

Navigating the Pivot: Actionable Strategies for a Self-Reliant U.S. Water Future

Executive Summary

The U.S. water sector is navigating a period of profound and rapid transformation. A systemic "Federal Pivot," documented in the 2025 analysis "Un-Charted Waters," has dismantled a half-century of centralized federal oversight, research, and financial support, creating a landscape of unprecedented risk and opportunity. The elimination of federal research bodies, the cancellation of billions in grants, and the removal of public datasets have created a dangerous "Knowledge Vacuum" and an "Infrastructure Funding Shock" that threaten to trigger a negative cascade of project paralysis, deferred maintenance, and the emergence of a two-tiered water system.

This report moves beyond an analysis of these risks to document the tangible, real-world solutions being implemented by proactive leaders across the sector. It provides concrete evidence that a cohort of innovative states, utilities, and private firms are not waiting for a federal rescue but are actively building the foundations of a more decentralized, resilient, and technologically advanced water future. The case studies presented herein, all active between 2020 and August 2025, offer a playbook of actionable strategies for industry professionals navigating this new reality.

The findings demonstrate that where federal support has receded, new models of self-reliance are proving effective. States like California are stepping up to become "Hyper-Competent" scientific bodies, replicating and even specializing federal research functions to tackle pressing regional challenges like PFAS contamination. In the data sphere, non-profit collaboratives and public-private partnerships are creating a new, more resilient data ecosystem, building the shared digital infrastructure the federal government no longer provides.

Crucially, technology is emerging as a direct substitute for cost-prohibitive capital investment. The City of South Bend, Indiana, leveraged a digital twin to optimize its existing sewer network, avoiding \$400 million in gray infrastructure costs and breaking the "infrastructure death spiral" described in "Un-Charted Waters". Concurrently, new financial instruments are overcoming the funding shock. The proven viability of Environmental Impact Bonds in Washington, D.C., and Buffalo, New York, demonstrates a scalable model for de-risking innovation and attracting private capital to green infrastructure projects.

While the challenges of the post-federal era are severe, the solutions are no longer theoretical. The strategies detailed in this report showcase a sector in the midst of a fundamental, and in many ways necessary, reinvention—one that prizes local initiative, data-driven management, and financial creativity.

Table 1: Summary of Actionable Strategies

Case Study Initiative	Lead Organization(s)	Core Problem Addressed	Solution Type	Strategic Implication
State-Led Science Initiative	CA OEHHA, SWRCB	Knowledge Vacuum;	State-Led Research	Demonstrates that a well-resourced

Case Study Initiative	Lead Organization(s)	Core Problem Addressed	Solution Type	Strategic Implication
		Regulatory Chaos (PFAS)		state can replace federal research capacity with a more agile, specialized scientific apparatus.
Great Lakes Water Quality Agreement	U.S. & Canadian Gov'ts, IJC	Risk of "Race to the Bottom"	Interstate Quality Compact	Provides a durable governance model for managing shared resources, but its success highlights the difficulty of replicating it without a strong "shared destiny."
California Data Collaborative (CaDC)	Non-profit of 19+ CA Utilities	Data Scarcity; High cost of analytics	Utility Data Trust	Offers a financially sustainable "third way" for utilities to access advanced analytics by pooling resources in a cooperative model.
Internet of Water (IoW) & WaDE	IoW Coalition, Western States Water Council	Lack of FAIR Data; Data Removal	Open-Source Infrastructure	Signals a shift from centralized data hosting to building the protocols for a resilient, federated data network.
Smart Sewer Network	City of South Bend, IN; Xylem	Infrastructure Death Spiral	Digital Twin	Proves that technology can be a direct substitute for massive capital spending, allowing utilities to solve major problems by optimizing existing assets.
Environmental Impact Bonds (EIBs)	DC Water; Buffalo Sewer Authority	Infrastructure Funding Shock; Risk of Innovation	Blended Finance	Establishes a proven financial instrument to de-risk innovation

Case Study Initiative	Lead Organization(s)	Core Problem Addressed	Solution Type	Strategic Implication
				for public utilities by sharing performance risk with private investors.
SWIFT Program Financing	Hampton Roads Sanitation District (HRSD)	Infrastructure Funding Shock	Blended Finance (WIFIA)	Shows how sophisticated utilities can overcome grant cuts by proactively blending federal loans (WIFIA), state loans (SRF), and local funds.
Direct Infrastructure Investment	Google; City of The Dalles, OR	Infrastructure Funding Shock	Public-Private Partnership	Represents a potent but potentially inequitable funding model that risks creating a two-tiered system based on a community's value to a corporation.

I. Introduction: The Post-Federal Landscape and the Imperative to Act

Framing the Challenge

For fifty years, the American water sector operated within a stable, if slow-moving, paradigm defined by centralized federal leadership. The U.S. Environmental Protection Agency (EPA) and the U.S. Geological Survey (USGS) served as the nation's scientific backbone, conducting foundational research, setting regulatory standards, collecting and disseminating critical data, and providing a significant backstop for infrastructure financing. As of 2025, this paradigm has been systematically dismantled. The "Federal Pivot" detailed in the foundational analysis "Un-Chartered Waters" is not a proposal but an operational reality, creating three interlocking crises for water professionals.

