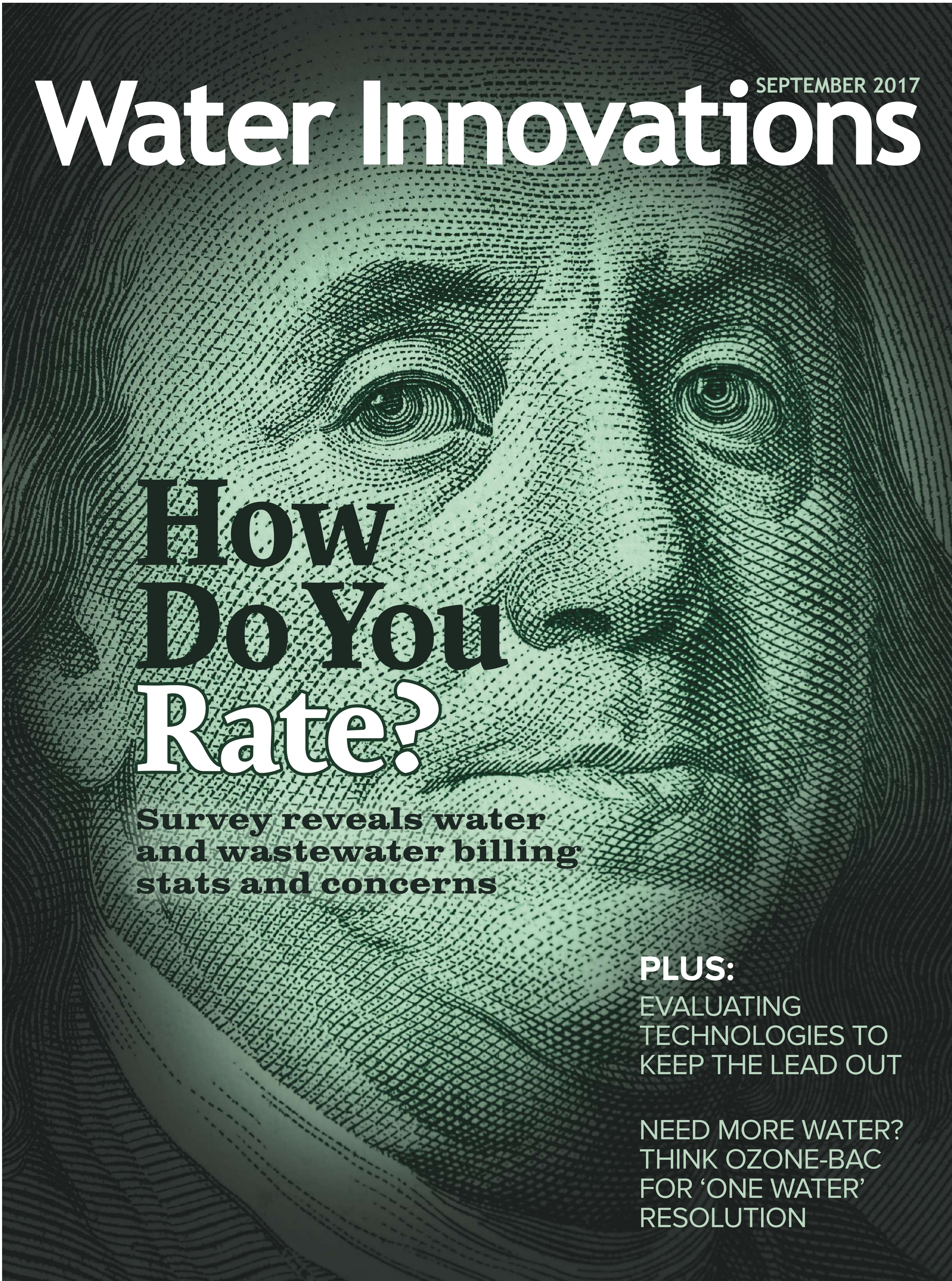
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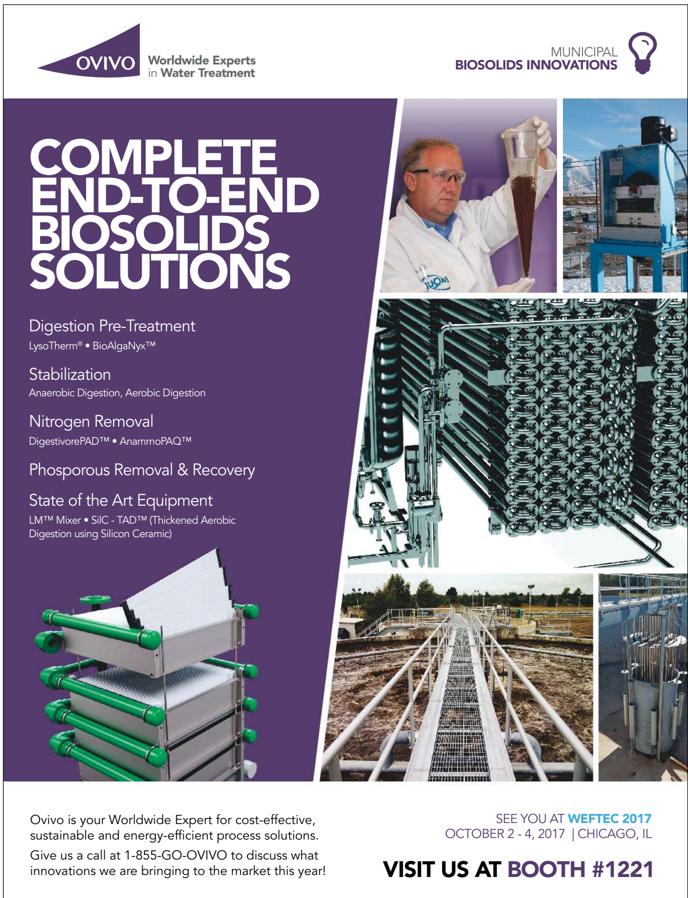

