Investing in Intelligent Technology:

Facing Today's Wastewater Challenges with the Future in Mind

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Wastewater collection and treatment is one of the most fundamental, critical services local governments and utilities provide residents. The wastewater treatment sector is facing numerous challenges, including limited resources to upgrade aging infrastructure; lack of adequate data and information for proactive system operation and maintenance; and difficulty in recruiting, training, and retaining skilled workers to replace an aging workforce.

Many utilities across the country are tackling these challenges by investing in water and wastewater infrastructure technology to create what are known as intelligent water systems. That term might sound futuristic but building an intelligent water system can be as simple as connecting existing sensors and meters and then transmitting data from them to allow for remote access to information. By improving access to timely data and information, utilities can improve their operations and decision-making. The technologies highlighted in this document are at work in many communities right now, helping them to create intelligent water systems to take on today's challenges while adapting and preparing for future challenges (e.g., increasingly intense wet weather events, population expansion, and attracting a technology-savvy and data-driven workforce). This document also demonstrates potential ways that communities can use funds from the Clean Water State Revolving Fund (CWSRF) to incorporate intelligent water systems in their utility operations.

This document is for communities that want to learn how other communities of various sizes, locations, and demographics are developing intelligent water systems and using CWSRF money to invest in technologies today for a more efficient and resilient water system in the future. The document provides a brief overview of select intelligent technologies: **telemetry, advanced metering, real-time controls, and Supervisory Control and Data Acquisition (SCADA) systems**. These intelligent technologies are highlighted because they:

- Are readily available, well established in practice, and widely implemented in intelligent water systems across a variety of communities.
- Can serve as building blocks for communities to expand into additional intelligent systems.
- Offer automated access to data and information that utilities can use to improve decision-making and reduce operational costs.

CWSRF Investment in Intelligent Technology in the United States

Over the last 10 years (2013–2023), the CWSRF has invested in 179 projects with intelligent technologies. Almost half of these projects are in small communities, and many are in rural and/or disadvantaged communities (Figures 1, 2 and 3).