First, the **"Knowledge Vacuum"** has emerged from the complete elimination of the EPA's Office of Research and Development (ORD), the cancellation of hundreds of research grants, and the purging of thousands of public datasets from federal websites. This has left utilities without a trusted, independent authority to validate new treatment technologies or provide the scientific basis for managing emerging contaminants like per- and polyfluoroalkyl substances (PFAS), creating what the analysis terms "regulatory chaos".

Second, the **"Infrastructure Funding Shock"** has been triggered by the near-complete

elimination of federal grant programs and deep cuts to the State Revolving Funds (SRFs), which have historically been the primary vehicle for federal financial support. This has shifted an estimated \$1.3 trillion infrastructure upgrade burden squarely onto states and local utilities, forcing project paralysis and difficult conversations about steep rate hikes or privatization. Third, these immediate shocks threaten to unleash a **"Negative Cascade"** of long-term systemic decay. This includes the risk of an "infrastructure death spiral," where funding cuts lead to deferred maintenance, system failures, credit downgrades, and an inability to borrow for critical repairs. It also includes the entrenchment of a "two-tiered water system," where wealthier communities can afford advanced treatment and infrastructure renewal while poorer communities are left behind. Finally, it creates the conditions for a "race to the bottom," where states, incentivized by federal rhetoric about reducing regulatory burdens, compete to lower environmental standards to attract industry, jeopardizing shared water resources.

From Peril to Possibility

While a sober assessment of these risks is critical, the theoretical debate over the wisdom of this federal pivot is over. It is the new reality. To lament this fact is a luxury the sector cannot afford. The critical question has shifted from "what if" to "what now?".

As argued in "Charting the Course," this crisis is also a catalyst. The federal withdrawal has shattered the rigid path dependencies that defined the industry for decades. This forced break from the status quo creates a once-in-a-generation opportunity for proactive leaders to build something fundamentally better: a water system that is more resilient, more technologically advanced, and truly self-reliant.

This report serves as a playbook for those leaders. It moves from the analysis of risk to the documentation of action. The following sections provide structured, evidence-based case studies of the specific strategies, technologies, and partnerships that are turning today's challenges into tomorrow's solutions. For utilities ready to lead, states willing to invest in their own capabilities, and professionals prepared to build rather than wait, this is a chronicle of how the U.S. water sector is beginning to navigate its uncharted waters.

II. The Rise of the Hyper-Competent State and Regional Coalitions

In the void left by the federal retreat, the most immediate and powerful response has come from state and regional actors. This chapter directly addresses the "Knowledge Vacuum" and "Regulatory Chaos" by showcasing how these entities are stepping in to provide the research, data, and standards necessary for public health protection. The evidence suggests that where political will and economic resources align, states can not only replicate but also specialize and improve upon former federal functions.

Case Study Brief 1: California's State-Led Science Initiative

- **Initiative/Project Name:** California's Multi-Agency Effort to Replicate and Surpass Federal Research Capacity
- **Lead Organization(s):** California Office of Environmental Health Hazard Assessment (OEHHA), State Water Resources Control Board (SWRCB), California Environmental Protection Agency (CalEPA).

- **Problem Addressed:** The "Knowledge Vacuum" and regulatory uncertainty following the elimination of the EPA's ORD and the rescission of federal PFAS rules. With the federal government no longer setting health-based goals or validating new treatment technologies for emerging contaminants, California faced the choice of waiting in a state of paralysis or building its own scientific capacity.
- **Solution Implemented:** California is operationalizing the "Hyper-Competent State" model, leveraging its immense scientific and economic resources to protect its citizens where the federal government no longer will. This is not a single program but a coordinated, multi-agency effort to create an independent, state-level scientific apparatus. Key components include:
 - **Independent PFAS Research and Regulation:** In response to federal inaction on PFAS, California has taken the lead. The SWRCB's Division of Drinking Water has formally requested that OEHHA, the state's scientific arm, establish Public Health Goals (PHGs)—the state's equivalent of federal MCLGs—for compounds like PFHxS, building on the PHGs already adopted for PFOA and PFOS in April 2024. OEHHA's process involves evaluating the latest science on health effects like immunotoxicity and carcinogenicity and using advanced methods like "Read-Across" to assess data-poor PFAS chemicals. This work directly replaces the stalled federal MCL process.
 - **State-Level Technology Validation:** The SWRCB is conducting its own applied research through initiatives like the "PFAS Broad Spectrum Project," which compares and validates different analytical methods for detecting a wide range of PFAS compounds. This fills the critical technology validation role once held by the EPA, giving California utilities a trusted, in-state source for assessing monitoring technologies.
 - **Specialized Research for State Priorities:** Beyond PFAS, the state is funding research tailored to its unique water challenges. The SWRCB's Recycled Water Research Program actively investigates the frontiers of direct potable reuse (DPR), funding expert panels and studies on pathogen monitoring, risk assessment, and the detection of unknown chemicals in recycled water—areas critical to California's future water security but not necessarily a top priority for a national agency. Similarly, the California Institute for Water Resources (CIWR) supports targeted research and training on nitrogen management in agriculture, a major issue for the state's Central Valley.
 - **Building Data and Analytical Capacity:** To support these new state-led mandates, California has established the necessary data infrastructure. This includes the Environmental Laboratory Accreditation Program (ELAP), which accredits labs to perform the new, state-required PFAS analyses, ensuring the state has the capacity to execute its own monitoring programs.
- **Funding Model:** State-level appropriations and bond measures (e.g., Proposition 1, the Water Quality, Supply, and Infrastructure Improvement Act of 2014).
- **Current Status & Measurable Outcomes:** The initiative is ongoing and expanding. OEHHA adopted PHGs for PFOA (0.007 parts per trillion) and PFOS (1 part per trillion) in April 2024. The SWRCB has issued statewide orders for PFAS monitoring, with analytical results publicly available on the GeoTracker mapping tool. The state continues to fund research into DPR and CECs, with multiple expert panel reports completed and new ones convened.
- **Strategic Implication:** The California case demonstrates that the "Hyper-Competent