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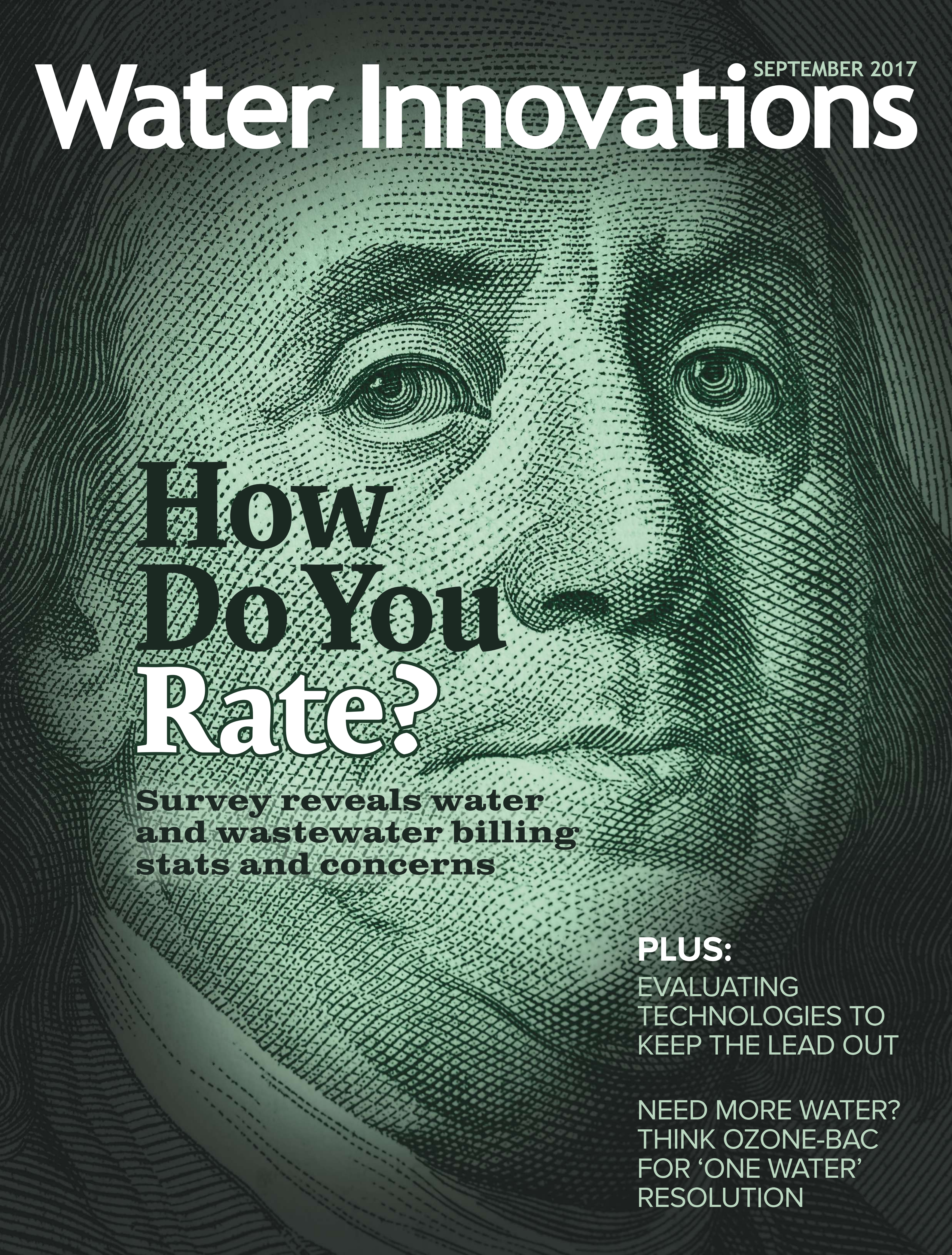

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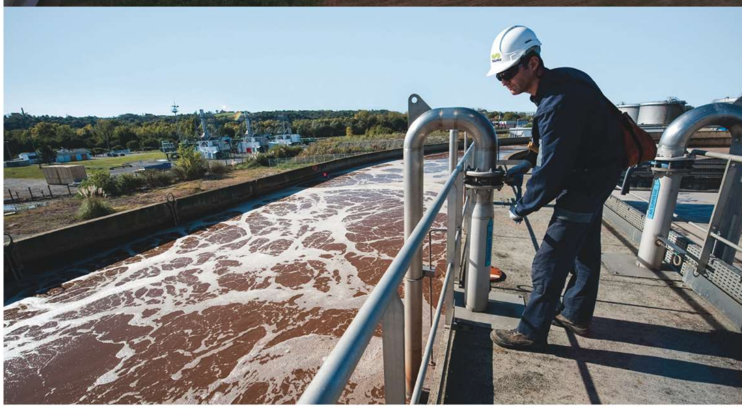

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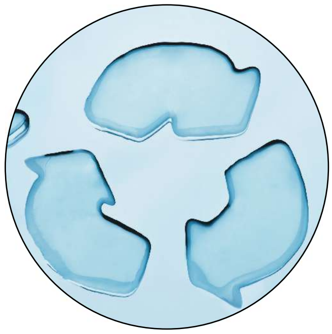
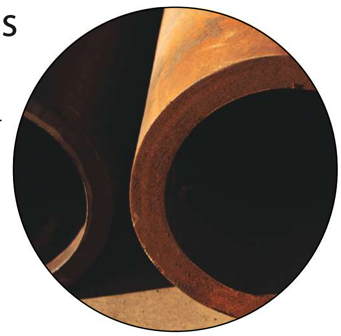


With lead contamination still a paramount concern for consumers around the country, many water utilities need to improve their buried infrastructure sooner rather than later. For those that cannot embark on ambitious replacement projects, a new report on coating and lining technologies for lead service lines might be the guide forward.



With infrastructure reliability on the brink, utilities are forced to raise rates to fund improvements. It's not a move that is undertaken lightly, nor should it be. The latest AWWA rate survey, produced with Raftelis Financial Consultants, highlights the plight of both utilities and consumers.

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EDITOR'S LETTER

By Kevin Westerling
Chief Editor, editor@wateronline.com

In It Together: Water Pros Share Problems And Solutions

You might say that there's a lot wrong with the water industry – problems including infrastructure, financing, and scarcity – but there's also a lot going right. In this Q&A, Water Environment Federation (WEF) President Rick Warner is a source of insight and optimism.

The value of water professionals was never lost on Rick Warner. After all, he pursued a career in the field, ascending all the way to president of the Water Environment Federation, assuming the "gavel of leadership" in September 2016. But even having entered his term with profound respect for water workers, he has since developed an even greater appreciation for the efforts and accomplishments of a widening set of environmental stewards.

It is, without doubt, an industry fraught with familiar challenges — one being water scarcity, which hits especially close to home for Warner. He is senior engineer for Washoe County, NV, where he's working to bring the state's first potable reuse project online in Reno. He's also a member of the American Water Works Association, the WateReuse Association, the Water Environment & Reuse Foundation, the Design-Build Institute of America, and the University of Nevada Civil and Environmental Engineering Advisory Board.

These credentials, along with his proven aptitude for leading and convening, made him a smart choice for president (his successful run ends in October, when he'll pass the gavel to President-Elect Jenny Hartfelder, PE, at the conclusion of WEFTEC 2017). Even so qualified, Warner says he learned quite a bit during his tenure. We discussed the current state and future direction of the industry, ongoing developments and discoveries, and how innovation — this publication's calling card — may be the key to solving our persistent water and wastewater challenges.

What trends or challenges do you predict for the industry within the next decade or so?

Unfortunately, some of the challenges are still around aging infrastructure and the need for investment. But the dynamics are challenging.

When the Clean Water Act was created about 45 years ago, many water and wastewater systems were federally funded with water grants. Now, almost universally, funding for water infrastructure comes from local government fees, connection fees, and user rates.

While some communities are more disadvantaged, the infrastructure still needs to get replaced on a regular cycle, and that issue will likely remain 10 years from now. We have, however, begun to make inroads toward bringing public awareness to the value of water and infrastructure.

It's wonderful when the public, policymakers, and public officials recognize that water infrastructure not only provides community health and recreation but also serves economic development.

When all of those things come together, you have triple-bottom-line benefit — social, environmental, and financial. That's where the real momentum comes, but getting there is the challenge.

Federal dollars through the State Revolving Fund loan programs or financing programs such as WIFIA [the Water Infrastructure Finance and Innovation Act] are going to help — but, again, it's most likely going to be the local folks who pay for infrastructure.

Can innovation around resource recovery, or elsewhere, help with financing new infrastructure?