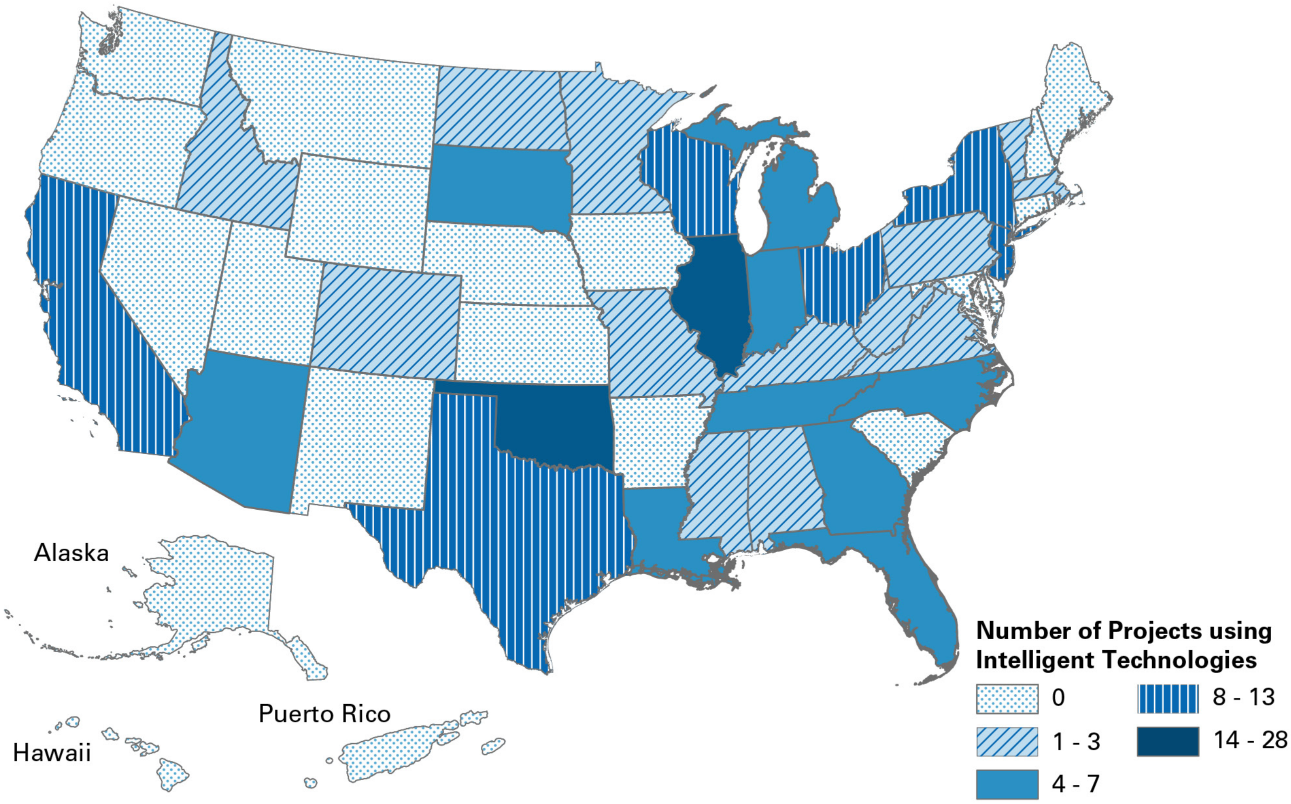


Figure 1. *Projects that have used CWSRF funding to implement intelligent technologies between 2013 and 2023.*[1]

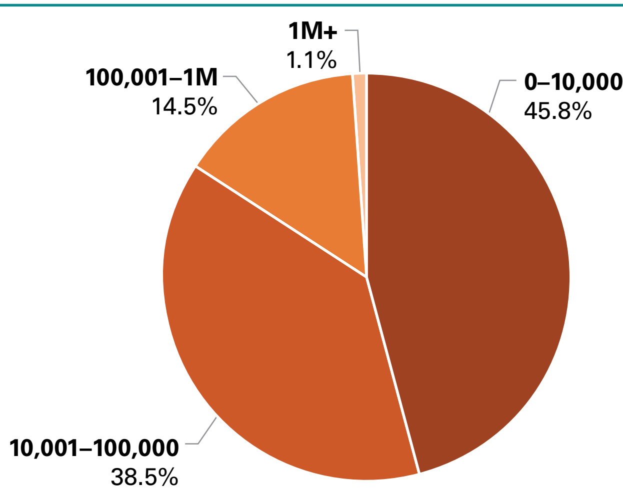


Figure 2. *Population size of project locations and relative percentage of the 179 communities that installed intelligent technologies between 2013 and 2023 using CWSRF.*

The Water Environment Federation's Intelligent Water Systems: The Path to a Smart Utility describes the value of and barriers to implementing intelligent technologies. EPA's Searchable Clearinghouse of Wastewater Technology (SCOWT) also includes resources about intelligent technologies for decentralized, wastewater and reuse water systems. The Water Research Foundation's webpage on Intelligent Water Systems includes resources on newly developed technologies for wastewater utilities.

1. Intelligent technologies presented in this map and other figures were identified from the EPA Office of Water State Revolving Fund database based on a keyword search for the following terms: *advanced metering infrastructure, automated meter reading, real time control, SCADA, and telemetry installations.*