State" model is not about creating a miniature replica of the EPA. It is about building a more agile, specialized, and context-specific scientific apparatus that is arguably more effective at solving pressing regional problems than the former centralized system, representing a key positive signal emerging from the federal pivot.

Case Study Brief 2: The Great Lakes Water Quality Agreement (GLWQA)

- **Initiative/Project Name:** The Great Lakes Water Quality Agreement (GLWQA)
- **Lead Organization(s):** The Governments of the United States and Canada, in partnership with Great Lakes states (Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, Wisconsin) and the Province of Ontario. The International Joint Commission (IJC) serves a critical binational oversight, monitoring, and advisory role.
- **Problem Addressed:** The need for a durable, cross-jurisdictional governance model for setting shared water quality standards and data-sharing protocols. This directly counters the "race to the bottom" risk described in "Un-Chartered Waters," where adjacent states are incentivized to deregulate in the absence of a federal backstop.
- **Solution Implemented:** The GLWQA is a long-standing, legally binding binational treaty, first signed in 1972 and most recently updated in 2012, that provides a comprehensive framework for managing the world's largest freshwater ecosystem. Unlike the vast majority of U.S. interstate water compacts, which historically focus on allocating water *quantity*, the GLWQA's primary focus is on restoring and protecting water *quality* and ecosystem health. Its key features include:
 - **Shared Governance and Objectives:** The agreement establishes a set of common general and specific objectives for the chemical, physical, and biological integrity of the Great Lakes. It creates a governance structure where the two federal governments, states, and provinces work collaboratively to develop and implement programs to meet these objectives.
 - **Mandated Data Sharing and Reporting:** The agreement commits the parties to accountability through regular reporting on progress, which is made available to the public. This mandate fosters a culture of data sharing and transparency. While the agreement itself does not create a single real-time data platform, it has been the catalyst for numerous data-sharing and monitoring initiatives, such as the Great Lakes Water Authority's early-warning system that uses real-time sensors to detect contaminants and university-led projects that collect real-time data from ferries crossing the lakes.
 - **Independent Oversight:** The IJC plays a crucial role as an independent arbiter, monitoring progress, reporting on the effectiveness of government actions, and providing scientific advice to the parties, lending credibility and accountability to the entire process.
- **Funding Model:** Funding is provided by the respective federal, state, and provincial governments to implement the programs required under the agreement. In the U.S., this has been significantly supported by programs like the Great Lakes Restoration Initiative (GLRI).
- **Current Status & Measurable Outcomes:** The GLWQA is an enduring and active agreement. It has been credited with significant achievements, including major reductions in phosphorus loading and persistent toxic substances over its 50-year history. The

agreement continues to guide binational efforts to address current challenges like nutrient pollution (Annex 4), aquatic invasive species (Annex 6), and chemicals of mutual concern (Annex 3).

- **Strategic Implication:** The GLWQA's success suggests a "shared destiny" precondition for robust interstate collaboration on water quality. For other regions to form similar quality-focused compacts, they will likely need a catalyst—a shared crisis or a powerful shared identity around the water resource—that is strong enough to overcome the short-term economic incentive to deregulate, representing a significant barrier to replicating this model nationwide.

III. The New Data Ecosystem: Building the Digital Foundation for Resilience

The federal pivot has created a "widening chasm" between the water industry's exponential need for data and the government's retreat from providing it. Modern water management relies on data-intensive modeling, AI, and real-time analytics, yet the public data infrastructure that once supported this work is eroding. This chapter documents the emerging ecosystem of non-governmental and public-private partnerships that are stepping into this chasm, not by recreating a single federal database, but by building a more decentralized, collaborative, and open-source digital foundation for the entire sector.

Case Study Brief 3: The California Data Collaborative (CaDC)

- **Initiative/Project Name:** The California Data Collaborative (CaDC)
- **Lead Organization(s):** A 501(c)(3) non-profit partnership of over 19 California water utilities, governed by a steering committee of its members. Key members include the Metropolitan Water District of Southern California, Alameda County Water District, and Desert Water Agency.
- **Problem Addressed:** The challenge for individual utilities, particularly small and mid-sized ones, to affordably develop and maintain the sophisticated data analytics capabilities needed for modern demand management, operational efficiency, and complex state regulatory compliance. "Un-Charted Waters" posits a stark choice: make "massive new investments" in private data systems or "operate with reduced analytical capabilities". The CaDC was formed to create a third option.
- **Solution Implemented:** The CaDC functions as a "Utility Data Trust," a cooperative where members pool resources to fund a shared, best-in-class data science and software development team. This model provides members with access to tools and expertise that would be prohibitively expensive to develop in-house. The operational model includes:
 - **Subscription-Based Shared Services:** Member utilities pay an annual fee, which funds the CaDC's operational costs. This allows them to leverage a common set of resources and a shared R&D budget to solve common problems.
 - **Secure Data Platform and Tools:** The CaDC provides a secure, web-based platform called **Wavelet** where members can upload, standardize, and analyze their water use data. The platform includes powerful tools like an **AMI Query Engine** to unlock insights from smart meter data and the **Urban Water Use Objective Easy Report**, a specific tool developed to help over 150 water suppliers with compliance for new state regulations.