Absolutely — we see it all the time. In fact, we've had great success at WEF embracing innovation, particularly around nutrients. We've helped communities implement innovative technologies to reduce the nutrients being discharged to their local water systems, while also reducing the amount of concrete infrastructure that has to be built. But what's really innovative is what's happening around energy recovery.

We're used to seeing wastewater systems utilize anaerobic digesters for some degree of energy production,

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but now a couple of facilities around the U.S., including East Bay MUD [Municipal Utility District] in Oakland, CA, are actually energy-positive because they are so efficient at capturing their biogas and turning it into electropower. WEF is positioned to help our communities, our utilities, and our members to reach these energy-neutral goals if that's what they choose.

But innovation isn't just about treatment; it's also about how we finance and construct our systems. We're seeing it in public-private partnerships and financing strategies such as design-build and design-build-finance-operate — all sorts of alternative project delivery methods.

One of the things that I love is our relationship with Imagine H2O and also BlueTech Research. These are companies that are working more closely in the private sector, accelerating conditions for new technologies to come into the marketplace. Partnering with these organizations brings new technology and new people to our membership, and it's an area of innovation we're very proud of.

What role does collaboration play in advancing clean water initiatives?

We understand that WEF has an important role, but we also understand that we can't do it alone, so we're partnering with multiple organizations and research entities.

One of my major initiatives coming in as president was to convene these organizations, including WEF, the American Water Works Association, and a number of research foundations and state organizations, and discuss how we can collaborate. We called it "Partnering For Impact" because we all recognize that we're doing good work individually, but by working together we can accelerate toward common goals. Our missions and visions are the same.

I'm also encouraged by what some utilities are doing. Many utilities are embracing innovation and research within the utility itself, or they're partnering with a local university to assist with pilot testing or building up research capacity at the local level. In fact, I'm doing something similar in my home state of Nevada, in Reno, where we're launching what we call the Nevada Water Innovation Camp. We bridged the collaboration with the local university to do common research and innovation together, and I suspect these types of utility-university partnerships will continue to grow.

"It's wonderful when you get the general public, policymakers, and public officials to recognize that water infrastructure not only provides community health and recreation but also serves economic development."

Rick Warner
president,
Water Environment Federation

How do you see water reuse, and particularly potable reuse, progressing in the future?

The whole category of water reuse is very exciting. We're seeing the population shift to arid parts of the U.S., which are already water-stressed, so water reuse is going to become ever more important.

Certainly usage has to be reduced, and then communities can move into recycling — and I categorize recycling as irrigation of parks or golf courses, etc. — to water reuse and, finally, to potable reuse. For the latter, it's going to take an enormous amount of effort on the regulatory side. Each state is responsible for its own water reuse regulations, so one real barrier is the lack of a common framework.

In terms of public acceptance, we've done a terrific job in the past 10 or 15 years to move past "toilet to tap" branding. We learned to slow down and really engage our communities, policymakers, and decision makers. We understand that the technology is there to treat well beyond drinking water standards, but you still need to have public acceptance.

There are some great examples out there — Orange County [Water District] is considered the gold standard for potable reuse; it's the biggest and has been doing it for a long time — but I'm rather intrigued by what Santa Clara Valley Water District is doing. It's established a physical treatment facility for potable reuse, but it's not returning it to potable. Instead, they utilize it for golf course and park irrigation and bring in tours.

They're also conducting research and innovation studies behind the scenes, but the focus is bringing in the public and allowing them to see the technology and get comfortable with it over time — to educate. That seems to be a great model.

There's a study that was done on Orange County, and it was done not on the technology but on the approach the organization took. It's labeled "legitimacy," and what it states is that the organization itself needs to be viewed by the public as an agency that's transparent, can collect data, and is very professional — someone you can trust. When you establish those conditions of legitimacy within your community, it allows you to then promote potable reuse projects. It's a slow process, but it goes back to agencies recognizing the social impact of these systems.

It's going to take all of us — drinking water agencies, traditional wastewater [WWTPs] or water resource recovery facilities [WRRFs], reuse and regulatory people — to come together to create a new water source for the community, and by default this becomes the "One Water" mantra. With potable reuse, it absolutely requires everyone to work together. I think it's the future, and I'm excited about it.

Water reuse typically involves reverse osmosis, but are other options emerging?

I can answer this with some degree of knowledge, because in Reno we're doing pilot and demonstration studies around technologies for potable reuse that do not use reverse osmosis [RO].

There are several systems being tested with conventional sand filtration — what you would see at a traditional water treatment plant — followed up with ozone, carbon filtration, ultraviolet light for disinfection, or some other advanced treatment process. And there are lots of communities working with research foundations and universities to come up with the right process units for their water systems — systems that are more energy-efficient, use fewer chemicals, and aren't hampered by the brine-management issues inherent with RO.

In the twilight of your term, how do you view the state of the industry?

It's truly the most fascinating time I can think of to be in the water sector — from technology and treatment processes to how people manage their systems — because there's so much innovation development and expertise in our field. I'm just profoundly impressed with the passion and willingness to take on complex issues. To experience it as WEF president, even for a year, has been a privilege.

The most valuable lesson I've learned is that we're really in it together. Our differences are very small, and what we share in common — protecting public health and the environment — is very strong.


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Navigating A Cyanobacterial Event: Lessons Learned In Balancing Risk And Cost For A Single Season

A case study from Lake Erie shows the value of adaptable monitoring plans and how to get ready to respond to dynamic situations.

By Silvia Vlad, Monique Waller, and Quirien Muylwyk

In the summer of 2016, the Region of Niagara — a regional municipality on the Canadian shore of Lake Erie serving 450,000 residents — faced the challenge of developing and implementing a cyanobacterial monitoring and response plan within a single season, while managing an active cyanobacterial event with the potential to impact one of the Region's six water treatment plants.

An increasing number of municipalities are affected by cyanobacteria or cyanobacterial metabolites each year, and many utilities have noted blooms appearing earlier in the spring and lasting longer into the fall. Several risks are inherent to a drinking water supply impacted by cyanobacteria — notably metabolite toxins (cyanotoxins), which can harm human and animal health, as well as the taste-and-odor compounds 2-methylisoborneol (MIB) and geosmin. While a range of options is available to utilities managing the risks posed by these blooms, tradeoffs exist between the costs of monitoring, using temporary mitigation techniques, or implementing permanent treatment measures. These challenges are further complicated by the intermittent nature of cyanobacterial events, for which the occurrence, duration, and magnitude are not easily predicted.

> *While a range of options is available to utilities managing the risks posed by these blooms, tradeoffs exist between the costs of monitoring, using temporary mitigation techniques, or implementing permanent treatment measures.*

In Spring 2016, operators at the DeCew Falls treatment plant reported needing to clean the intake bar screens of algal debris more often than in past years. Although no toxins had yet been detected, the Region wanted to understand the potential implications of finding cyanobacteria in their source — including potential cyanotoxin production, a timeline for toxin intrusion into the plant, and barriers needed to prevent the toxin from entering the water supply. The Region of Niagara engaged CH2M to obtain answers to their questions when elevated algal activity was confirmed in the raw water storage reservoir upstream of the DeCew Falls plant.