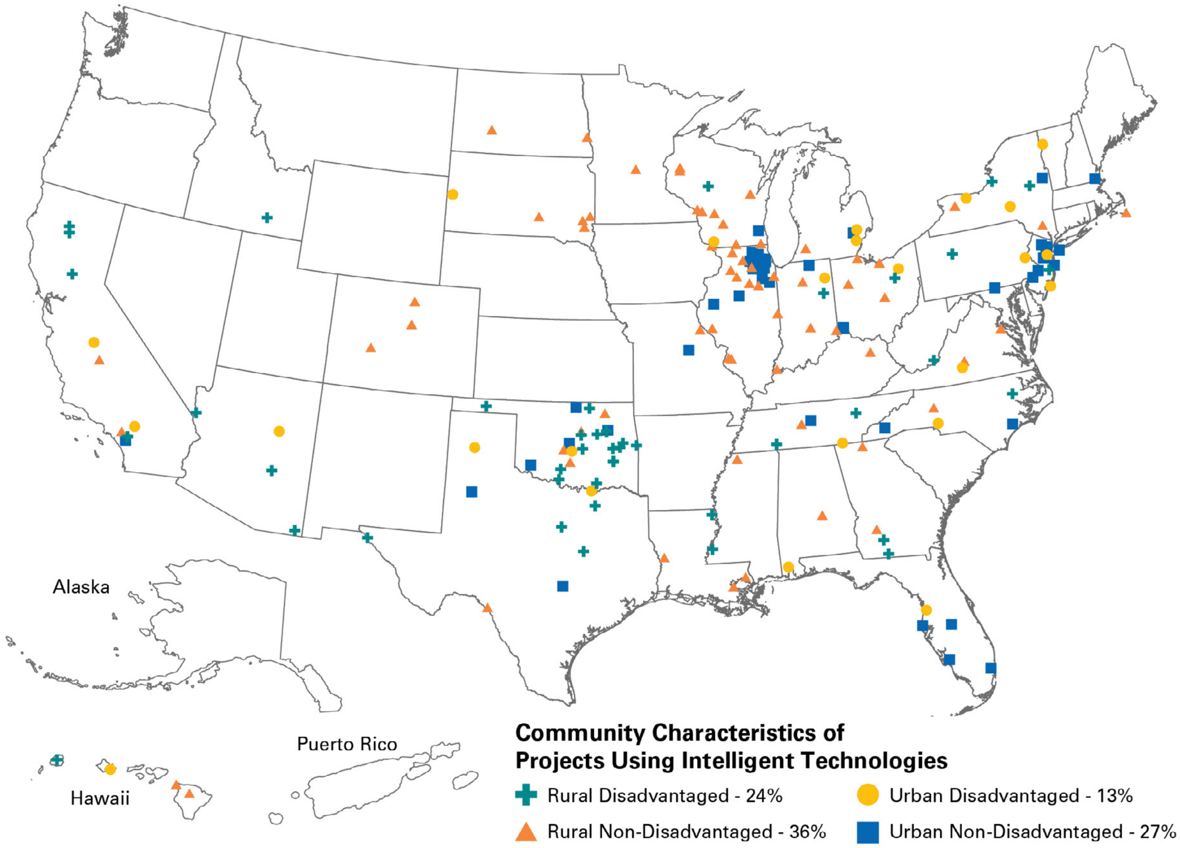


Figure 3. *Locations and characteristics of the communities that installed intelligent technologies between 2013 and 2023 utilizing CWSRF.*[2]

2. The 2020 Census defines an urban area as "a densely settled core of census blocks that meet minimum housing unit density and/or population density requirements. This includes adjacent territory containing non-residential urban land uses. To qualify as an urban area, the territory identified according to criteria must encompass at least 2,000 housing units or have a population of at least 5,000." Rural areas include all census blocks not located within an urban area. Disadvantaged areas were identified using the Climate and Economic Justice Screening Tool.

Building Intelligent Water Systems with Established Technologies

Many types of intelligent technologies are well established in the water sector and can be funded through the CWSRF program (Figure 4). These technologies can then be integrated with each other to build an intelligent water system. For example, the installation of telemetry in conjunction with existing sensors can provide real-time access to operational information. A utility can then manage these data and automate operational processes using a SCADA system with real-time control

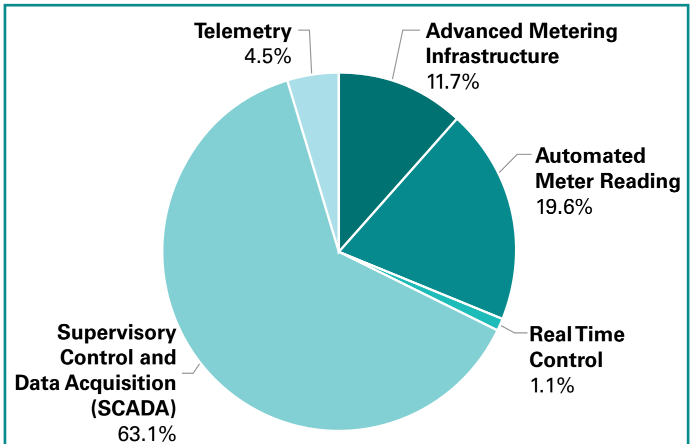


Figure 4. *Proportion of 179 projects by intelligent technology type that utilized CWSRF between 2013 and 2023.*

technology. Building on this infrastructure, the utility can integrate artificial intelligence (AI) and machine learning software, which can evaluate historical data, provide predictive capabilities, and perform analyses on a scale not possible for an individual, reducing risk and enhancing proactive action planning. By combining intelligent technologies, a utility can improve asset management and achieve a better understanding of its collection and treatment system performance. Such improvements can help the utility meet and maintain regulatory compliance, among other benefits.