- **Collaborative Governance:** The CaDC is governed by its members, who co-develop priorities and pilot projects. This participatory model, built on a standardized "trust framework" of data sharing agreements, has been essential for building the trust required for utilities to share sensitive data.
- **Funding Model:** The primary funding source is annual subscription fees from member utilities. This is supplemented by strategic partnerships and grants.
- **Current Status & Measurable Outcomes:** The CaDC is a growing and financially sustainable organization. It has successfully developed and deployed multiple data tools used by its members. Testimonials from members like the Metropolitan Water District of Southern California highlight the value of the collaborative, stating it is like "multiplying that team by ten to solve your utility problems". The CaDC has also provided critical technical analysis that has informed statewide policy, demonstrating its value beyond individual member services.
- **Strategic Implication:** The CaDC is a proven, financially sustainable model for how utilities can collaboratively overcome the "data chasm" without bankrupting themselves or waiting for a federal return. It transforms a competitive burden into a shared asset, offering a scalable "third way" for the industry.

Case Study Brief 4: The Internet of Water (IoW) & The Water Data Exchange (WaDE)

- **Initiative/Project Name:** Building Open-Source National Water Data Infrastructure
- **Lead Organization(s):** The Internet of Water (IoW) Coalition (a project of the Lincoln Institute's Center for Geospatial Solutions) and the Western States Water Council (WSWC).
- **Problem Addressed:** The fragmentation and lack of standardization of water data across hundreds of federal, state, and local agencies. Data is often difficult to find, inaccessible in proprietary formats, and not interoperable. This long-standing issue has been critically exacerbated by the federal pivot and the removal of centralized federal datasets, making a cohesive national water data picture nearly impossible to assemble.
- **Solution Implemented:** The IoW and its partners are pioneering a federated, open-source approach to data infrastructure. Instead of trying to build a new, single national database, they are building the "digital roads and bridges" that allow decentralized data to be connected and understood.
 - **IoW's National Coordinating Role:** The IoW acts as a national-level coordinator, tool-builder, and advocate for open data principles. It develops and promotes the adoption of open-source standards and technologies like **Geoconnex**, a system that provides permanent, linkable identifiers for water data tied to specific geographic features (streams, aquifers, etc.). It also fosters a **State Agency Peer-to-Peer (P2P) Network** to share best practices and provides technical assistance to help agencies modernize their data management.
 - **WaDE's Regional Implementation:** The Water Data Exchange (WaDE), managed by the WSWC, is a premier, real-world implementation of IoW principles. WaDE is a centralized, cloud-based platform that ingests disparate water rights, supply, and use data from the 18 WSWC member states. It then transforms this data into a standardized, machine-readable format, making it findable, accessible, interoperable, and reusable (FAIR). This enables, for the first time, consistent

regional analysis across state lines. WaDE is explicitly recognized as a major data hub of the Internet of Water.

- **Funding Model:** The IoW is supported by philanthropic foundations and federal partners. WaDE is supported by the WSWC member states and federal partners.
- **Current Status & Measurable Outcomes:** Both initiatives are active and expanding. The IoW's P2P network includes numerous state agencies, and its tools are being adopted by partners. As of early 2022, all 18 WSWC member states are participating in the WaDE Program to some degree, a major achievement in regional data sharing. WaDE has evolved into its third phase, developing the **Western Water Data Access and Analysis Tool (WestDAAT)**, a user-facing dashboard to make the aggregated data more accessible for decision support.
- **Strategic Implication:** This represents a fundamental architectural shift from a centralized data repository to a federated network. The future of water data is not about one big database, but about creating the protocols and tools that allow many databases to speak the same language, resulting in a more resilient, if more complex, model.

Case Study Brief 5: Microsoft & Ecolab Enterprise Data Partnership

- **Initiative/Project Name:** Co-development of an Enterprise-Scale Water Management Data Platform
- **Lead Organization(s):** Microsoft and Ecolab.
- **Problem Addressed:** The need for large industrial, commercial, and institutional water users to unify disparate water data streams—including water quantity, quality, financial, and operational data—for comprehensive sustainability reporting and operational efficiency. This challenge is magnified in a post-federal world where standardized public data is less available, forcing organizations to rely more on their own complex internal data.
- **Solution Implemented:** This partnership represents a deep product integration, moving beyond a simple marketing alliance to a co-developed solution for enterprise customers. The joint offering combines the power of Ecolab's **ECOLAB3D™** digital services platform with **Microsoft Cloud for Sustainability**. The integrated solution allows organizations to:
 - **Unify Data:** Ingest and centralize water consumption data from diverse sources and integrate it with other environmental, financial, and operational data within the Microsoft Cloud for Sustainability's purpose-built water data model.
 - **Analyze and Report:** Use interactive dashboards built on Microsoft Power BI to visualize water data, track progress against sustainability goals, and generate reports formatted for ESG disclosure standards.
 - **Link Water and Energy:** Use digital technologies to explicitly link water efficiency gains with energy savings and reduced greenhouse gas emissions, addressing the critical water-energy nexus.
- **Funding Model:** Commercial partnership, with the joint solution offered as a service to enterprise customers.
- **Current Status & Measurable Outcomes:** The partnership was announced in March 2023 and the joint solution is actively being marketed to customers. Both companies are using the platform to advance their own corporate water goals; Microsoft aims to be water positive by 2030, and Ecolab has launched its "Ecolab Water for Climate" program to help customers achieve dual business and sustainability goals.
- **Strategic Implication:** This partnership signals the maturation of the corporate water