CH2M worked with the Region through the summer and early fall to:

1. Develop a proactive, cost-effective monitoring program that could generate useful data at the right time to support sound decision-making about cyanotoxin management, both during the current event and for monitoring during subsequent seasons.
2. Evaluate existing treatment capabilities already in place at the DeCew Falls plant.
3. Identify and prepare to implement seasonal or short-term treatment augmentations.

Tiered Monitoring

Recommendations were developed for monitoring the source, in-plant, and treated water for algae, cyanobacteria, and their metabolites across six of the Region's treatment plants, to provide supplemental information beyond what was obtained through monitoring practices already in place.

The monitoring plan was used to identify both the occurrence of algae, cyanobacteria, or their metabolites, and their impact on plant performance using a variety of tools, including visual observations of the

source water, coordination with other Lake Erie users, and understanding and anticipating the behavior of the lake. The tiered monitoring approach considers location-specific factors at each plant, the time of year, and conditions observed in the source water to select the appropriate monitoring protocol. Factors such as shallow intakes, intakes situated close to the shore, and sources either directly on Lake Erie or impacted by Lake Erie were used to assess the risk at each of the Region's water treatment plants. Monitoring protocols for high-, moderate-, and low-risk plants were established for each of three temporal and water quality scenarios:

- Transitional season monitoring, in spring and fall, using triggers to prompt routine summer monitoring;
- Routine summer monitoring, when the likelihood of occurrence is relatively higher; and
- Event monitoring, to determine the cause and effect during a confirmed cyanotoxin event.

Triggers to move among the three scenarios included source water temperature, trends in cyanobacterial indicator parameters, the startup of prechlorination for zebra mussel control, and the detection of cyanotoxins in either the source water (above a threshold) or treated water (at any concentration).

Understanding the monitoring logistics proved critical, given the breadth of possible monitoring parameters, locations, analytical methods, and timelines. Challenges of sampling and analytical logistics were overcome in the short term through collaboration with the local conservation authority, internal and external laboratories (including Provincial and Federal resources), along with increased staff-time commitments to monitoring. The tiered monitoring plan allowed the Region to obtain valuable information without the need to sample extensively at all six sites (potentially backing up analysis of critical samples), with the understanding that the interim logistics implemented for the 2016 season could be further refined in subsequent years. Local lab analytical capabilities and turnaround times were significant factors in the development of the monitoring plan.

Existing Treatment Capabilities

To understand the implications of the monitoring findings, a desktop assessment of the existing treatment capabilities of the DeCew Falls plant was undertaken. As a conventional treatment plant, DeCew Falls already featured chlorination (both intake and disinfection chlorination) with the potential to oxidize dissolved cyanotoxins. Existing chlorination practices were based on a range of goals, including preventing zebra mussel growth at the intake, minimizing disinfection byproduct formation, maintaining a level of pre-oxidation which helped the plant maintain pretreatment performance, and achieving pathogen disinfection requirements. With the introduction of an additional goal — managing cyanobacterial and cyanotoxin impacts — treatability tradeoffs for chlorination had to be considered. Once cyanobacteria were confirmed in the reservoir, prechlorination at the DeCew Falls plant was turned off in an effort to prevent lysis of cyanobacterial cells (and the release of any toxins contained within the cell membranes). However, the lack of prechlorination resulted in increased settled water turbidity and filter performance challenges, and prechlorination was ultimately resumed at a low level. Performance observations at the plant were integrated with industry information from a literature scan to develop preliminary chlorination guidelines for three scenarios. These guidelines were intended to provide a starting setpoint from which the plant could fine-tune operations, should it become necessary to consider cyanotoxin oxidation among the treatment goals for chlorination.

Logistics are critical:

Where should the monitoring occur?

When should the samples be collected?

Who will collect the samples?

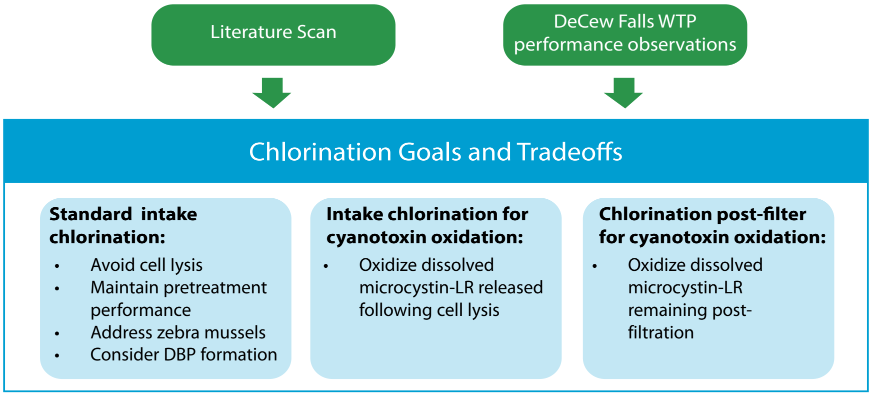
What should be tested for?

What methods should be used?

Who will analyze the samples?

Can information be obtained quickly enough to react to a cyanotoxin event?

The tiered monitoring approach considers location-specific factors at each plant, the time of year, and conditions observed in the source water to select the appropriate monitoring protocol.



Treatment Augmentation

In concert with the analysis of existing treatment capabilities, bench-scale testing was completed at the DeCew Falls plant to identify modifications to the existing treatment which the Region could implement relatively quickly if toxins were detected at the plant. Based on the results of the bench-scale study, operating with an enhanced coagulation dose of the existing plant coagulant (alum) was selected as the preferred short-term solution that used the existing infrastructure, and a range of potential polymers was screened. The polymer investigations identified a product which could assist in forming a fast-settling, heavy floc to promote better settling of cyanobacterial cells and prevent re-suspension of the sludge. Once a preferred polymer was selected, logistical considerations such as the availability of supply, location for injection, make-down system requirements, and regulatory approvals for implementation of a new chemical system were addressed, and the Region prepared to enact treatment augmentations, if necessary.

Recognizing that further fine-tuning of plant operations may be required under changing water quality conditions throughout a cyanobacterial event, a training program for the Region's staff was incorporated in the bench-scale studies. Increasing the Region's in-house capacity to develop and carry out jar test plans will provide greater flexibility in determining the appropriate response and implementation for subsequent events, including continued examination of coagulant, chlorine, and polymer doses.

Monitoring Implementation, Response Readiness, And A Cyanotoxin Framework

Within the 2016 cyanobacterial season, a tiered monitoring plan was implemented by the Region of Niagara, and while cyanotoxins were only ever detected upstream of the DeCew Falls treatment plant (never at the plant itself), the Region was ready to use existing chlorination capabilities to manage dissolved toxins and had obtained approvals from the regulator to implement a polymer system for augmented removal of cyanobacterial cells, should it have become necessary.

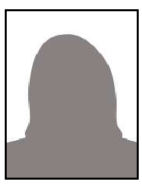
The Region successfully navigated the potential pitfalls of gathering data about a cyanobacterial event, analyzing the data to understand the implications, and preparing a treatment response plan. A teamwork approach to communication, monitoring logistics, implication analysis, and decision execution was integral to the process, and included O&M staff, summer interns, quality and compliance staff, the Region's laboratory staff, Public Health officials, the local conservation authority, university researchers, and other municipalities.