Intelligent Technology Spotlight

Telemetry

Telemetry systems automatically transmit data from sensors at remote points in the collection and treatment system to a communications center for review and analysis. The use of telemetry allows utilities to gather real-time data for an accurate overview of system operation. Telemetry systems can be used in combination with other technologies, including real-time controls, to create a more robust intelligent water system. For example, a small community might implement telemetry systems with flow monitoring to better understand the impacts of infiltration and inflow. Compared to typical manual field measurements, telemetry reduces the lag times for transmission of data. This allows for more efficient and informed decision-making and reduces the time technicians spend taking manual measurements, providing more time to focus on proactive asset management.

According to the National Association of Clean Water Agencies (NACWA) guide for Envisioning the Digital Utility of the Future, intelligent technologies can benefit utilities in significant ways. For example, they can:

- Reduce operational costs.
- Manage and mitigate risks.
- Enhance the customer experience.
- Improve financial execution.
- Optimize asset performance and uncover hidden value.
- Leverage existing communications and computing platforms.
- Maximize the engagement and efficiency of employees.
- Integrate water quality, policy, and performance.

Metering

Automated Meter Reading (AMR) is used to automatically read drinking water system data from installed meters. These meters have a data transmitter that can send water flow and alarm data to a receiver in close proximity (usually when an operator drives or walks by). The data are then transferred to a database where they can be readily analyzed.

Advanced Metering Infrastructure (AMI) is an integrated system of water meters, telemetry, and data management systems that can automatically transmit usage data directly to utility personnel in a remote location. AMI enhances a utility's ability to monitor consumption patterns, identify leaks, and improve overall facility water management.

Both solutions provide a community with the ability to monitor and analyze data quickly and more efficiently, compared with the manual reading of water meters. This allows faster communication with customers. By showing usage data in near real-time, a utility can help identify leaks and encourage water conservation, potentially leading to reductions in potable water demand and use. Such reductions decrease the discharges that require treatment at the wastewater treatment plant, reducing energy usage and maximizing the plant's treatment capacity.

Modernizing Metering Improves Data for Community

Rochester, NY

The City of Rochester, New York, services 59,000 metered accounts. The city has embarked on a 20+ year initiative to convert its meter reading system to be AMR capable. By the end of 2024, the system will be 85 percent converted. The city secured CWSRF funding to cover a portion of the project, which enabled it to continue charging affordable water rates during the upgrades rather than passing along all costs to customers. AMR-capable meters improved the efficiency of meter reads and provided quicker alerts of leaks or other unusual conditions. The new meters, along with future improvements to modernize the billing and reading software, will allow the city to provide real-time consumption data to customers in the future.

Real-Time Controls

Real-time control devices (i.e., programmable controllers) can autonomously activate pumps, valves, etc. in the field to optimize performance or make process adjustments based on data transmitted from remote sensors. For instance, the dosage of chemicals or the timing of aeration cycles and process streams can be controlled without active operator input. These types of automated controls can improve system efficiency and reduce energy use and the need for chemical addition. They can also be used to dynamically control and optimize storage handling during wet weather events. This automation reduces the demand on the utility's workforce to monitor and analyze water quality and flow data and adjust controls.

Real-time controls can control a single device or many devices throughout a system, typically using SCADA. These controls can be enhanced by using data analytics, modeling or even artificial intelligence (AI) to optimize operations.

Real-Time Controls Reduce Combined Sewer Overflow Volumes

Metropolitan Sewer District of Greater Cincinnati

CSO181 dry and during overflow. Source: MSD of Greater Cincinnati.

