SEPTEMBER 2023

# Water Innovations

## THE SUSTAINABILITY ISSUE

Preparing For Water Challenges Ahead

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## Editor's Insight



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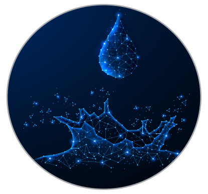



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# FROM THE EDITOR

By Kevin Westerling
Chief Editor, editor@wateronline.com

## Racing Towards Sustainability

As water and wastewater utilities get to grips with decarbonization, many have set ambitious targets to achieve greenhouse gas (GHG) reduction goals.

Global water technology company Xylem works closely with utilities to help them achieve these goals. To evaluate progress across the industry, it recently commissioned a survey of 100 utilities across North America and Europe.

I spoke with Austin Alexander, Xylem's VP of sustainability and social impact, to break down the results and key trends driving a greener water industry.

**Austin Alexander**
VP of Sustainability and Social Impact, Xylem

### What proportion of utilities are setting GHG reduction and net zero emissions goals?

In 2022, GWI reported that 81 water and wastewater utilities had set net zero, carbon, and climate neutrality targets, serving over 230 million people. Of these, 26 utilities, serving over 72 million people, had joined the UNFCCC (United Nations Framework Convention on Climate Change) Race to Zero campaign.

This tallies with the results of our recent survey. Out of 100 participating utilities, 48% had a net-zero emissions goal and 42% had an emissions reduction goal. Of the utilities that did not have a GHG goal, nearly half of these were planning to implement one in the next five years.

If you conducted the same survey five years ago, you would have quite different results. Few utilities spoke about decarbonization at the same level. The data shows how far the water industry has come.

### What does that path look like for utilities?

Our white paper, *Net Zero – The Race We All Win*, outlines a detailed road map for optimizing operations. This includes setting targets, embedding net-zero strategies into capital planning, and transforming from treatment to resource recovery.

Before getting into the practical steps of implementing technology, getting a baseline data set that can inform a realistic goal is important. You don't have to reinvent the wheel. Many companies, including Xylem, already have publicly disclosed targets and have leveraged resources and organizations like the Science Based Targets initiative to get there.

While targets are a key step, they won't reduce emissions. Efficient technologies — together with changes in process, policy, and practice — will. A lot of the technology we need to decarbonize already exists and is relatively easy to leverage. This can help utilities find the low-hanging fruit that can be addressed with cost-neutral, or even cost-saving, solutions.

We advocate for taking a long hard look at the root cause of inefficiencies across a network. Solving those operational efficiencies will reap a return for the climate and for their bottom line.

### What is the sentiment around GHG reduction within the water sector?

Utilities around the world are on the front lines of the impacts of climate change, from drought to floods, all while providing a critical resource.

In our survey, we found that most utilities list climate change among their top three challenges. They are feeling the impact. Key stakeholders, such as municipal governments and local communities, can see the impact of climate change on clean drinking water and sanitation.

However, utilities are also under a lot of cost pressures, which can make them hesitant to invest resources in decarbonization until the benefits to their operations, customers, and business are completely clear.

It is on us to make the case that reducing emissions can be done in a way that is cost-effective and affordable.

For instance, a lot of utilities cite resilience to extreme storms and floods as a major concern. In Buffalo Sewer Authority (BSA), U.S., we can see how it addressed that challenge by using advanced digital solutions to help water managers improve operational and environmental outcomes at an affordable cost.

BSA saved $145 million by deploying a smart sewer system that reduced polluted water flowing into its rivers during storm events. The utility is a great example of being innovative to bridge resource gaps, efficiently serve the community, and save a significant amount of embedded carbon while being more prepared for climate change.

### What are the drivers for net zero, and how do they differ across geographies?

Approaches to decarbonization are certainly influenced by the different local drivers.

We recently released *Solving Water in Rural America: A Xylem Report*, which showed that access to safe and reliable water is not guaranteed for more than 2 million Americans.

The report presents the full scope of the rural water crisis, outlining the regional, regulatory, and environmental factors that have contributed to these water challenges, as well as the practical steps individuals, government bodies, and organizations can take to address this crisis. These challenges and cost pressures are the backdrops that utilities work against as they make decisions on how to decarbonize.

Regulation is also a major driver, sometimes in promoting efficiencies but often directly through sustainability regulations. In Europe, regulation on decarbonization is quite evolved, both regionally and locally, which is encouraging utilities to step up and become sustainability leaders.

### What solutions are utilities embracing to reach their GHG goals?

We have seen many utilities embracing solutions that are cost-effective, streamline their operations, and are available today.

Xylem research previously found that 50% of energy-related emissions from the wastewater sector can be abated with existing technologies. Things like intelligent wastewater pumping systems, adaptive mixers with variable speed drives, and real-time decision support systems are solutions already in play around the world; but the really striking figure was that about 95% of this impact is achievable at zero or negative cost.

### Xylem recently launched its 2022 sustainability report. What are the key takeaways, trends, or surprises from the report?

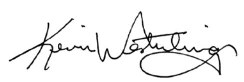
We believe water can lead the global conversation — and more importantly action — on climate mitigation, with real, meaningful GHG-reduction commitments across the sector.

This starts with us. We are currently finalizing our Science Based Targets and have committed to reaching net-zero emissions by 2050 while hitting more immediate, interim targets.

To practice what we preach, we're looking across our entire operation and value chain. From our facility's energy use, where we reduced net Scope 1 and 2 GHG emissions by 21% year-on-year, to our supply chain, where we've partnered with more than 30% of our global supply base to begin reporting on key sustainability metrics with third parties.

We have also taken steps to align our sustainability, operational, and financing strategies across our value chain, most recently in a five-year $1 billion revolving credit facility directly tied to our Scope 1 and 2 GHG emissions.

While we're committed to reaching net-zero emissions by 2050 across our entire value chain, this isn't just about our own emission profile. We have a role in influencing the conversation to reduce emissions and facilitating the adoption of technology that can move the sector to net zero. ■

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# Engineering-Grade Security For Water Systems

An overview of the risk landscape for water utilities, along with a new set of strategies to quell the threat.

By Rees Machtemes

In March, the U.S. EPA ordered states to add cybersecurity criteria into their regular audits of water utilities. This is not a surprise, as cyberattacks with physical consequences have been more than doubling annually since 2019. This is bad news, and we will almost certainly see additional regulations within the next few years. There is good news as well — the engineering profession has powerful and often-neglected tools for addressing cyber risks. These tools are unique to operational technology (OT) and industrial environments — tools and approaches that are not even mentioned in cybersecurity standards such as the NIST Cybersecurity Framework or the IEC 62443 series. Better yet, the protections provided by engineering-grade solutions are deterministic and predictable, even in the face of the most powerful attacks. By deploying engineering-grade protections today, water utilities can get ahead of the cybersecurity problem, rather than constantly chasing new regulations.

### New Orders From The EPA

In their 13-page order to states, the EPA argues that securing public water systems' (PWS) operations against cyberattack is essential to the supply of safe drinking water.[1] The order came with a 100-page guidance document designed to find and fix "significant deficiencies."[2] The guidance document is structured as a checklist of cyber-specific audit criteria, organized into eight major categories: account security, device security, data security, governance and training, vulnerability management, supply chain and third-party services, incident response and recovery, and "other." These criteria mirror the most important functions in the five pillars of the NIST Cybersecurity Framework. In short, the guidance is very sensible and covers the basics expected of any modern IT or OT cybersecurity program.