Ultimately, a monitoring and response framework was developed to support the Region in managing potential cyanobacterial impacts going forward. While circumstances might differ between events or evolve throughout the duration of an event, the framework will allow the Region to obtain needed and actionable information, understand the current treatment capabilities and augmentation options, and have the in-house training to further fine-tune the treatment parameters. By ensuring that tiered monitoring and response measures are in place, issues such as sample frequencies and locations, preliminary treatment set-points, and media release timelines will be addressed ahead of time, allowing the Region's staff to focus on critical questions rather than laboratory logistics during future events. ■

About The Authors

Silvia Vlad is a water treatment engineer in CH2M's Toronto, Canada office and holds a Masters of Applied Science from the University of Waterloo, where her thesis focused on the treatment of the cyanotoxin anatoxin-a in drinking water. Silvia is delighted to be part of an industry that strives towards a resilient global water supply through ambitious policy initiatives, open communications, and effective engineering solutions.

Monique Waller obtained her Master's degree in civil engineering from the University of Toronto in 2008, after which she joined CH2M's Kitchener office. Monique has supported a range of municipal drinking water treatment and distribution projects, including water quality and optimization studies, environmental assessments, and hydraulic modeling of water distribution systems.



Quirien Muylwyk, MASc., P.Eng., is the National Practice Leader for Water Quality with AECOM. Quirien has more than 20 years of experience in strategic planning for regulatory compliance and growth, the design and construction of new works, and process optimization for municipal water systems. Her work has focused on making the link between performance inside the treatment plant and performance in the distribution system, all with the purpose of promoting public health.

Need More Water? Think Ozone-BAC For 'One Water' Resolution

If you thought reverse osmosis was the one and only choice for potable water reuse, think again. Ozonation followed by biological activated carbon (ozone-BAC) is more suited to inland communities and may be better at removing chemicals of emerging concern (CECs).

By Vijay Sundaram

A finite freshwater supply and an ever-increasing demand for water are making sustainable water resource management necessary for many cities. Inland and coastal communities alike are becoming more water-conscious and are planning or have already implemented water-conservation measures to reduce their water demand/water footprint.

For most communities, the next step in sustainable water resource management is diversification of their water supply portfolio. Considering the available new water supply options, highly treated municipal wastewater is the most reliable, yet underutilized source of freshwater in many urban areas.

Reuse of refreshed municipal effluent is not new. Well-known reuse projects have been in practice since the 1980s. However, the methods for providing advanced treatment to wastewater and the realistic options for reuse water have changed significantly. The new water planning paradigm considers all water in the hydrosphere as "one water," and the potential for use and reuse is summarized schematically in Figure 1. When considering wastewater as a reliable source for augmenting a community's water supply, there are two basic options:

Dual Pipe (Conventional): Dual plumb the community (i.e., install "purple pipe") to keep recycled water

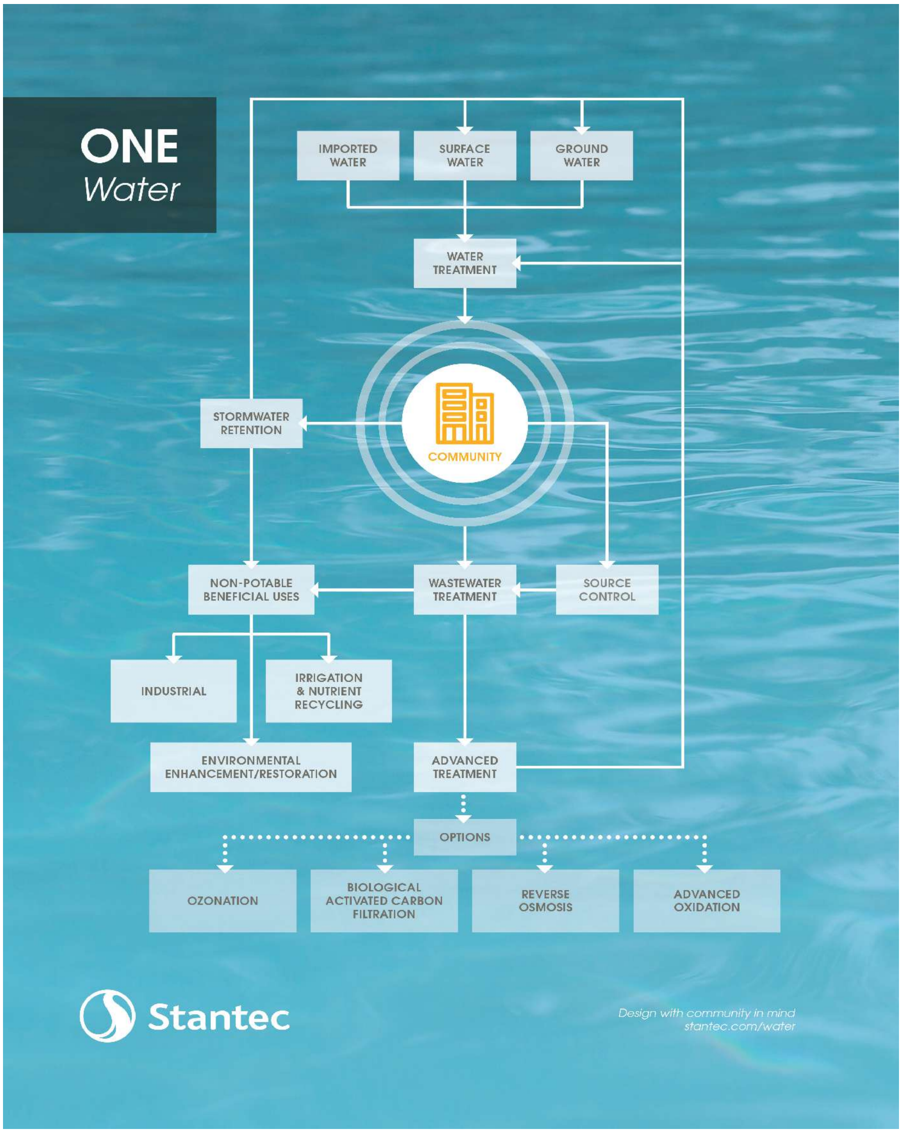


Figure 1. Illustration of One Water approach

separate from potable water.

Single Pipe (The Future): Refresh the wastewater to where it is safe for potable water augmentation.

The "Dual Pipe" approach spends less money on wastewater treatment but more on the dual-pipe distribution system, its long-term maintenance, and control of "cross connections" risk.

The "Single Pipe" approach spends more money on advanced wastewater treatment but less on distribution piping and has no cross-connection concerns. Improvements in advanced wastewater treatment technologies are tilting the economics in favor of the "Single Pipe" approach. Consequently, numerous cities and towns are currently planning and implementing potable reuse projects as the more economical alternative.

In implementing a One Water future, both regulators and the public are concerned about pathogens, carcinogens (such as disinfection byproducts [DBPs], pesticides, heavy metals, etc.), and chemicals of emerging concern (CECs, which include hormones, pharmaceuticals, personal care products, etc.).

Improvements in advanced wastewater treatment technologies are tilting the economics in favor of the "Single Pipe" approach.