stewardship market, moving from high-level pledges to integrated, enterprise-grade software solutions that directly address the complex data management challenges left by the federal retreat.

Case Study Brief 6: Google's Direct Investment in Public Water Infrastructure

- **Initiative/Project Name:** Google-The Dalles Public Water System Infrastructure Upgrade
- **Lead Organization(s):** Google LLC; The City of The Dalles, Oregon.
- **Problem Addressed:** The "Infrastructure Funding Shock" for a smaller municipality needing to fund essential upgrades to its public water system to support new industrial growth and ensure long-term supply reliability.
- **Solution Implemented:** A direct, transactional public-private partnership where corporate investment was traded for water resources. To secure the water needed to cool its massive data center facilities in the city, Google directly funded, constructed, and then transferred ownership of critical public water infrastructure to The Dalles. This went far beyond paying standard System Development Charges (SDCs). The agreement included:
 - A combined contribution of **\$28.5 million** toward improvements to publicly owned infrastructure.
 - Specific projects funded by Google included **two new wells, two reservoirs, a pump station, and a sanitary sewer lift station.**
 - Google also fully funded and completed a new **Aquifer Storage and Recovery (ASR)** system, which increases storage for summer demand and improves groundwater health, before transferring ownership to the city.
 - In addition to these capital contributions, Google also transferred existing water rights to the city and pays the same full water use rates as all other industrial customers.
- **Funding Model:** Direct private investment and asset transfer in exchange for water rights and service.
- **Current Status & Measurable Outcomes:** The infrastructure projects are complete and have been transferred to city ownership. The agreement has enabled the city to significantly upgrade its water supply system to meet growing needs while Google has secured the water required for its data center operations, which globally withdrew 8.65 billion gallons in 2023.
- **Strategic Implication:** This model is a potent but potentially inequitable solution to the funding shock, highlighting the risk of the "two-tiered water system" forecasted in "Un-Charted Waters". While a clear win for The Dalles, this type of direct corporate investment is only available to communities that possess a resource a large corporation wants, creating a potential divide between communities that can attract such partnerships and those that cannot.

IV. Applied Technology in Practice: From Digital Twins to Demonstrable ROI

As federal support wanes, utilities are under immense pressure to do more with less. The threat of an "infrastructure death spiral"—where the inability to fund massive capital projects leads to

accelerating decay—is a primary concern. This chapter provides concrete evidence of how applied technologies like Artificial Intelligence (AI) and Digital Twins are being deployed not merely as novelties, but as essential tools for optimizing existing assets, avoiding catastrophic failures, and substituting technology for concrete, thereby fundamentally altering a utility's financial trajectory.

Case Study Brief 7: City of South Bend's Smart Sewer Network Optimization

- **Initiative/Project Name:** Smart Sewer Network Optimization via Digital Twin
- **Lead Organization(s):** City of South Bend, Indiana; Xylem Inc..
- **Problem Addressed:** The City of South Bend was under a federal consent decree to address its combined sewer overflow (CSO) problem, which was dumping 1-2 billion gallons of polluted water into the St. Joseph River annually. The conventional solution required a massive gray infrastructure investment plan that was financially crippling for the city of just over 100,000 people, creating a classic scenario that could trigger an "infrastructure death spiral".
- **Solution Implemented:** Instead of building a larger, more expensive sewer system, the city partnered with Xylem to build a smarter one. They deployed an operational digital twin of their sewer network using the **Xylem Vue powered by GoAigua** platform. This "smart sewer" system integrates real-time data from a network of over 165 sensors and 13 automated gates and valves installed throughout the collection system. The digital twin provides:
 - **Real-Time Visibility and Control:** Operators can see the status of the entire network in real time.
 - **Predictive Analytics:** The system uses AI to predict how the network will react to wet weather events.
 - **Automated Optimization:** Based on predictions, the system automatically adjusts gates and valves to move flows to under-utilized parts of the network, maximizing in-system storage and preventing overflows before they happen.
- **Funding Model:** Utility capital investment in technology, financed through local rates and bonds. This technology investment allowed the city to avoid a much larger capital expenditure.
- **Current Status & Measurable Outcomes:** The project is fully implemented and has produced dramatic, quantifiable results that were endorsed by the Department of Justice and the EPA in an updated consent decree in 2021.
 - **Capital Avoidance:** The city saved an estimated **\$400 million** in capital expenditures compared to the original gray infrastructure plan. This equates to avoiding a cost of nearly \$10,000 per citizen.
 - **Operational Savings:** The optimized system has generated approximately **\$1.5 million in annual operations and maintenance (O&M) cost savings**.
 - **Performance Excellence:** The system has eliminated dry weather overflows and reduced overall CSO volume by over **80%**, far exceeding the original consent decree requirements.
 - **Environmental Impact:** The reduction in pollution has led to a **50% average reduction in E. coli concentration** in the St. Joseph River, significantly improving local water quality.