### An Increasing OT Threat Environment

The deteriorating threat environment is what motivates this increased focus on cybersecurity in sanitary audits. Today's ransomware criminals are opportunistic, target anyone with money, and employ increasingly sophisticated attack strategies. In the last several years, ransomware criminals were responsible for most of the attacks that impaired critical infrastructures and other industrial operations. The *2023 Threat Report*,[3] a joint initiative by ICSStrive and Waterfall Security Solutions, examines cyberattacks with physical consequences to industrial operations and critical infrastructures, including water and wastewater systems. The report includes a comprehensive list of all such attacks since 2010, including links to public reports and sources that can be used to verify details of the attacks. The report concludes that most attacks with physical consequences are criminal ransomware, with hacktivist threat actors behind most of the rest. Figure 1 shows that the number of attacks with physical consequences on industrial targets have more than doubled every year since 2019.

These include attacks on water systems. In June 2022, during the peak of monsoon season, Goa's Water Resources Department had 15 flood monitoring systems rendered inoperable by ransomware. Without a budget to restore the monitoring systems, it was decided to operate without visibility into the watershed management program, impacting local water treatment. In December 2022, Empresas Publicas Medellín suffered a BlackCat/ALHPV ransomware attack. While affecting IT and billing systems primarily, the attack had the side effect of cutting off water for 28,000 customers on prepaid water plans. More recently, in April 2023, Galil Sewage Corp. became a victim of a GhostSec hacktivist attack, where internet-connected pump controllers were defaced and disabled.

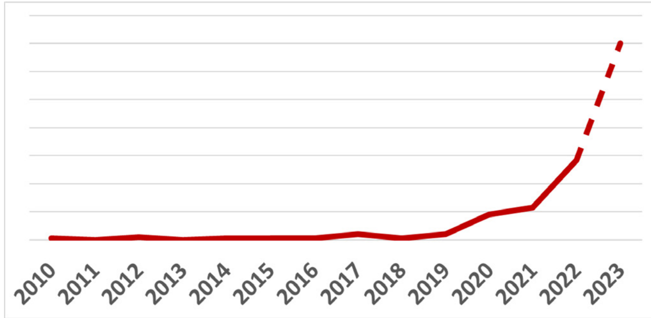


**Figure 1.** Attacks on OT with physical consequences

In addition to these consequential attacks, there have been many near misses — attacks that could have been consequential if the circumstances had been slightly different. In August 2022, a botched Cl0p-gang ransomware attack on Thames Water fell apart when attackers attempted to extort the utility and threatened to shut down operations. In fact, they had breached South Staffordshire Water's network, another utility elsewhere in the UK. In July 2022, a ransomware attack hit the Narragansett Bay Commission in Rhode Island. While a spokesperson for the commission claimed there was no disruption to wastewater collection and treatment, the organization had in fact paid a $250K ransom, and further details were not made public. Finally, who can forget the February 2021 attack at Oldsmar, FL, where an operator observed a remote user attempting to increase lye levels well beyond safe levels.

### Standards Change And Evolve

As the OT threat environment continues to deteriorate, it is only a matter of time before new regulations are enacted to deal with increasing threats to water and wastewater. Figure 2 illustrates a timeline of new and recent cybersecurity directives, putting the EPA directive to PWS in perspective.


**Figure 2.** A timeline of recent government cybersecurity regulations

After the Colonial Pipeline incident, where a gasoline pipeline went down for six days, the Transportation Safety Administration (TSA) issued security directive 2021-02, subsequently revised twice to the current TSA 2021-02C version. Like the EPA guidance, the pipeline directive talks mostly about conventional approaches to cybersecurity but had some new approaches as well. What's new is language about securing the critical boundary between IT and OT networks. The directive states that the goal of a pipeline operator is to prevent disruption of physical operations, even if the IT network is crippled. The directive requires that, during incident response activities, the IT network must be completely separated from the OT network, so that pipeline operations can continue "at necessary capacity" while the IT network is restored. This means there cannot be any OT dependencies on IT networks or services. In particular, the directive calls out "trust relationships" as particularly dangerous dependencies that must either be eliminated or, if they cannot, must be documented to the TSA with a detailed plan as to how to achieve the "necessary capacity" goal despite the trust relationship before and during an incident.

More recently, the U.S. National Cybersecurity Strategy was released. It contains five pillars, the first of which is to defend critical infrastructure. The introduction to the strategy makes two important points. One explains that cyberattack tools, techniques, and procedures (TTP), that were once the sole domain of nation states with nearly unlimited resources, are now available for purchase to any attacker with money. Ransomware criminals have lots of money. These powerful nation-grade attack tools are now a pervasive threat, targeting anyone with money.

A second point in the national strategy's introduction is an ambitious goal: A single person's momentary lapse in judgment, such as clicking on an insecure link or inserting a compromised USB drive, should not have national security consequences or impact critical infrastructure. This is ambitious, but by deploying engineering-grade protections now, utilities can meet this goal. It is possible for utilities to engineer themselves out of the cybersecurity problem, rather than constantly chase new regulations.

### Engineering-Grade Protections

While the engineering profession has managed risks to safety, the public, and the environment for a long time, managing cyber risk is new to the profession. In June 2022, the U.S. Department of Energy (DOE) published the Cyber-Informed Engineering (CIE) Strategy, a strategy that is now being broadened to include all critical infrastructures, including water treatment and distribution systems. A key goal of the strategy is to develop a body of engineering knowledge for managing cyber risk, and that body of knowledge has two key components. The first and predictable part is to document cybersecurity practices relevant to protecting industrial control systems, so that engineers can apply these practices more consistently. The second is to identify process, automation, and network design elements that are unique to the engineering profession and can be used to address cyber risk — design elements that are not cybersecurity controls and so do not exist in conventional cybersecurity approaches, including the NIST CSF and the IEC 62443.

One such design element is network engineering, including the techniques documented in the book *Secure Operations Technology* (SEC-OT).[4] Network engineering is focused on preventing cyber-sabotage attacks from reaching networks whose worst-case consequences of compromise are unacceptable. The most common example of network engineering is the unidirectional gateway deployed at the IT/OT consequence boundary — the boundary between the IT network whose worst-case consequences of compromise are generally acceptable business consequences and the OT network whose worst-case consequences of compromise are unacceptable threats to public safety. The gateways permit OT data to flow into IT networks to enable business automation for efficient operations and physically prevent any cyber-sabotage attacks from flowing back into protected OT networks.

A second example of an engineering-grade design element is manual operations as a fallback during cyber emergencies. Being able to conduct manual operations will take away a big lever — the threat of shutdown — from cyber-threat actors like criminal ransomware gangs. This is a change of mindset, as many engineering teams prided themselves on eliminating manual operations a decade ago in the name of efficiency and cost savings. Operating a water treatment or distribution system manually, while disconnected from IT during a cyber emergency, is a powerful tool for reducing cyber risk to public safety.

A third example is the use of analog safety systems, as documented in the text *Security PHA Review for Consequence-Based Cybersecurity* (SPR).[5] SPR is adapted from the well-known OSHA process hazard analysis (PHA) methodology, widely used for mitigating risks to safety in industrial processes.

For example, if your life depends on an automated steam boiler not exploding, would you prefer that the boiler be engineered with redundant mechanical over-pressure release valves or a longer password on the boiler's programmable logic controller? Security PHA review is a way to identify cyber risks to safety and recommends the deployment of un-hackable analog safety devices as backups to digital safety systems.

All these examples are unique to the engineering domain. Where is a manual fallback, or over-pressure valve, or unidirectional gateway in the NIST CSF or IEC 6443? These are powerful tools to reduce cyber risk to critical infrastructures, in addition to the cybersecurity tools to which we have long become accustomed.