Pathogens, DBPs, And CECs

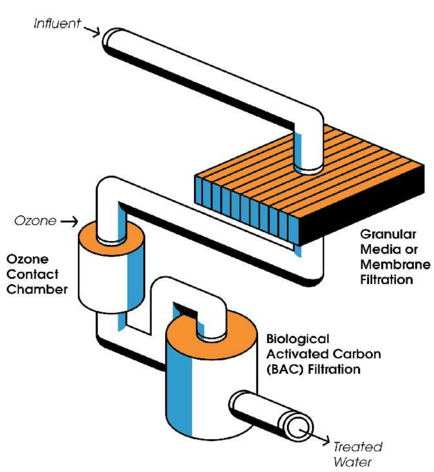
Pathogens are the foremost concern with every reuse project, particularly One Water projects. Because no water can be tested for every possible pathogen, the regulatory community has studied the matter in detail and has developed analytical protocols that protect public health. Specifically, if removing particular indicator pathogens (e.g., *Giardia lamblia*, *Cryptosporidium parvum*, *enteric viruses*, and *coliforms*) is demonstrated, then the water is judged safe for reuse, even drinkable. The technologies to remove pathogens from drinking water standards exist and are being implemented.

DBPs are commonly detected in potable water supplies, regardless of whether water reuse is involved. Common DBPs include total trihalomethanes (TTHMs), haloacetic acids (HAA5), bromate, and NDMA (N-Nitrosodimethlyamine). Control of DBPs during water treatment and distribution requires a deep understanding of DBP precursors and formation pathways. As examples, total organic carbon (TOC) is a good indicator of the presence of TTHM precursors; TTHMs can be formed during chlorine-based disinfection processes; formation of bromate during ozonation becomes a concern if relatively higher levels of bromide are present in the influent; NDMA is an emerging DBP formed during chloramination and, to a lesser extent, during ozonation. The key to One Water projects, as with conventional projects to a lesser extent, is controlling DBP concentrations to acceptable levels by the design and operation of the treatment methodologies used. Control of DBPs and other carcinogens to meet drinking water standards is now possible and is being demonstrated by several One Water projects.

Within the water resource profession, the presence of CECs is considered the "fingerprint" that the water has been impacted by human activity, even if the water and its source appear pristine. CECs include hormones, pharmaceuticals, and personal care products. Obviously, municipal wastewater, being heavily impacted by human activity, contains relatively high concentrations of a wide range of CECs. CEC removal has been possible but expensive. Recent innovations related to the application of the ozone-BAC (ozonation followed by biologically activated carbon) treatment process train are paving the way for cost-effective CEC control and potable reuse across the nation.

RO — The Gold Standard

Reverse osmosis (RO) is the current "gold standard" for potable reuse of municipal wastewater. RO-based treatment trains have demonstrated removal of pathogens, DBPs, and CECs to drinking water standards. Unfortunately, RO treatment and associated pretreatment steps are expensive to build and operate, and all the removed contaminants are concentrated in a waste stream (sometimes called "reject" or a "brine stream") that is 10 to 20 percent of the influent flow to the RO process. Disposal of this brine stream is another major expense if oceanic



Ozone-BAC Technology

Influent: Ozone-BAC treatment step is located downstream of the biological secondary treatment. Fully nitrified secondary effluent is the recommended influent for ozone-BAC treatment train.

Filtration: Secondary effluent is filtered through a granular medium (sand) or membrane filtration step prior to ozone-BAC treatment train.

Ozonation: Oxidation of contaminants is achieved in the ozonation step. Ozone oxidizes and converts slowly biodegradable refractory CECs to readily biodegradable oxidation byproducts.

Biological Activated Carbon Filtration: Ozonated effluent is filtered through a BAC bed. It utilizes granular-activated carbon with adsorption capacity as the filter medium. Thus, BAC treatment combines
1) biodegradation to remove CECs and oxidation byproducts, and
2) adsorption to remove CECs that are not amenable for biodegradation.

Treated Water: Ozone-BAC effluent is subjected to a final disinfection step prior to water supply augmentation.

Figure 2. Ozone-BAC technology description

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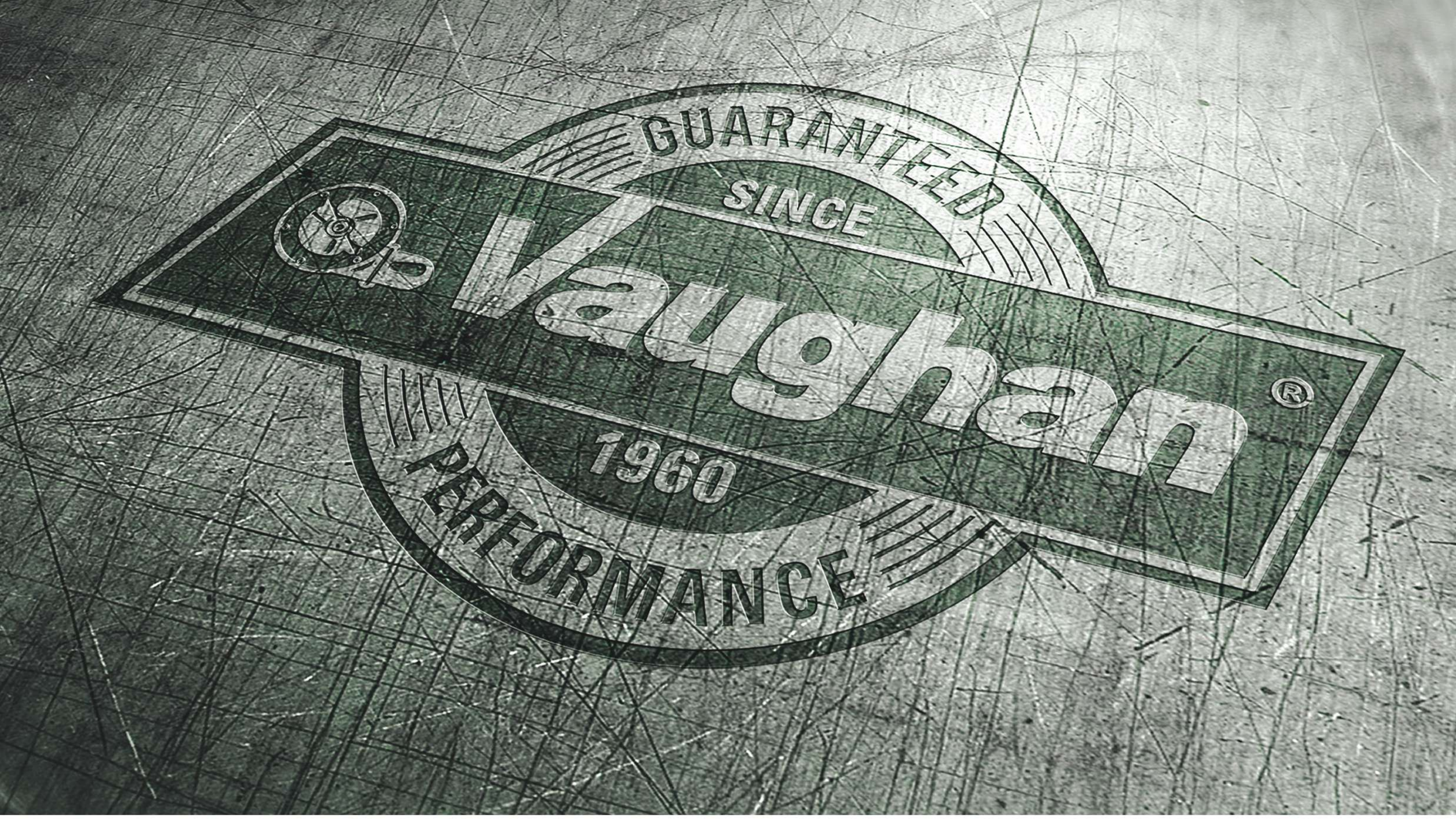

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The ozonation step oxidizes CECs that are residual from conventional wastewater treatment processes into short-chain organic compounds that are biodegradable. Next, the BAC step metabolizes these short-chain organics into even simpler organics.

discharge is not available. Therefore, inland locations considering potable reuse are either planning very expensive RO-based treatment trains with brine-handling facilities, or they are exploring alternative treatment trains that are equally effective in providing barriers for pathogens, CECs, and DBPs.