- **Strategic Implication:** The South Bend case is the premier example of technology serving as capital substitution. It demonstrates a paradigm shift from CAPEX-heavy solutions to OPEX-driven, intelligent system management. For utilities facing an infrastructure funding shock, the strategic lesson is to rigorously evaluate whether technology can replace concrete, thereby breaking the death spiral.

Case Study Brief 8: Moulton Niguel Water District's AI-Powered Efficiency Platform

- **Initiative/Project Name:** AI-Powered Demand Management and Leak Detection Platform
- **Lead Organization(s):** Moulton Niguel Water District (MNWD), a public utility in South Orange County, California.
- **Problem Addressed:** The persistent need to improve long-term water use efficiency, manage customer demand during California's frequent droughts, and reduce non-revenue water loss from leaks, all within the financial constraints of a post-federal funding environment.
- **Solution Implemented:** MNWD executed a multi-million-dollar, systemwide upgrade, replacing all 55,000+ traditional meters with smart meter technology. This created a foundational data stream that powers a sophisticated, internally managed analytics platform. The key components are:
 - **Data Infrastructure:** Every hour, smart meters record water use data, which is transmitted to a secure cloud database hosted on **Amazon Web Services (AWS)**. This provides the high-resolution data necessary for advanced analytics.
 - **AI-Driven Budget-Based Rates (BBRS):** MNWD's in-house team uses this granular data to power its BBRS, which provides customers with individualized water budgets based on factors like property size and local weather data provided by partners like HydroPoint Data Systems. An econometric modeling study confirmed that this data-driven rate structure was directly responsible for a **20% reduction in water usage** compared to peak demand levels.
 - **Proactive Leak Alerts:** The district's data scientists developed AI/ML algorithms that run on the AWS-hosted data to analyze hourly usage patterns. The system automatically identifies anomalies indicative of leaks (e.g., continuous water flow overnight) and sends proactive alerts to customers through a dedicated online portal (MyWater MNWD) and smartphone app, allowing for immediate intervention.
- **Funding Model:** The project was funded primarily through utility capital investment, supported by over **\$2 million in federal grants** from the U.S. Department of the Interior's Bureau of Reclamation, demonstrating a successful blend of local and federal resources.
- **Current Status & Measurable Outcomes:** The systemwide meter upgrade was completed in January 2022. The integrated system is fully operational and is expected to conserve an estimated **500 million gallons of water per year** through improved efficiency and rapid leak detection.
- **Strategic Implication:** MNWD demonstrates the powerful synergy created by combining a full smart meter deployment with an in-house data science capability and a scalable cloud backend. This creates a versatile platform for enhancing operational efficiency, driving conservation, and improving customer engagement and service.

V. Innovative Governance and Finance: Overcoming

the Infrastructure Funding Shock

The "Infrastructure Funding Shock" described in "Un-Chartered Waters" has forced utilities and regional bodies to fundamentally rethink how capital projects are financed and executed. With traditional federal grants largely eliminated, a new generation of financial and governance models is emerging. These models move beyond simple grant-seeking to embrace sophisticated blended finance, public-private risk sharing, and new forms of collaboration that unlock previously inaccessible capital. This chapter details real-world examples of how the sector is overcoming financial paralysis.

Case Study Brief 9: The Chicagoland Watershed Coordinator

- **Initiative/Project Name:** Chicagoland Watershed Coordinator Program
- **Lead Organization(s):** Quantified Ventures, a specialized outcomes-based capital firm.
- **Problem Addressed:** A critical "knowledge gap" prevents many viable nature-based infrastructure projects from accessing available capital. Small municipalities, non-profits, and local conservation groups often lack the financial expertise, staff capacity, and technical knowledge to navigate the complex application processes for large funding pools like the State Revolving Funds (SRFs), leaving billions in available financing untapped.
- **Solution Implemented:** The Chicagoland Watershed Coordinator program, launched by Quantified Ventures, acts as a specialized financial intermediary and capacity-builder. The program does not provide capital directly; instead, it provides the expert guidance needed to unlock existing capital for local partners. Its core functions are:
 - **Expert Technical Assistance:** The Watershed Coordinator works directly with municipalities, utilities, and non-profits to identify eligible natural infrastructure projects (e.g., green stormwater infrastructure).
 - **Navigating the Funding Process:** The Coordinator provides hands-on support to guide these organizations through the entire funding and financing process, particularly for SRF loan applications.
 - **Facilitating Collaboration:** The program helps facilitate stakeholder collaborations, build community engagement, and support the formation of watershed-level coalitions to advance larger, more impactful projects.
- **Funding Model:** The technical assistance provided by the Watershed Coordinator to local partners is supported by philanthropic funding. This allows smaller organizations to access top-tier financial advisory services at no cost.
- **Current Status & Measurable Outcomes:** The program is active in the Chicagoland area, working with local partners to identify and develop a pipeline of nature-based solution projects eligible for SRF financing. The model builds on Quantified Ventures' national experience in structuring innovative financing for projects like the Buffalo Sewer Authority EIB.
- **Strategic Implication:** This model provides a highly scalable and replicable solution for unlocking existing but inaccessible capital. It demonstrates that in a post-federal-grant world, a dedicated financial intermediary can play a critical role in aggregating small projects and providing the necessary expertise to channel state-level funding toward critical green infrastructure.