Another security engineering risk-mitigation strategy that has been proposed for the water sector is to ensure that water treatment systems can be run manually in the event of a cyberattack on the operational network. It also might present a problem to smaller utilities utilizing pre-built treatment skids that are pre-engineered, or that have a process with too quick a transit time or requiring sensitive and highly accurate computer control that a human would not be able to manually perform. It also requires additional operator training and regular practice drills to ensure that manual operations would be successful in an emergency.

### The Fundamental Difference

Public water systems are fundamental to society and public safety. They must be protected differently, because the consequences of a cyberattack on water system automation networks are more serious than the same attack targeting less consequential IT networks. Cyberattacks impairing water system operations have become very real and are increasing exponentially. Cyber-informed engineering is a new approach to designing safer, more resilient water systems. One big advantage of these engineering tools is that, rather than chasing the new government regulations that will inevitably arise in the years ahead, these tools enable water utilities to get ahead of the cyber problem with efficient and long-lasting engineering solutions. ■

**References:**

1. Memorandum: *Addressing PWS Cybersecurity in Sanitary Surveys or an Alternate Process* (pdf); United States Environmental Protection Agency; March 3, 2023; https://www.epa.gov/system/files/documents/2023-03/Addressing_PWS_Cybersecurity_in_Sanitary_Surveys_Memo_March_2023.pdf
2. Guide: *Guidance on Evaluating Cybersecurity During Public Water System Sanitary Surveys* (pdf); United States Environmental Protection Agency; March 3, 2023; https://www.epa.gov/system/files/documents/2023-03/230228_Cyber_SS_Guidance_508c.pdf
3. Report: *2023 Threat Report* (pdf); ICSStrive & Waterfall Security Solutions; May 8, 2023; https://waterfall-security.com/scada-security/whitepapers/2023-threat-report/
4. Book: *Secure Operations Technology*; Andrew Ginter; Abterra Technologies Inc; 2018; https://waterfall-security.com/sec-ot
5. Book: *Security PHA Review for Consequence-Based Cybersecurity*; Edward Marszal and Jim McGlone; International Society of Automation (ISA); 2019

### About The Author

Rees Machtemes is a professional engineer with 15 years of hands-on experience with both IT and OT systems and a director of industrial security at Waterfall Security Solutions. He has designed power generation and transmission substations, automated a food and beverage plant, audited and tested private and government telecom solutions, and supported IT data centers and OT hardware vendors. This experience has led him to champion cyber-safe systems design and architecture. An obsessive tinkerer and problem-solver, he's often found next to a soldering station, mechanic's toolbox, or stack of UNIX servers. He holds a B.Sc. in electrical engineering from the University of Alberta.

# IoT And Smart Stormwater Management In The Face Of Climate Extremes

By Phil Beecher

*While climate change is most often associated with water scarcity concerns, its connection to severe storms cannot be overlooked — in terms of both potential dangers and benefits.*

The dynamic nature of our climate patterns brings with it the need for innovative and adaptable solutions. This spring, severe storms and higher than average snowmelt caused runoff issues that placed immense pressure on both urban and agricultural environments. In California, atmospheric rivers pushed rainfall across the state to 400%-600% above average,[1] with the resulting flooding costing more than a billion dollars.[2] With La Niña officially over after three years and the likelihood that El Niño will develop this year,[3] chances for increased Pacific rainfall further rise.

On the flip side, this summer's sweltering heat in the American Southwest[4] was a harsh reminder of the imperative to manage water resources effectively. With the ever-increasing presence of technological advancements, leveraging IoT (Internet of Things) in stormwater management is not just smart, but essential.

## The Dual Challenge Of Climate Variability

As regions worldwide grapple with the impacts of climate change, the contrast between wet and dry periods becomes more pronounced. Last winter's severe storms left an indelible mark on the American landscape, particularly the increasing volumes of water runoff that must be properly managed to avoid damage and to bolster reservoirs.

Water management in extreme conditions becomes a twofold challenge: first, to effectively manage and channel this runoff during wet seasons, and, second, to preserve it as a resource to combat the dry summer months.

Moreover, the soaring temperatures this summer across much of the U.S. exemplify the second half of this challenge. Dry summer months place a strain on aquifers. By managing stormwater runoff during wetter seasons, we can replenish these aquifers, ensuring consistent water supply during periods of scarcity.

## IoT: Advancing Stormwater Management

In an extreme weather environment that we are still trying to understand, IoT's integration into stormwater management can be likened to fitting our cities with a new set of intelligent eyes and ears. Through IoT networks that connect a variety of "smart devices" across large-scale outdoor networks, IoT sensors and devices can capture real-time data regarding water levels, quality, and flow rates. This data, in turn, allows for timely and effective decision-making.

Recent research from Wi-SUN Alliance[5] reveals an appetite for these types of IoT implementations. Nearly three-quarters of respondents were eager for the development of weather and climate-related initiatives. Additionally, a full 75% shared that they support the need for pilot programs to prove the value of innovative IoT deployments, wherein cities experiment with integrating IoT technology into their stormwater management systems. These pilots serve as a foundation for larger, more widespread initiatives, driving the move toward more sustainable urban water management.

## The Imperative Of Open Standards

In the world of technology, as with stormwater management, flexibility is key. This is where open standards come in, both with regard to the sensors and devices, as well as with the networks that they operate on.

> **In the world of technology, as with stormwater management, flexibility is key.**

From a device standpoint, open data standards ensure compatibility allowing a wide range of devices to communicate seamlessly, ensuring that the collected data is cohesive, integrated, and actionable.

Furthermore, open standards encourage competition among vendors, ensuring that state and local governments have access to the best, most cost-effective solutions. This creates an ecosystem where technological advancements can be rapidly adopted, ensuring that our stormwater management systems are always at the forefront of what's possible.

Communication network technology cannot be overlooked. Cellular networks, including 5G communications, lack the energy efficiency and cost-effectiveness for running a water network. Municipalities and states can benefit from deploying field area networks (FANs) based on wireless mesh topologies. Open-standards-based FAN technology — such as Wi-SUN FAN which is designed to support large-scale outdoor networks — helps drive down costs and improve energy efficiency while delivering enterprise-grade security and interoperability, providing support for a diverse range of devices.

## An Interconnected Future

Our climatic challenges are complex, requiring solutions that are both innovative and interconnected. The extreme weather events of the past year — from torrential winter storms to scorching summer heatwaves — underline the importance of a responsive, smart stormwater management system. By embracing IoT technology and the principles of open standards, we're not just responding to these challenges but actively preparing for a future where such events might become the norm. Through innovation, pilot programs, and the commitment to integrated solutions, we pave the way for a more sustainable and resilient urban landscape. ■


**References:**

1. https://earthobservatory.nasa.gov/images/150823/storms-soak-california
2. https://www.nytimes.com/2023/01/10/us/california-storm-damage.html
3. https://public.wmo.int/en/media/press-release/wmo-update-prepare-el-ni%C3%B1o
4. https://www.cnn.com/2023/07/17/weather/southwest-us-arizona-record-heat/index.html
5. https://wi-sun.org/news/utilities-call-for-smart-utility-investment/


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# New School Of Thought On Reducing LEAD EXPOSURE For Children

The EPA wants water authorities to help schools and childcare centers get the lead out of drinking water, but what resources are available to help water authorities?

By Jonathan Cuppett

Concerning the *Lead and Copper Rule Revisions* (LCRR), the U.S. EPA is leveling particular attention on schools and childcare centers. The effects of lead ingestion include reduced IQ and attention span, learning disabilities, poor classroom performance, hyperactivity, behavioral problems, impaired growth, and hearing loss, effects that are especially pronounced in young children and occur at much lower lead exposure levels than they do in adults.