Between 2017 and 2019, the Metropolitan Sewer District of Greater Cincinnati (MSD) used Ohio State Revolving Fund financing to address discharges from a large combined sewer outfall (CSO181). During dry weather, wastewater flows are treated at the Mill Creek Wastewater Treatment Plant. Prior to the upgrades, about 916 million gallons of untreated wastewater a year would overflow at this outfall during rainfall events into a channel that discharges to Mill Creek. To address the discharges, MSD installed a real-time control facility at CSO181. The facility houses specialized gates and bending weirs automatically controlled by a series of flow and level sensors located at the facility and remotely at critical points in the downstream sewer system. The facility's automated controls monitor and adjust to temporarily store excess sewage and rainwater during storms and then send the combined flow to the Mill Creek plant when capacity in the sewer system is available. MSD estimates that the facility reduced discharges from this outfall by 557 million gallons annually—a 61 percent reduction. The real-time controls installed at CSO181 are part of MSD's efforts to develop a "smart sewer," that connects collection system sensors and remote assets installed across MSD's service area in a shared communication and control network. MSD has installed similar controls at seven CSOs (out of 250), but the entire system benefits because the monitoring and control technologies manage the system dynamically and automatically to adjust interceptor sewer capacity during peak wet weather events.

SCADA

SCADA systems use both software and hardware to monitor and analyze wastewater in real time at a central location, enabling the utility to make more timely and informed operations and maintenance decisions. SCADA systems can receive and analyze sensor data to automatically control motors, pumps, variable-frequency drives, and other equipment in the field based on

> **"It's my firm belief that how we're doing this is how collection systems should be managed in the 21st century, and the technology exists to do that."**
>
> —**Reese Johnson,**
> Superintendent, Compliance Services Divisions, Metropolitan Sewer District of Greater Cincinnati

operating parameters, setpoints, real-time data, and alarms. SCADA systems can display data using visual interfaces (e.g., graphical user interfaces) to convey information quickly and simplify the workforce's operations. SCADA also can enhance a utility's system security by providing constant monitoring and immediate notification of any security breaches. SCADA can also reduce the need for regular operator patrols and can drastically reduce the frequency of visits to remote sites. Today's SCADA systems also have the capability to interface with smart phones and tablets, making critical data even more immediately accessible.

SCADA Leads to Better Data, Reduced Demand on Workforce

Globe, Arizona

The Pinal Creek Wastewater Treatment Facility serves over 7,000 customers in Globe, Arizona, many of whom are low-income, according to the U.S. Census Bureau. In 2020, the city used CWSRF funding to replace the existing SCADA system at the treatment facility. The Water Infrastructure Finance Authority of Arizona worked closely with city staff, helping with administrative challenges and providing guidance throughout the CWSRF application process. The new SCADA system provides more complete and accurate system operating data. The automated system monitoring has decreased the demand on Globe's workforce by reducing the number of field visits and manual system observations required.

EPA's Smart Data Infrastructure for Wet Weather Control and Decision Support (2021) provides additional guidance and case studies on how communities can use intelligent systems to control wet weather discharges in or near real time.

Making Intelligent Technology Accessible

Implementing intelligent technologies can seem daunting for many communities—particularly those with small budgets and resource limitations. A portion of the CWSRF funds are set aside through the Green Project Reserve for innovative projects—including intelligent technologies—that integrate energy or water efficiency. In addition, SCADA, telemetry, real-time controls, and other intelligent technologies can often be implemented as part of a larger improvement project. See EPA's CWSRF website for other project eligibilities.

Recognizing the benefits, some states have made a coordinated effort to promote and fund intelligent technologies. For example, the Oklahoma Water Resources Board has issued CWSRF loans for over 20 projects that included intelligent technologies across different municipal authorities since 2015. These projects have focused on increasing the state's water efficiency and have included accessible intelligent water system technologies like AMR/AMI and telemetry. In 2012, Oklahoma passed the Water for 2060 Act, which established a statewide goal of consuming no more fresh water in 2060 than was consumed in 2012. To achieve this goal without limiting future growth, Oklahoma looked to implement technologies to promote water efficiency.

The Oklahoma Water Resources Board highlighted the eligibility of water efficiency projects under the SRF Green Project Reserve marketing efforts. The Board also encouraged municipalities across Oklahoma to apply for SRF funding and awarded additional points for projects that fulfill the goals of the Water for 2060 Act.