Case Study Brief 10: The DC Water and Buffalo Sewer Authority Environmental Impact Bonds (EIBs)

- **Initiative/Project Name:** Environmental Impact Bond (EIB) for Green Infrastructure Financing
- **Lead Organization(s):** DC Water; Buffalo Sewer Authority (BSA). Key partners include Quantified Ventures (transaction intermediary) and private investors such as Goldman Sachs Urban Investment Group and Calvert Impact Capital.
- **Problem Addressed:** The "Infrastructure Funding Shock" combined with the significant performance risk associated with investing in innovative but relatively unproven green infrastructure (GI) solutions to meet pressing regulatory mandates for combined sewer overflow (CSO) reduction. Public utilities are traditionally risk-averse, making it difficult to justify large investments in new approaches over certain, if more expensive, gray infrastructure.
- **Solution Implemented:** The Environmental Impact Bond is a sophisticated blended finance model that raises private capital for a public project while explicitly linking the financial return to investors to the achievement of pre-defined, measurable environmental outcomes. This structure transfers performance risk from the utility and its ratepayers to the private investors.
 - **DC Water (2016 - The Pioneer):** Issued a **\$25 million, tax-exempt EIB** in a private placement to fund its first large-scale GI project. The bond featured a three-tiered risk-sharing mechanism: if the GI project underperformed in reducing stormwater runoff (below 18.6%), the investors would make a "risk share payment" of \$3.3 million to DC Water. If it overperformed (above 41.3%), DC Water would pay investors a \$3.3 million "outcome payment." If performance fell in the middle tier, no contingent payment was due.
 - **Buffalo Sewer Authority (2021 - Scaling the Model):** Issued a much larger **\$54 million EIB** to finance its "Rain Check 2.0" green infrastructure program. This bond included a novel call feature: if BSA met or exceeded its performance target (installing 200 acres of GI), it gained the option to refinance or retire the bond at a lower cost, creating a positive incentive for success.
- **Funding Model:** Blended Finance (Municipal Bond with an outcomes-based, private investor risk-sharing component).
- **Current Status & Measurable Outcomes:**
 - **DC Water:** The project was a success. Post-construction monitoring showed a stormwater runoff reduction of nearly 20%, landing in the neutral performance band where no risk or outcome payment was required. The bond was fully repaid in 2021, and the pilot's success has informed DC Water's ongoing, larger-scale GI implementation. The project also spurred the creation of a green jobs certification program.
 - **Buffalo:** The \$54 million bond was **8.6 times oversubscribed**, demonstrating powerful investor demand for such instruments. The bond received strong credit ratings (A+ from S&P) and is funding an accelerated pace of GI installation of over 28 acres per year.
- **Strategic Implication:** The EIB is a powerful financial tool that enables utilities to pilot innovative, potentially cost-saving technologies by de-risking the fear of failure. This is a

critical enabler of the very innovation needed to survive the post-federal era.

Case Study Brief 11: Hampton Roads Sanitation District's Proactive Financing Strategy

- **Initiative/Project Name:** Sustainable Water Infrastructure for Tomorrow (SWIFT) Program
- **Lead Organization(s):** Hampton Roads Sanitation District (HRSD), a mid-to-large regional wastewater utility serving 1.9 million people in southeast Virginia.
- **Problem Addressed:** The need to overcome the "Infrastructure Funding Shock" to finance a massive, multi-billion-dollar capital program. The SWIFT program is essential for HRSD to meet stringent regulatory requirements for nutrient reduction in the Chesapeake Bay and to address regional water security challenges, including replenishing the stressed Potomac Aquifer and mitigating land subsidence. The total initial program cost is \$2.9 billion.
- **Solution Implemented:** HRSD developed a sophisticated and proactive blended finance strategy that demonstrates how a well-managed utility can navigate the post-federal funding landscape. Instead of relying on grants, HRSD aggressively pursued and secured low-cost federal loans, blending them with state and local funding sources. The cornerstone of their strategy is a **\$1.3 billion master agreement** with the EPA's **Water Infrastructure Finance and Innovation Act (WIFIA)** loan program. This single agreement provides a long-term, stable source of capital covering nearly half of the initial program costs. The remaining funds are sourced from:
 - Virginia's Clean Water State Revolving Fund (CWSRF) financing.
 - Local borrower-produced contributions (i.e., revenue from rates).
- **Funding Model:** Blended Finance, strategically combining a large-scale Federal Loan (WIFIA), a State Loan (SRF), and local utility revenues.
- **Current Status & Measurable Outcomes:** The SWIFT program is well underway, with multiple WIFIA loan tranches already disbursed, including a \$268 million tranche announced in late 2024. The financial benefits are substantial: the WIFIA financing alone is estimated to save HRSD ratepayers **\$211.5 million** in interest costs compared to typical municipal bond market financing. The program, once complete, will reduce HRSD's surface water discharge to the Chesapeake Bay watershed by approximately 90% (about 50-100 million gallons per day) and will replenish the vital Potomac Aquifer with highly treated water.
- **Strategic Implication:** HRSD provides the premier case study for how a well-managed utility can thrive in the post-federal funding landscape. It demonstrates that while federal *grants* may be scarce, federal *financing* tools like WIFIA remain a cornerstone of funding for large, complex projects, rewarding utilities with the financial sophistication to proactively blend them with state and local sources.