To address the One Water project needs of inland communities, the question was asked whether RO (a desalination process developed decades ago) was truly the best technology for removing CECs, which are primarily organics. The answer to this question may well be no; it's ozone-BAC technology. The ozonation step oxidizes CECs that are residual from conventional wastewater treatment processes into short-chain organic compounds that are biodegradable. Next, the BAC step metabolizes these short-chain organics into even simpler organics. A schematic of an ozone-BAC process is shown in Figure 2. As shown, treated wastewater must be filtered prior to ozone-BAC treatment. This filter may be part of the wastewater treatment plant or part of the water reuse treatment process. A description of the ozone-BAC process relative to the Figure 2 schematic is presented below.

Filtration tanks for biological activated carbon treatment.

Ozone-BAC Technology Development And Maturation

While some communities have been utilizing ozone-BAC for decades, engineering services company, Stantec, reported one of the earliest data sets on the CEC removal capabilities of ozone-BAC when treating filtered wastewater. That data set was based on the field performance of an ozone-BAC process operated from 2008 to 2010 at the City of Reno's Reno-Stead Wastewater Reclamation Facility (WRF). CEC removal in ozone-BAC was extensive and reliable and was achieved mainly via three treatment mechanisms: 1) oxidation, 2) biodegradation, and 3) adsorption, resulting in true treatment, not just concentration.

Since then, Stantec has been working on the optimization and design of ozone-BAC for potable reuse applications, including water treatment in Gwinnett County. Since reporting the Reno project findings, several full-scale ozone-BAC projects have been implemented in New Mexico and Texas, and field investigations are being conducted in Virginia and Florida. Stantec is currently designing full-scale ozone-BAC processes for agencies in Southern California.

Optimization Of Ozone-BAC For Potable Reuse Applications

Water Environment & Reuse Foundation (WE&RF) Project 15-10 is a research project in collaboration with American Water, Stantec, Washoe County, Nevada, Xylem, and WE&RF. The goals of the project are to:

1. Understand water quality differences between ozone-BAC and RO effluents.
2. Optimize ozone-BAC treatment mechanisms and design parameters.
3. Develop an ozone-BAC guidance manual for potable reuse applications.

The project team is currently conducting diagnostic pilot testing at Washoe County's South Truckee Meadows WRF in Reno, NV. This research project has been providing valuable insights on the roles of the ozone and BAC steps in controlling DBP formation and maximizing CEC removal. The guidance manual is considered as the next step in ozone-BAC technology maturation as it allows regulators and designers to better understand the technology's capabilities and limitations.

Ozone-BAC And Its Role In Future Water Management

Ozone-BAC has an important role in removing CECs found in municipal wastewater prior to reuse as part of One Water resource planning. Ozone-BAC-based treatment trains are proven to be effective in providing pathogen log reductions and minimizing DBP formation as well. RO still has a place in One Water planning, but primarily for use in its original role to remove salt if needed, and only to the extent needed based on One Water project-specific factors. In such cases, the RO unit would treat just a portion of the reuse water downstream of the ozone-BAC process. ■

About The Author

Vijay Sundaram, a chemical engineer by training, has 15 years of experience designing advanced water and wastewater treatment systems using physical, chemical, and biological processes. He is the water resource technology leader at Stantec, and as a resident of drought-sensitive California, he's focused on creating safe, cost-effective, and reliable water sources.

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Process Water: Building A Better System

With factors such as scarcity, aging infrastructure, and water quality driving the price of municipal water higher, businesses are increasingly considering other means of securing supply. This article examines the trend toward alternatively procured process water and its impact on municipal and commercial interests.

By Deonta Smith

One of the most indispensable utility resources in the U.S. is the water supply. Consequently, developing and coordinating programs that will provide some degree of water conservation is essential. The nation's demand for water has increased over the past decade, as households and businesses continue to depend on a reliable, clean supply of water for drinking, agriculture, industrial production, and other high-volume applications. One solution relating to water efficiency is the use of process water. Process water — an emerging alternative to traditional water supply consumption — is the supply of treated or recycled fresh water from an owned source, or surface water from a nearby river that is purified by the users' upstream filtration system. In many industrial and commercial processes, the use of process water allows businesses to increase water consumption without shrinking the nation's water supplies. Moreover, process water is likely to be less contaminated than the water sourced from public distribution systems, which can pick up lead and other contaminants from aged pipes.

Though outsourcing process water has been cost-effective for end users, suppliers have been met with heightened production costs as strengthening demand has prompted upstream suppliers to raise the price of inputs. This trend has been causing the price of process water to rise during the past three years. As a result, users are currently facing a dilemma where they must decide whether to continue procuring from existing producers or begin producing process water in-house.

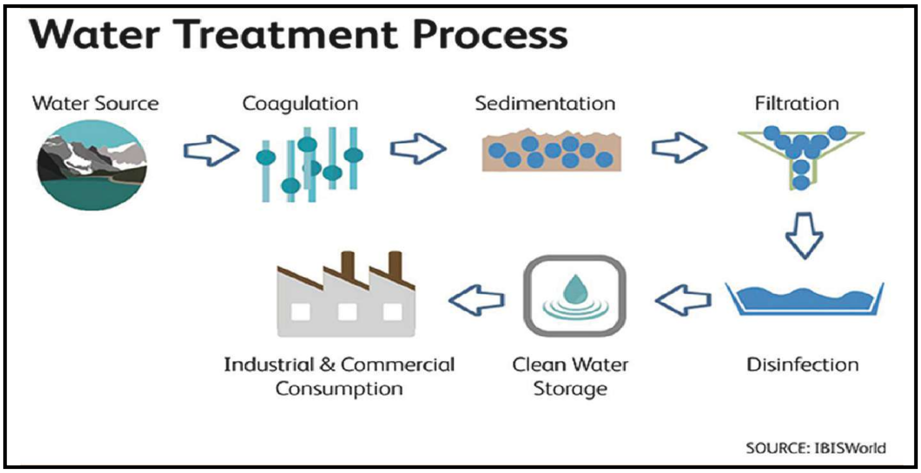
Given the breadth of industrial and commercial processes in which the use of water is integral, and because reserves are shrinking, the need to identify an alternate resource is imperative.

Prioritizing Conservation And Purification

The National Oceanic and Atmospheric Administration and the U.S. EPA have found that the average annual rainfall has been declining consistently since 2007. The EPA attributes this trend to climate change and expects that water supplies will continue to shrink as a result. In response to the EPA's findings, public and private water supply distributors have sought to curb the nation's water consumption by raising prices. However, in spite of increased water utility prices, the use of water supply has steadily inched upward.