Therefore, the LCRR has focused on places where children are likely to consume tap water and where they spend a significant portion of their young lives. Even when water systems are meeting all federal and state health standards regarding lead, older schools and childcare centers may have aged plumbing materials that can contribute to lead in drinking water.

While some states already require schools to test for lead in drinking water, not all of them do. Community water systems are typically the local water authorities on clean drinking water, so they have been tasked by the EPA to close the gap in helping centers for early childhood education start the process for ensuring that children in their care are not exposed to lead in their drinking water. This has resulted in certain requirements for how community water systems must engage with elementary schools and childcare facilities.

### Requirements Of The LCRR That Are Not Going To Change

The EPA finalized the LCRR[1] in January of 2021 and announced that a new rulemaking, Lead and Copper Rule Improvements (LCRI), would be issued before the compliance deadline of Oct. 16, 2024, which could make material modifications to the LCRR. This arrangement has put many community water systems in limbo, as they are hesitant to take action and spend resources prematurely.

However, there is one condition of the LCRR that the EPA has said will not change: Community water systems must have developed and submitted a *Lead Service Line Inventory* by the 2024 compliance deadline.

Everything else that follows in this article, including the school and childcare requirements,[2] is subject to change with the release of the LCRI. Currently, providers must submit a finalized list of every school and childcare center served by a water network by the 2024 deadline. Water systems will likely need to work with their state's department of education as well as consulting their own records to compile this list.

While we don't yet know what will change, every indicator is that the changes will be more, not less, stringent than what has already been published. What follows is an overview of what water utilities should expect regarding their responsibilities to schools and childcare centers.

### Requirements Begin With Communication

Beginning in 2025, community water systems will be required to communicate the following to all elementary and childcare facilities that it serves:

1. An annual overview of the health risks of lead exposure in children
2. Notification that the water system is required to sample for lead at elementary schools and childcare facilities
3. A proposed schedule for sampling at the facility
4. Information about sampling for lead in schools and childcare facilities.

A helpful resource for rolling out these four steps is the *3Ts for Reducing Lead in Drinking Water,*[3] a publication from the EPA. While this publication is designed for schools and childcare facilities, it contains language and guidance that community water systems will find helpful as they embark on working with schools and childcare centers.

Community water systems also must contact the secondary schools (high schools) identified in the list annually and provide them with health information, information on how to request sampling, and information about sampling for lead in schools and childcare facilities. The difference for high schools is that testing must be offered but is not mandatory.

Schools and childcare facilities will be exempt from testing if they were built after Jan. 1, 2014, or after the date that their state implemented the *Reduction of Lead in Drinking Water Act* standards — whichever is earlier. Community water systems also are not required to test schools or childcare facilities that are themselves regulated as a public water system, as those are classified as "Non Transient Non Community Water Systems" and are directly subject to all LCRR requirements.

### The Lowdown On Sampling

Beginning in 2025, community water systems must conduct sampling in at least 20% of elementary schools (typically K–eighth grade) and childcare facilities each year, and continue for five years until all elementary schools and childcare facilities have been sampled. (Again, those built after Jan. 1, 2014, are exempt.) An alternative schedule can be approved by the state, as long as all elementary schools and childcare facilities are sampled once within a five-year period. Schools that refuse or do not respond may be accounted for in the 20% testing rate with proper documentation. Community water systems are not required to sample any individual school or childcare facility more than once every five years.

At least 30 days prior to sampling, the water system must provide instructions to facilities on how to identify outlets for sampling.

Five samples are required for schools, and two samples are required for childcare facilities at outlets typically used for consumption. For schools, these typically include two drinking water fountains, one kitchen faucet used for food or drink preparation, one classroom faucet or other outlet used for drinking, and one nurse's office faucet, as available. For childcare facilities, these typically include one drinking water fountain and either a kitchen faucet used for preparation of food or drink or one classroom faucet or other outlet used for drinking.

If any facility has fewer than the required number of outlets, the water system must sample all outlets used for consumption. If any facility does not contain the type of faucet listed above, the water system shall collect a sample from another outlet typically used for consumption, as identified by the facility.

Samples from the cold water tap must follow these requirements:

- Each sample for lead shall be a first draw sample of water that has been stationary (untapped) in the plumbing system of the sampling site (building) for at least eight but no more than 18 hours.
- The sample must be 250 ml in volume.
- The water system, school, or childcare facility, or other appropriately trained individual, may collect samples.

Beginning in 2025, secondary schools (high schools, or grades nine-12), as well as elementary schools and childcare facilities, must be sampled upon request. If a water system conducts tests at more than 20% of the schools/childcare facilities it serves during a year, it may defer additional requests to the following year.

### Notification Of Results And Waivers

A water system must provide analytical results to the school or childcare facility no later than 30 days after receipt of the results, along with information about remediation options (if lead is detected). The water system also must provide analytical results annually to the local and state health departments, as well as the state regulator if different from those listed previously.

During the cycle of mandatory sampling in elementary schools and childcare facilities, a state may issue a written waiver to a community water system if there is already a state or local program to sample for lead in drinking water at schools or childcare facilities that meets the requirements of this rule. This also may include schools or childcare facilities that are sampling for lead through a facility's or district's policy if the sampling meets the final rule requirements. Waivers may also be included in other circumstances depending on the requirements of the existing/current program. However, sampling conducted at schools or childcare facilities prior to 2025 does not qualify for a waiver. When a community water system has completed the requirements for all elementary schools and childcare facilities once, the EPA requires the system to sample elementary and secondary schools and childcare facilities upon request.

### What Happens If Lead Is Detected?

While strongly encouraged by the EPA, communication to parents, staff, and other stakeholders, as well as remediation, are voluntary and up to the school or childcare facility. The community water system is required only to provide remediation options as provided in *3Ts for Reducing Lead in Drinking Water,* a publication that also outlines easy-to-follow suggestions for communicating with stakeholders.

Possible remediation options include:

- Disconnect or replace problem outlets
- Post "Not for Drinking/Cooking" at problem outlets
- Flush taps prior to use
- Provide bottled water
- Install filters on problem outlets
- Replace or bypass old plumbing pipes and fixtures.

Following remediation efforts, schools and childcare facilities should be encouraged to engage in follow-up testing to ensure that lead is no longer present.

### The Bad News: The Cost And Administrative Burden Of Testing Are High

According to the American Public Works Association (APWA), approximately 85% of water utilities have three or fewer employees, so adding school and childcare facility testing to their overfull to-do list is daunting. Likewise, school administrators already juggle an impossible load and may wonder where they will find the time to undergo training, participate in the testing, and oversee mitigation, if indicated.

Furthermore, the cost per facility for sampling, analyzing, remediating, and supporting programming is estimated to be thousands of dollars or more depending on what remediation actions are taken. When multiplied across a district, the numbers can quickly add up.

### The Good News: Expert Help And Funds Are Available

Many community water systems are enlisting the help of LCRR experts to manage the process of working with schools and childcare facilities. Private companies like 120Water can provide exceptional efficiency and cost-effectiveness in overseeing communication with schools and childcare facilities, scheduling and executing initial sampling, and follow-up sampling and stakeholder communication, ensuring that community water systems are successfully meeting the established deadlines for testing at all eligible facilities in their service jurisdiction. As of March 2023, the company had taken nearly 200,000 samples at over 3,500 schools and childcare facilities.