VI. Strategic Synthesis & Forward-Looking Recommendations

The case studies presented in this report paint a clear picture of a sector in transformation. The federal pivot, while disruptive, has catalyzed a powerful wave of innovation and self-reliance.

The theoretical potential for a decentralized, market-driven water future is being made real by proactive leaders on the ground. Synthesizing the evidence from these pioneering efforts reveals an emerging playbook for success in the post-federal era. This playbook is defined by a series of fundamental strategic shifts away from the old model of passive federal compliance.

The Emerging Playbook for a Self-Reliant Water Future

Successful utilities and state agencies in this new landscape are not acting as passive service providers but as entrepreneurial leaders, regional conveners, and sophisticated financial managers. Their actions point to four key strategic shifts:

1. **From Federal Reliance to Regional Self-Sufficiency:** The most resilient regions are those that are actively investing in their own scientific and governance capabilities. The **California** case study demonstrates that a "Hyper-Competent State" can build a specialized research apparatus that is more agile and responsive to local needs than its federal predecessor. The **Great Lakes Water Quality Agreement** shows that durable, quality-focused interstate compacts are possible, but likely require a strong sense of "shared destiny" to overcome the economic pressures that encourage a "race to the bottom". The strategic imperative is to move from a mindset of federal dependence to one of investing in and owning regional science and governance.
2. **From Data Scarcity to Data Collaboration:** The "widening chasm" between the need for data and the decline in public provision is being bridged not by a single entity, but by a new ecosystem of collaboration. The **California Data Collaborative** proves the viability of the "Utility Data Trust" model, where utilities pool resources to gain access to analytics capabilities that would be unaffordable individually. On a national scale, the **Internet of Water** and **WaDE** are building the open-source digital infrastructure—the common language and protocols—for a more resilient, federated data network. The strategic shift is from viewing data as a scarce commodity to be hoarded, to treating data infrastructure as a shared asset to be co-developed.
3. **From CAPEX-Heavy to Tech-Driven Operations:** The most powerful response to the "Infrastructure Funding Shock" is not always finding new money, but reducing the need for it. The **City of South Bend** provides the definitive case study of technology as capital substitution. By investing in a digital twin to optimize its existing sewer network, the city avoided \$400 million in gray infrastructure costs, fundamentally breaking the "infrastructure death spiral". Similarly, **Moulton Niguel Water District's** use of AI and smart meters to reduce water loss and manage demand demonstrates how technology can maximize the efficiency of existing assets. The strategic imperative is to rigorously evaluate technology as a direct alternative to concrete, shifting focus from massive capital projects to intelligent system management.
4. **From Grant-Seeking to Sophisticated Finance:** The era of passive grant applications is over. Successful utilities are now acting as sophisticated financial managers. The **Hampton Roads Sanitation District** case shows how proactively pursuing and blending diverse capital sources—like federal WIFIA loans, state SRFs, and local revenues—can successfully fund multi-billion-dollar programs. The **DC Water and Buffalo Sewer Authority** EIBs demonstrate how innovative financial instruments can be used to de-risk innovation, transferring performance risk to private investors and enabling utilities to pilot new, cost-saving approaches. The strategic shift is from being a grant-seeker to being a capital-strategist.

Horizons and Headwinds: The Next Wave of Challenges

While this report documents significant progress, the transition to a fully decentralized and self-reliant water future is far from complete. The very solutions being pioneered are giving rise to a new set of strategic challenges that will define the next decade for the water sector.

First, the rise of direct public-private partnerships, while a potent solution to the funding shock, carries significant **equity implications**. The model seen in The Dalles, Oregon, where Google directly funded public water infrastructure, is powerful but risks entrenching the "two-tiered water system" forecasted in "Un-Charted Waters". It creates a world where a community's water security could become dependent on its economic value to a large corporation, leaving communities without such assets further behind.

Second, the explosion in data sharing and collaboration necessitates the development of new frameworks for **data governance, security, and privacy**. As utility data trusts (like the CaDC) and open-source platforms (like the IoW) become more prevalent, the industry will need to establish robust, trusted standards for how sensitive customer and operational data is managed, shared, and protected from misuse or cyber threats.

Finally, and perhaps most critically, the sector faces an immense **"human capital crisis"**. The strategies outlined in this report—from running state-level research programs to negotiating multi-billion-dollar blended finance deals and managing AI-driven digital twins—require a workforce with skills in data science, financial analysis, risk management, and complex partnership negotiation. These are not skills that have been traditionally cultivated in the risk-averse, compliance-driven culture of many public utilities. Attracting, training, and retaining this new generation of talent, in direct competition with the technology and finance sectors, may be the single greatest barrier to scaling these innovative solutions nationwide.

The path forward is being forged, but the work of building a smarter, more resilient, and truly self-reliant water future has only just begun. It is no longer a choice, but a shared and urgent duty.

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