has already happened in a number of countries around the world (such as Israel) where advanced technologies are making water more resilient, efficient, and circular. This golden age of technology in water can come about if we as a nation revolutionize the way we approach water conservation, energy efficiency, and resource recovery. There are now key game-changing developments that can make usable atypical water sources, reduce energy consumption, and increase recovery. These include new membrane technology, digital technologies, AI, and machine learning to propel the nation into a more sustainable future.

To address water scarcity through harnessing unconventional water resources such as brine water or wastewater, energy consumption must be reduced in water treatment and distribution systems. Energy-intensive processes, such as desalination and wastewater treatment, have traditionally posed significant challenges due to their high energy requirements. However, advancements in technology have enabled the development of innovative solutions. Smaller nations, particularly island nations, utilize desalinization for large portions of their agricultural and public use, including for their drinking water.[15] Energy recovery devices, such as pressure exchangers and turbines, can be implemented to capture and utilize the excess energy generated during the water treatment process. These devices convert pressure energy into mechanical energy, subsequently reducing the overall energy demand. Furthermore, improvements in pump efficiency, the implementation of variable frequency drives, and the optimization of distribution networks through advanced control systems can also contribute to substantial energy savings in water management.

One of the biggest trends increasing the ability to solve water scarcity through using unconventional water resources is the advancement in membrane technology. This has emerged as a game-changer in the water industry, facilitating increased water recovery rates, reduced wastewater, reduced energy consumption, and higher reliability. Historically, traditional filtration techniques often resulted in significant water losses during the treatment process. However, the advent of advanced membranes has dramatically improved water recovery efficiency. New generation membranes, such as forward osmosis and osmotically assisted reverse osmosis (concentrate recovery reverse osmosis) membranes, enable high rejection of contaminants beyond the normal osmotic pressure limitations that had capped the use of membrane technology. These membranes have enhanced selectivity, enabling the removal of even smaller particles, salts, and organic matter from water sources. As a result, the ability to recover water through membranes has significantly increased, making feasible the use of water sources that have previously been deemed not economic to treat and reducing the strain on freshwater sources – thus improving overall sustainability.

The integration of digital technologies can revolutionize the water sector, enabling more efficient and effective water management. The application of artificial intelligence and machine learning algorithms as well as new and innovative sensing technology in water-related processes can prove to be invaluable in optimizing resource utilization, reducing costs, and improving decision-making. These algorithms can analyze vast amounts of data collected from sensors, weather forecasts, and historical records to optimize water treatment processes and predict demand patterns. A usage case example could be the system

[15] United Nations Department of Economic and Social Affairs, "Antigua and Barbuda | Department of Economic and Social Affairs." https://sdgs.un.org/basic-page/antigua-and-barbuda-34110.

currently in place on the Central Arizona Project canal which uses some technology but is people-labor intensive and could benefit from machine learning to proactively avoid water disasters. By identifying patterns and trends, these technologies enable better decision-making regarding water allocation, supply network optimization, and asset management. Additionally, AI-powered predictive maintenance systems can identify potential equipment failures in advance, reducing downtime and minimizing resource waste.

The golden age of technology in water must focus on resource recovery, transforming what was once considered waste into valuable resources. Wastewater treatment plants are now transitioning from being mere pollution control facilities to resource recovery centers generating energy that oftentimes covers the requirements of the plant, leading to the increase of net zero water facilities. Advanced treatment processes and technologies, such as anaerobic digestion and nutrient recovery, facilitate the extraction of energy, nutrients, and reusable water from wastewater. These recovered resources can be harnessed for energy generation, agricultural purposes, and industrial applications, creating a more circular and sustainable approach to water management. Additionally, as the requirement of desalinating sea water grows, there is also a movement to utilize all the technology mentioned to recover valuable salts from sea water brine.

Some municipalities and states are utilizing technologies for the reuse of treated blackwater/recycled/reclaimed water for landscape and golf course irrigation, indoor fire protection, and toilet flushing in commercial buildings and other commercial/industrial uses. The major concerns with such usage continue to be safety, potential impact in natural settings on flora and fauna, as well as impact to aquifers. If technology and public acceptance can be advanced, the ability to recycle water directly into drinking water will become widespread.

A golden age of technology in water can signify a transformative era in which game-changing advancements are deployed wisely as part of a national water plan. Revolutionizing the water sector would require Federal investment. In implementing this plan, the nation can ensure efficient water management, alleviate stress on freshwater sources, and create a more sustainable and resilient future.

Appendix D: Historical Foundations of Two Cabinet Agencies

Arguably power, water, and transportation are three of the critical infrastructures for functioning communities and for the nation. This appendix outlines a brief history of the creation of the Department of Energy and the Department of Transportation.

Department of Energy (DOE)

The Department of Energy was created in 1977 and was the twelfth cabinet-level department. Until the early 1970s there was a perception in the United States that energy was relatively cheap and the supplies plentiful. The shock of the Oil Crisis in the early 1970s showed that the United States was highly dependent on imported oil, endangering the economy and posing a threat to national security. In proposing the Department of Energy, President Carter stated in his State of the Union message in 1977:

"The Department of Energy… will be a permanent part of the American government. Its importance cannot be overstated. It will be charged with the responsibility of preparing America to meet the energy needs of the future."