In the infrastructure bill passed in 2021, Congress earmarked $15 billion to replace lead pipes and $200 million for lead testing and remediation in schools. As this money trickles into state funds, water systems should take advantage of unprecedented funding opportunities to fulfill the EPA's new lead and copper rule requirements and ensure safe drinking water for our nation's children. ■

**References:**

1. https://doh.wa.gov/community-and-environment/drinking-water/contaminants/lead/lead-and-copper-rule-revisions
2. https://www.cdmsmith.com/en/Client-Solutions/Insights/Sampling-for-Lead-at-Schools-and-Child-Care-Centers
3. https://www.epa.gov/ground-water-and-drinking-water/3ts-reducing-lead-drinking-water

### About The Author

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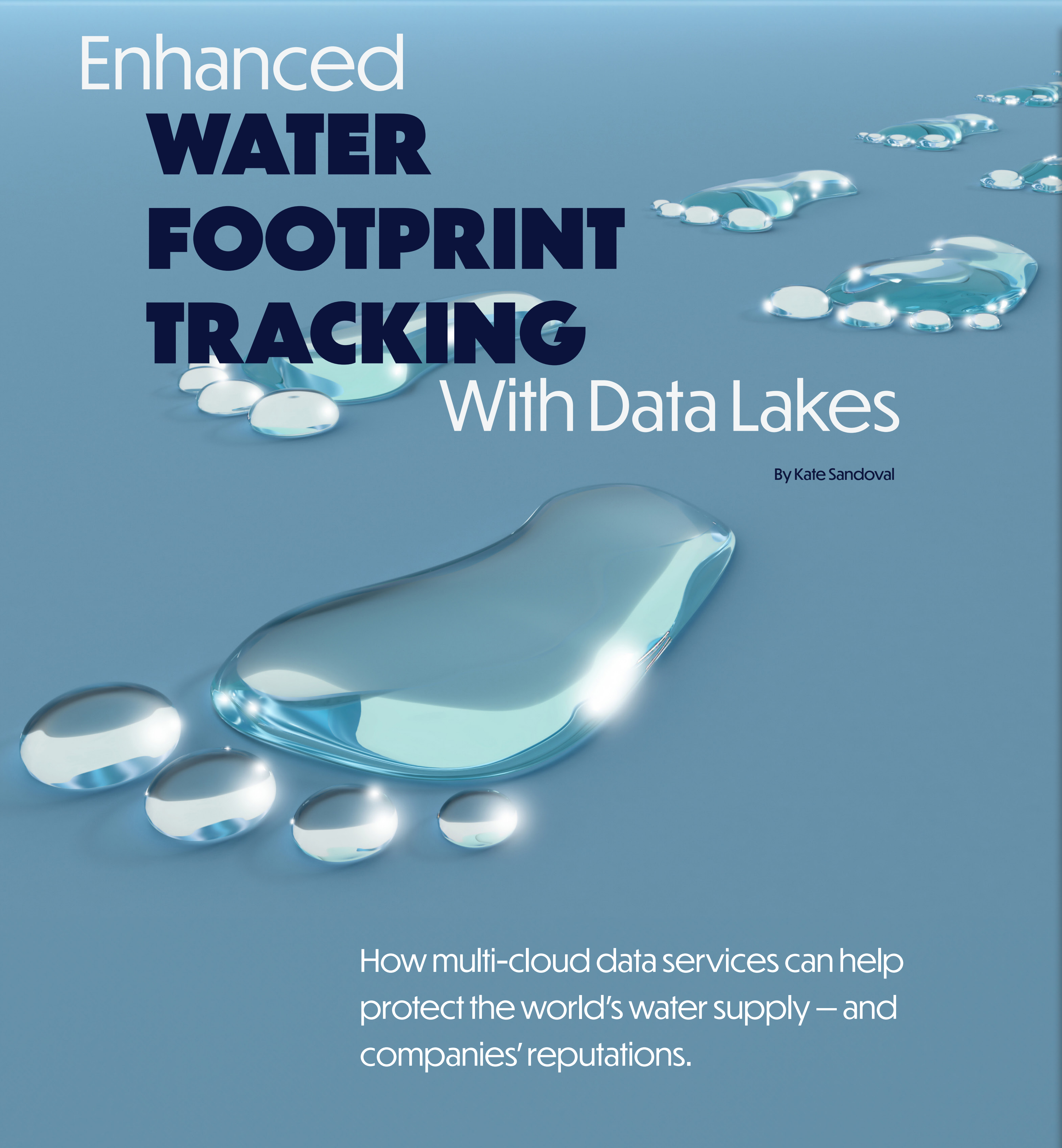


# Enhanced WATER FOOTPRINT TRACKING With Data Lakes

By Kate Sandoval

How multi-cloud data services can help protect the world's water supply — and companies' reputations.

There has been a steady stream of news regarding megadroughts and severe water shortages. Most recently, Arizona, California, and Nevada agreed to conserve at least 3 million acre-feet of water by 2026 to help keep the drought-stricken Colorado River flowing. The goal: Keep the river full. Unfortunately, this problem is far from solved. Individuals, small businesses, and multinational corporations need to ask themselves today what they can do to lessen the severity of droughts and floods tomorrow. Even the most sustainable companies and water-rich countries need to immediately start having conversations about the effects of climate change and their impact on water quality and security.

Water is essential to every person and business on the planet, making it critically important for all of us to understand how to consume water responsibly while helping to create a more sustainable future. Just like carbon before it, water is now the consequential topic of 2023. In order to remedy the damage done to this non-fungible resource, data must be systematically collected, cleaned, analyzed, and acted upon to generate a data-driven approach to water usage transformation.

### What Is A Water Footprint?

The total amount of freshwater used in the production or supply of goods and services by an organization is a water footprint. Water footprints fall into two categories: direct (operational) and indirect (supply chain). A direct water footprint represents the specific water usage of an organization for its daily business operations, whereas an indirect water footprint is the water used in production activities, or throughout the supply chain, to fulfill a request for said organization. These categories are defined and measured in three ways:

- **Blue:** Volume of surface and groundwater consumed as a result of the production of a good or service
- **Green:** Volume of rainwater consumed during the production process
- **Gray:** Volume of polluted water resulting from the making of a product.

There's a lot to account for when companies decide to track their water footprints as part of their environmental, social, and governance (ESG) strategies, and data lakes can help.

### Data Lakes Enable Water Footprint Tracking

Companies have to simultaneously adhere to standards set by their own organization and industries to align with ESG strategies. Accurately reporting on ESG goals can positively or negatively impact an organization and change public and internal perceptions. Companies hitting the mark with their ESG goals are able to draw in investors, attract new customers, tap into new markets, retain top talent, and improve their bottom line.

As a finite resource, water is being tracked by companies as part of their ESG strategies. However, companies are using various solutions to capture and manage data associated with water footprints. ESG-specific platforms track the data, but how do they know the data they are tracking is data worth tracking?

Companies face two challenges when it comes to data. The first is the volume of data that needs to be processed and analyzed in order for companies to make informed decisions. The second is the complexity of the data itself. Water footprint data can come from a variety of sources, and just like water, that data needs to be clean in order to be consumed.

Modern Big Data solutions can help companies track their water footprints by providing the insights and information they need to identify and manage risks and opportunities, enhance transparency and accountability, improve decision-making, and meet regulatory requirements. But it can become difficult to navigate the labyrinthine structure of Big Data, especially with compounding features that exponentially increase the cost and complexity of an organization's data. Such data can be highly variable, difficult to make sense of, and challenging to identify the patterns and trends needed for informed decision-making.