Source: OWRB.

The Oklahoma Water Resources Board granted communities loans with below-market interest rates for these water efficiency projects. The loans allowed smaller communities to implement intelligent water system technologies that can help generate revenue for the utility and help reduce the demand on the workforce. Communities like the city of Shawnee utilized these funds for the installation of AMR/AMI technology that can aid in the early detection of leaks and remove the need for staff to manually read water meters.

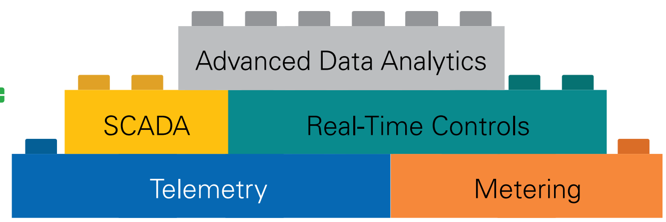
Addressing Broadband Need and Cybersecurity Risk

Communities—particularly in rural areas—may also have concerns about having sufficient broadband to support intelligent technologies. Not all intelligent technologies require broadband; some use radio waves or cellular signals. However, as technologies increase in complexity, reliable internet is key. BroadbandUSA provides resources and news related to national telecommunications programs, including funding opportunities such as the Tribal Broadband Connectivity Program, which began in 2021 and as of July 2023 has awarded $1.78 billion to 191 Tribal entities. CWSRF money can be used to fund the purchase and installation of intelligent technologies at publicly owned treatment works. Funds can be used for the initial purchase and installation of internet connectivity equipment required for intelligent technologies, but not for ongoing fees or bills associated with internet connectivity.

Cybersecurity risk is real for all wastewater systems, no matter the size, and could be a source of concern when new interconnected technologies are considered. Existing resources may help communities navigate how to keep their systems cyber-secure:

- The Cybersecurity and Infrastructure Security Agency (CISA), Federal Bureau of Investigation (FBI), and EPA published an Incident Response Guide to assist owners and operators in the water and wastewater sector with best practices for cyber incident response and to provide information about federal roles, resources, and responsibilities for each stage of the response lifecycle.

- EPA, CISA, and FBI developed the Water and Wastewater Systems Sector Top Cyber Actions Fact Sheet. This fact sheet highlights the top cyber actions water systems can take to reduce cyber risk; improve resilience to cyberattacks; and provides free services, resources, and tools to support these actions, all of which can be taken concurrently.
- CISA can help drinking water and wastewater systems identify and address vulnerabilities with a free vulnerability scanning. CISA utilizes automated tools to conduct vulnerability scanning on external networks looking for vulnerabilities and weak configurations that adversaries could use to conduct a cyberattack.
- The U.S. Department of Energy outlined 21 Steps to Improve Cyber Security of SCADA Networks.
- The American Water Works Association's Cybersecurity and Guidance website provides resources such as an assessment tool and guidance, policy actions, education opportunities, and events.
- EPA's Cybersecurity Technical Assistance Program provides primacy agencies, drinking water and wastewater systems, circuit riders, and technical assistance providers consultations regarding cybersecurity.
- EPA's Water Sector Cybersecurity Evaluation Program provides free cybersecurity assessments for drinking water and wastewater systems to identify gaps or vulnerabilites in information technology and operational technology.
- CISA and EPA's Water and Wastewater Cybersecurity Toolkit consolidates key resources for water and wastewater systems at every level of cybersecurity maturity.
- The Water Environment Federation's Water Security and Emergency Response website compiles a list of federal and non-profit cybersecurity resources for water utilities.



Looking for Technical Assistance?

Contact EPA's WaterTA Program to identify resources for technical assistance in your community. Technical assistance providers can help:

- Identify technology options
- Select the most appropriate technology
- Assess costs and benefits
- Evaluate operations and maintenance impacts
- Identify financing options and secure funding

For more information visit EPA's Clean Water State Revolving Fund and Searchable Clearinghouse of Wastewater Technology (SCOWT), NACWA's Envisioning the Digital Utility of the Future, WEF's Intelligent Water Systems: The Path to a Smart Utility, and WRF's Intelligent Water Systems.