DOE concentrated the facets of energy policies, planning, and research and development into a single agency, consolidating many programs across the U.S. Federal government. The DOE was charged with promoting energy independence, development, and production of nuclear power, creating a comprehensive and balanced national energy plan, ensuring the security and reliability of energy for the nation, and conducting long-term research and development on energy technologies. An important bulwark of DOE's mission over the years has been the stewardship of nuclear weapons and addressing the pollution associated with nuclear weapon production. The regulatory functions had been tasked to the Nuclear Regulatory Commission (NRC) earlier in 1974.

Department of Transportation (DOT)

The Department of Transportation (DOT) was created in 1966 and not as a response to a national crisis. Various recommendations for an agency for transportation were promoted as early as 1937, and even as far back as 1874. Multiple reports and committees recommended the creation of a transportation department through the 1940s, 1950s, and 1960s.

The sparks that eventually led to the DOT's creation were the recommendation from the President's Task Force on Transportation and a letter from administrator of the then-independent Federal Aviation Agency (FAA) to President Johnson. The FAA was a powerful agency and would have been expected to form the primary obstacle to the formation of a transportation department.

President Johnson sent a special message on transportation to Congress, requesting the creation of the department. In part the message stated:

> "The United States is the only major nation in the world that relies primarily upon privately owned and operated transportation.
>
> That national policy has served us well. It must be continued.

> But private ownership has been made feasible only by the use of publicly granted authority and the investment of public resources…Enlightened government has served as a full partner with private enterprise in meeting America's urgent need for mobility.
>
> That partnership must now be strengthened with all the means that creative U.S. federalism can provide. The costs of a transportation paralysis in the years ahead are too severe. The rewards of an efficient system are too great. We cannot afford the luxury of drift – or proceed with "business as usual."

DOT's Strategic Plan for 2022-2026 notes its leadership in transportation safety, upgrade and modernization of the nation's transportation infrastructure, facilitation of healthy and sustainable transportation options for Americans through public transit and rail, support the transition to net-zero emissions through EV technologies, support equitable transportation for historically underserved communities, improve marine and navigable infrastructure to strengthen national supply chain and create a world-class organization and workforce.

Appendix E: Acknowledgements

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Appendix F: Definitions

Term	Common Definition
Aquifer recharge	Water that moves from the surface or unsaturated zone into the saturated zone, which is an underground rock formation or sedimentary deposit that holds water.
Aquifer storage	Natural stores in the ground that can be positioned between less than 100 meters to many hundreds of meters deep, depending on the type of subsoil.
Blackwater	Wastewater from toilets.
Greywater	Household wastewater that does not contain serious or body or food wastes, such as from sinks, baths, or washing machines. It can be reused for some purposes without purification, such as watering plants or flushing toilets.
Rainwater harvesting	The collection and storage of rain for use. It can be collected on a small or large scale, from roofs, fields, rivers, or other sources.
Reclaimed water	The process of converting municipal wastewater (sewage) or industrial wastewater into water that can be reused for a variety of purposes.
Water reuse	Also known as water reclamation, water reuse is the process of converting municipal wastewater (sewage) or industrial wastewater into water that can be reused for a variety of purposes.

Appendix G: Acronyms and Abbreviations

Acronym/ Abbreviation	Definition
AI	Artificial Intelligence
ASCE	American Society of Civil Engineers
ASDSO	Association of Dam Safety Officials
AWWA	American Water Works Association
BRIC	Building Resilient Infrastructure and Communities
CEO	Chief Executive Officer
CERP	Comprehensive Everglades Restoration Plan
CISA	Cybersecurity and Infrastructure Security Agency
CWSRF	Clean Water State Revolving Fund
DRIP	Dam Rehabilitation and Improvement Project
DWSRF	Drinking Water State Revolving Fund
EPA	Environmental Protection Agency
FEMA	U.S. Federal Emergency Management Agency
FIRO	Forecast-Informed Reservoir Operations
GRACE	Gravity Recovery and Climate Experiment
IIJA	Infrastructure Investment and Jobs Act
IoT	Internet of Things
IRA	Inflation Reduction Act
IT	Information Technology
NASA	National Aeronautics and Space Administration's
NIAC	National Infrastructure Advisory Council
NOAA	National Oceanic Atmospheric Administration
NPDWR	National Primary Drinking Water Regulations
NSC	National Security Council
PFAS	Per – and Fluoroalkyl Substances
SCADA	Supervisory and Control Data Acquisition
Subcommittee	Water Security Subcommittee
TVA	Tennessee Valley Authority
U.S.	United States
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
WEF	Water Education Foundation
WIFIA	Water Infrastructure Finance and Innovation Act
WIIN	Water Infrastructure Improvements for the Nation Act

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