A multi-cloud data services (MCDS) platform is versatile and compatible with modern data lakes, alleviating some of the complexities that come with Big Data solutions. Data lakes, data warehouses, and even data lakehouses can all help organizations track their water footprints as part of their ESG strategies. Regardless of where an organization's data are stored, an MCDS platform seamlessly integrates within an organization's existing ecosystem. This enables organizations to leverage their data as they see fit, while at the same time increasing the quality so they can confidently set data-driven goals to improve their future water footprint.

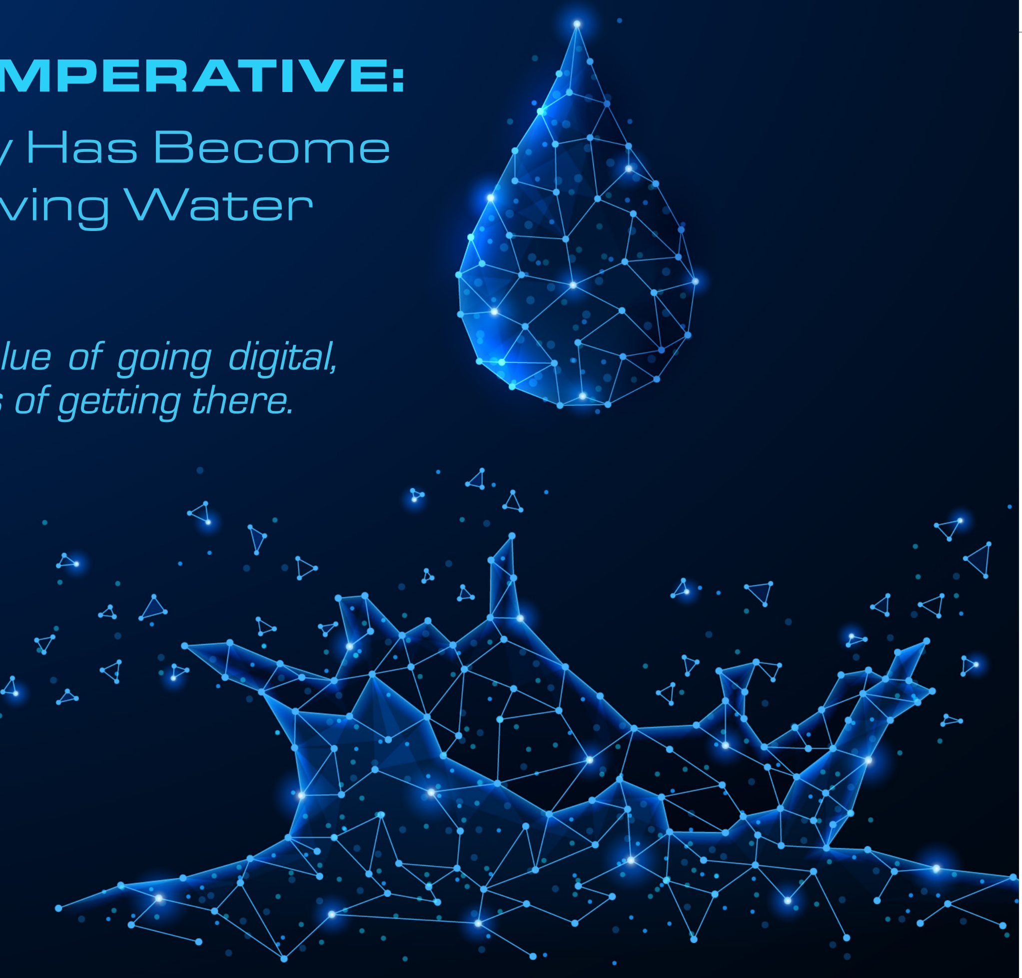
Sustainability enhancements will continue to grow as ESG conscious organizations attract investors, bring in new customers, open new markets, retain top talent, and improve their bottom line. Data lakes help organizations collect data easier, but trusted data are needed to help drive and sustain these efforts. A data lake paired with an MCDS platform allows for data-driven decision-making, helping to ensure responsible business practices are measurable, now and in the future. ■


### About The Author

Kate Sandoval is senior product marketing manager at Faction, Inc. (factioninc.com), a multi-cloud data services provider.

# THE DIGITAL IMPERATIVE:

## How Technology Has Become Essential To Solving Water



*Understanding the value of going digital, as well as the process of getting there.*

By Michele Samuels

As innovative utilities around the world continue to implement advanced solutions, we often hear of the "Aha!" moments that have reaffirmed digital strategies in the minds of water leaders.

Sometimes referred to as "turning on the lights," these moments represent greater visibility — the ability to see utility operations clearly, without the murky shadows of outdated systems, data deluges, and information silos.

Suddenly, operators are empowered to bridge the gap between data and decision-making, delivering transformative outcomes for their communities as a result.

**Often, we see utilities beginning to implement digital solutions to meet regulatory requirements, but that's usually only a fraction of the improvements they can achieve.**

Take the Metropolitan Sewer District (MSD) of Greater Cincinnati, for example. Serving a population of more than 850,000 people across 290 square miles, the utility operates combined stormwater and sanitary sewer systems — some of which were constructed more than a century ago. Dealing with increased volumes of sewer overflows, and with mitigation costs proving far too much to pass along to ratepayers, the utility turned to digital to optimize.

To get better control over its buried sewer system, the utility deployed a real-time decision support solution that delivers automated, optimized control. The utility then took its combined sewer overflow (CSO) monitoring data, flow monitors, and real-time control facilities, and tied them together in a SCADA system. According to Reese Johnson, compliance services division superintendent, "The insights were mind-blowing."

Thanks to that enhanced level of visibility, MSD had its "aha" moment and was able to reduce sewer overflow volumes by 247 million gallons and save US$38 million in the process.

By tapping into the power of data and analytics, MSD could unpack what was happening across its entire sewer system and maximize its existing assets. The beauty of that enhanced visibility is the greater situational awareness it brings. The utility can now address the critical challenges of today, while getting ahead of the problems of tomorrow.

### Going Digital Is Not An Outcome

As MSD demonstrated, digital is not an outcome but a way to solve problems. From working inside water utilities and collaborating closely with leaders and operators, we have seen the complexities involved in keeping the taps running and water moving. We've also seen the powerful impact that digital solutions can have on utility operations, no matter where a utility is on its digital transformation journey.

Often, we see utilities beginning to implement digital solutions to meet regulatory requirements, but that's usually only a fraction of the improvements they can achieve. Increasing layers of data can be added across utility operations — at asset, process, and system levels — to drive huge business and community impacts.

For example, when it comes to intelligent asset management, innovative solutions are allowing operators to get a handle on the current picture to make faster decisions. By simply "turning on the lights" within their system, utilities aren't relying on age alone to manage critical assets. Advanced digital solutions are empowering them to understand what assets they have, their location and specification, and — crucially — their condition.

**Successful transformation means finding a sustainable pace of change, putting quality data to work, and building thoughtfully on each success.**

In Canada, EPCOR Water Services provides water and wastewater services to more than 85 communities. The utility serves 800,000 people in the Edmonton, Alberta region alone and has assumed ownership of smaller regional utilities as the city expands. One of those was the Northside Pipeline, a 16.7-km (10.4-mile) water main comprised of prestressed concrete cylinder pipes (PCCP) that provide drinking water to around 60,000 people.

The average life expectancy of PCCP mains can range from 50 to 100 years, depending on design, manufacturing, installation, and operation. At 40 years old, the Northside Pipeline was getting close to that range. While the pipeline had no documented history of failures, anecdotal tales of leaks and breaks marred its history.

While PCCP mains failures are rare, they can be catastrophic to local communities, causing significant flooding and damage, as well as disrupting other critical infrastructure. To understand exactly what was going on, EPCOR wanted hard data. Using advanced sensing tools, including electromagnetic and acoustic monitoring inspections, the utility rolled out an advanced condition assessment program to evaluate the health of a 9.4-km (5.8-mile) section of the pipeline.

Using digital technology to analyze, distill, and consolidate the resulting data, EPCOR could pinpoint "trouble spots" within the pipeline network — including leaks and signs of pipe deterioration. While 99.2% of the inspected pipe sections were in good service condition, it found 10 pipes with distress, ranging from low-level deterioration to more significant damage, and three leaks.

Rather than wait for a disruption of service, the utility could now proactively address structural weaknesses and optimize its pipeline rehabilitation and replacement program, deploying resources to the areas that matter most. Not only has the utility saved on pipeline replacement costs, but it has also reduced water loss.

The benefit is two-fold in its business and community impacts. That is the type of value digital delivers.

### The Digital Imperative

As the water sector's transformation continues to gain pace, digital technologies are now being recognized as imperative. Utilities understand the need to modernize and recognize the value of digital. The key question is not why, but how. What is lacking — particularly for many smaller utilities — is knowing where to start or how to scale.

From my experience working with utilities around the world, and as a digital water expert passionate about driving innovation across the industry, I know that "Big Bang" transformations are rare. The incremental but intentional improvements over time are the ones that have paid the greatest dividends. Successful transformation means finding a sustainable pace of change, putting quality data to work, and building thoughtfully on each success.

That experience also tallies with the other water, wastewater, and stormwater utility leaders and experts consulted for Xylem's paper, *Ripple Effect: A Movement Towards Digital Transformation.*[1] While the group consulted for the paper spans the scope of utility sizes, locations, and resources, one common thread ran through each of their experiences: a thoughtful, systematic approach to "going digital" can and will lead to powerful outcomes.

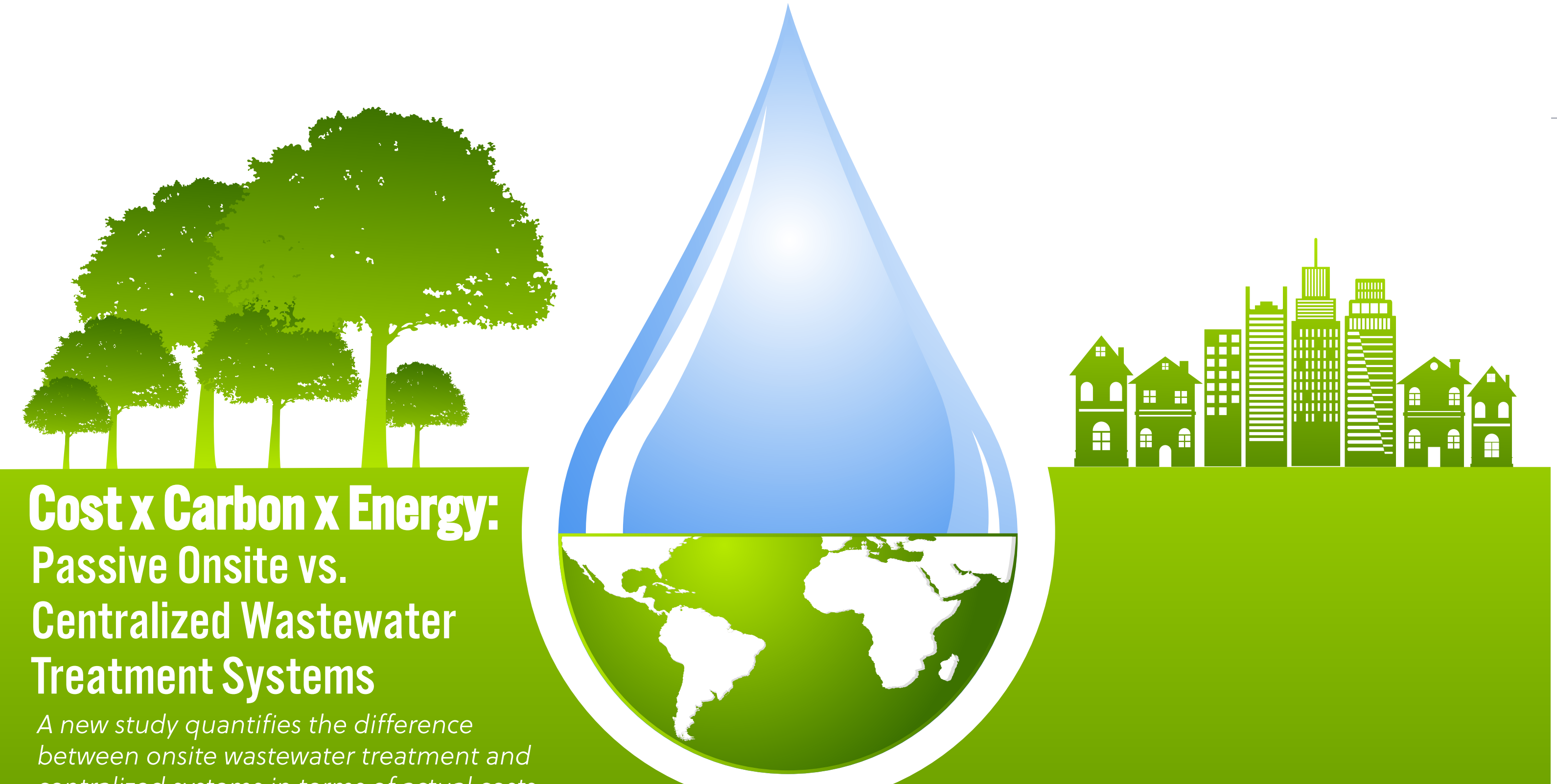
Every small win is another piece of the jigsaw, and every move brings the industry one step closer to achieving one common goal — building a resilient, sustainable, and equitable water future for all. ■

**References:**

1. https://www.xylem.com/siteassets/campaigns/ripple-effect/opp_xylem-ripple-effect-whitepaper_final_a4-wide.pdf

### About The Author

Michele Samuels, PE, is the strategic accounts manager at Xylem. Michele is a certified Asset Management Professional (IAM) and holds master's degrees in both engineering and business from the University of Toronto and Warwick Business School, respectively.



# Cost x Carbon x Energy: Passive Onsite vs. Centralized Wastewater Treatment Systems

*A new study quantifies the difference between onsite wastewater treatment and centralized systems in terms of actual costs and those to the environment.*

By Jonathan Kaiser

With rapid population growth worldwide, green building and development are becoming increasingly important. It is estimated that the world's population is increasing at a rate of approximately 75 million people per year. This increase in population creates an increased demand for potable water, leading to amplified domestic wastewater production. The wastewater infrastructure supporting a population must change to accommodate the population shifts on a local level. And this frequently means the construction of new homes served by an onsite wastewater treatment system or expansion of the footprint and capacity of centralized wastewater treatment plants (WWTPs).

An analysis was performed to quantitively determine the cost for treatment, embodied carbon, and embodied energy associated with the O&M of centralized WWTPs and two types of passive onsite wastewater treatment systems. Embodied carbon refers to the total amount of greenhouse gas emissions produced throughout the entire lifecycle of a substance. This includes emissions from raw material extraction, manufacturing, production, and transportation. Embodied energy refers to the total amount of energy consumed during the lifecycle of a substance.

O&M data were collected from 17 centralized WWTPs across eight states. The average influent flows were broken down for this analysis into less than and greater than 2 MGD (7.5 million liters per day). The same analysis was performed for two different types of onsite wastewater treatment systems: gravity and pump. Pump systems represent both pump-to-gravity systems and pressurized systems. For both centralized and onsite wastewater treatment systems, averages were calculated for the unit treatment cost, embodied carbon (kg $CO_2$), and embodied energy (MJ) per kilogram of biochemical oxygen demand (kg BOD), and total suspended solids (kg TSS) removed.

## Treatment Cost

A summary of the total cost of BOD and TSS treatment for centralized and onsite wastewater treatment systems is shown in Figure 1. Compared to centralized WWTPs with daily design flows of less than 7.5 million liters per day, gravity and pump onsite systems achieve approximately a 78% and 74% cost reduction per kilogram of BOD and TSS, respectively. Centralized WWTPs with daily design flows greater than 7.5 million liters per day are shown to be much more efficient in treatment cost.

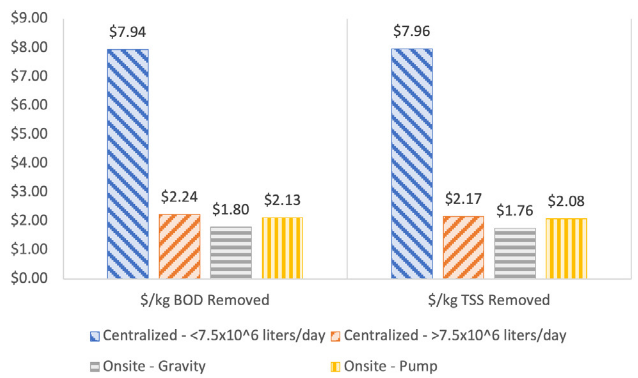



**Figure 1.** Average treatment cost for centralized and onsite wastewater treatment systems

## Embodied Carbon Footprint

Figure 2 shows the embodied carbon footprint for centralized and onsite wastewater treatment systems. As shown, gravity and pump systems were calculated to only have a small fraction of the embodied carbon footprint as compared to centralized WWTPs.

## Embodied Energy Footprint

The average embodied energy footprint for centralized and onsite wastewater treatment systems is shown in Figure 3. Onsite wastewater treatment is shown to have a reduced embodied energy footprint from centralized treatment regardless of whether the centralized WWTP is above or below the daily design flow of 7.5 million liters per day.

## Conclusion

As shown in Figures 1, 2, and 3, onsite gravity and pump systems provide a high reduction of treatment cost, embodied carbon, and embodied energy compared to centralized WWTPs. This applies to centralized WWTPs capable of handling both above and below 7.5 million liters (1,980,290 gallons) per day. Although both onsite and centralized wastewater treatment systems provide excellent treatment, there are substantial O&M cost savings relating to passive onsite wastewater treatment systems. The passive nature of soil-based treatment systems, where natural physical, chemical, and biological processes remove chemicals, viruses, and bacteria from wastewater is the biggest differentiator, as there is no cost to perform the treatment process itself. There is an incrementally higher treatment cost associated with pumped onsite wastewater treatment systems, but the costs are still substantially lower than WWTP treatment system costs. As with the cost of treatment, the lack of substantial energy input and the absence of chemical additions provide a greatly reduced embodied carbon footprint and embodied energy footprint associated with onsite wastewater treatment systems.

## Other Considerations

Two prominent contaminant classes of emerging pollutants in wastewater are pharmaceutical and per- and polyfluoroalkyl substances (PFAS). Although pharmaceuticals and PFAS are not new contaminants in wastewater, they are of emerging concern due to their potentially detrimental environmental and public health implications.

When humans consume pharmaceuticals, their bodies partially metabolize the drugs. The rest is carried through to wastewater treatment systems. The presence of pharmaceuticals in wastewater systems raises potential environmental and public health concerns. At low concentrations, pharmaceuticals can still negatively affect the biology of aquatic ecosystems. The contribution of pharmaceuticals to the embodied carbon footprint and embodied energy footprint in wastewater is indirect. Pharmaceuticals can complicate treatment processes, especially for centralized WWTPs. Additional energy and resources may be required to effectively eliminate the presence of these compounds during the treatment processes. Also, during combined sewer overflow (CSO) events, when raw sewage is discharged from centralized WWTPs, the untreated pharmaceuticals enter receiving waterbodies and contaminate the environment.

PFAS are human-made chemicals that are common in consumer products because of their beneficial water and grease-resistant properties. Research is ongoing relating to specific embodied carbon and energy values related to PFAS, but the production of PFAS is known to require an immense amount of energy.

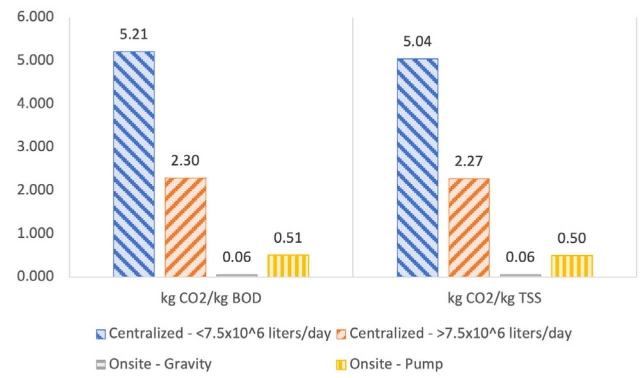



**Figure 2.** Average embodied carbon footprint per kilogram of BOD and TSS removal for centralized and onsite wastewater treatment systems

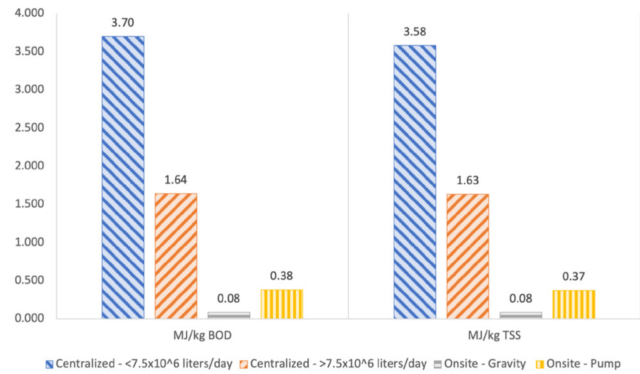


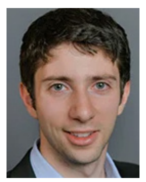

**Figure 3.** Average embodied energy footprint per kilogram of BOD and TSS removal for centralized and onsite wastewater treatment systems

And treating wastewater contaminated with this pollutant can be challenging, often requiring the use of advanced wastewater treatment technologies. These technologies consume elevated amounts of energy, contributing to the overall energy footprint.

Both pharmaceuticals and PFAS create challenges for WWTPs. Typical treatment processes in these plants may not effectively remove these substances. PFAS, for example, are known for resistance to degradation. Mitigation of these emerging pollutants in wastewater requires increased energy, leading to increased treatment costs and increased carbon and energy footprints.

As society becomes increasingly aware of sustainable development, it's important to incorporate lifecycle assessments into wastewater management and treatment processes to develop environmentally friendly solutions to address these emerging pollutants, while minimizing the overall environmental footprint of the wastewater treatment. ■

## About The Author



Jonathan Kaiser joined Infiltrator Water Technologies (Infiltrator) in 2016 as a project engineer after graduating with his BS in environmental engineering from the University of Vermont. Jonathan spends his time at Infiltrator working on septic system design, product regulation, and R&D initiatives. He also serves as the vice chair of the National Onsite Wastewater Recycling Association (NOWRA) Emerging Professionals Committee and serves on the board of directors for the Connecticut Onsite Wastewater Recycling Association (COWRA).

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