Given the ineffectiveness of these price hikes, a number of other conservatory measures have been implemented. These efforts have primarily focused on employing water reuse practices and reducing waste, with one of the more promising practices being the use of process water as a substitute. Not only does process water allow for the reduction of traditional water consumption among industrial and commercial businesses, but it is also a cheaper alternative to water received from public and private reservoirs.

EPA studies have shown that the water sourced from public and private distribution systems has been accumulating increasing amounts of rust due to aging pipelines. As a result, the EPA now requires that water leaving a city's water plant be tested for microorganisms (e.g., *Cryptosporidium* and Legionella) that thrive in aged piping systems. In effect, locales (e.g., Oakland, CA) are collectively spending around $50 billion each year purifying the water in their distribution systems (this is considerably less expensive than replacing their aging infrastructures).



High amounts of lead have also been identified in a number of municipalities. To protect themselves, a number of commercial firms have agreed to increase their use of process water. For example, the food and beverage industry uses public water for many purposes. Operators in this industry have a major stake in ensuring that water used in their processes is of high quality and purity, since it is used to make products that will be consumed. Moreover, water is also used to clean and sanitize floors, processing equipment, containers, vessels, and the raw food products prior to processing. Given the breadth of industrial and commercial processes in which the use of water is integral, and because reserves are shrinking, the need to identify an alternate resource is imperative.

Cost Trends for Water-Related Markets

Market	Price Growth (2014-2017)	Price Growth (2017-2020)
Water Treatment Chemicals	-0.6%	0.7%
Water Quality Testing Equipment	1.2%	0.8%
Water Quality Testing Services	1.0%	1.2%
Water Well Drilling Services	4.4%	3.9%
Water Trucks	0.9%	1.5%
Water Hauling & Vacuum Services	0.7%	1.8%
Wastewater Treatment & Disposal	1.3%	2.0%

SOURCE: WWW.IBISWORLD.COM

To Build Or Not To Build

Water supply conditions have been spurring a dramatic increase in demand for process water in the past three years; however, suppliers have not been equipped with the reserves to meet this demand growth. Further, process water suppliers have incurred higher operating costs. In response to sales growth, upstream suppliers have raised the price of integral inputs and equipment used in the process water production process. Consequently, to protect their profit margins, process water suppliers have been passing their heightened production costs on to buyers in the form of higher prices.

Downstream suppliers that have negatively affected bottom lines include water treatment chemical suppliers, water quality testing equipment suppliers, water well drilling service providers, and water hauling and vacuuming suppliers. For example, the price of water treatment chemicals is influenced by the production of process water because water softening compounds and demulsifiers are integral inputs used in the process water production process. According to IBISWorld, the price of these inputs and other water treatment chemicals increased 1.0 percent in 2016 and is projected to grow at a slightly faster pace in 2017, thereby making it more difficult for process water suppliers to expand production levels to satisfy demand growth. Similarly, IBISWorld projects spikes in the price of water trucks, which are used to store and transport process water. This trend will hinder suppliers' ability to control their overall costs. Because the price of sourced goods and services will negatively affect suppliers' bottom lines, suppliers are expected to raise the price of process water.

In the event that the spike in input costs persists and water supply rates continue to increase, industrial and commercial firms will look to other solutions, such as establishing water treatment facilities in-house, to offset continuous price hikes. In fact, in recent years, many large industrial firms that require significant quantities of process water have turned to building on-site process water facilities, bypassing the need for outsourcing. Unfortunately, this method is often not cost-efficient for all buyers. For low-volume water users, this alternative is costly and therefore not a practical solution.

Looking Forward

Although municipalities have every intention of building low-cost, high-quality water supply systems, the constant delay and its impact on the existing water supply systems are expected to make it less feasible to do so. According to the American Water Works Association, to replace all pipes in the U.S. today, water utilities would have to invest $250 billion to $350 billion over the next 20 years. If the investment isn't made soon, this cost could triple by 2030. However, demand for process water is expected to expand in the next three years alone, causing prices to rise as a result. Growth in the price of process water will, in turn, prompt more investments to be made in in-house water processing. ■

About The Author

Deonta Smith is a lead procurement research analyst for IBISWorld, specializing in construction and infrastructure. He holds a bachelor's degree in economics from Pepperdine University. The research featured in this article can be found at ibisworld.com/procurement.

Evaluating Technologies To Keep The Lead Out

With lead contamination still a paramount concern for consumers around the country, many water utilities need to improve their buried infrastructure sooner rather than later. For those that cannot embark on ambitious replacement projects, a new report on coating and lining technologies for lead service lines might be the guide forward.

By Peter Chawaga

Since late 2015, when a public health emergency was declared in Flint, MI, much of the country's drinking water focus has been trained on the threat of lead contamination.

The daily work of treatment professionals and utility workers must confront a wide range of contamination issues, but many consumers are still preoccupied with the potential of their hometown becoming the next Flint. And their concerns are not misplaced.

An April 2016 study conducted by the American Water Works Association found that 6.1 million lead service lines (LSLs) serve up to 22 million people throughout the country. It may seem like a priority to fully replace those with new pipelines as soon as possible.

But, unfortunately, it isn't that easy. It can be incredibly expensive to fully replace service lines (which is why some of our country's drinking water infrastructure has been in place since World War II). In some cases, it may not even be legal for a municipality to replace the sections of lines that fall under private property. As a more feasible alternative, many drinking water providers should consider buffering LSLs with noncorrosive material.

An April 2016 study conducted by the American Water Works Association found that 6.1 million lead service lines (LSLs) serve up to 22 million people throughout the country.

"For specific situations where full lead service line replacement does not appear to be technically feasible, or economically or socially acceptable, lining or coating the customer-owned portion of the LSL should be considered as an option," said Jonathan Cuppett, a research manager for the Water Research Foundation (WRF). "Potential benefits of lining and coating include reasonably long service lives, cost savings relative to LSL replacement, fewer and shorter disruptions to traffic, reduced damage to landscaping and driveways, less potential for damage to other utility lines, and facilitating delays of LSL replacements until they can be more efficiently and more cost-effectively performed."

Assessing Options

To help drinking water utilities explore lining options to protect consumers from lead contamination, WRF put together a research project, *Evaluation of Lead Service Line Lining and Coating Technologies*.

Fully funded by the U.S. EPA, the six years of research that went into the publication of the project sought to evaluate lining and coating technologies as an alternative to full replacement of LSLs and copper service lines (CSLs) and to make recommendations about which technologies to pursue.

"To accomplish these primary objectives, the investigators sought … to obtain and evaluate information on many different aspects of lining and coating," Cuppett said.

The researchers looked at each technology's effectiveness at preventing lead release and reducing tap water lead levels, their commercial availability, long-term effectiveness and durability, costs to property owners, and more.

The technologies that WRF reviewed were chosen based on their history of success, required installation and return-to-service time, impacts on flow rate and pressure, and the potential to minimize disruptions.

From there, the researchers gathered and reviewed reports on lining and coating water service lines, collected information from water utility personnel and consulting engineers, and collected data from manufacturers.

It may go without saying, but a critical conclusion of this effort was that the idea of lining LSLs is a valid one and that the practice may be a critical aspect of how our water providers combat rampant contamination problems.

"Lining or coating technologies can effectively reduce or eliminate the release of lead from LSLs and may be useful in reducing exposure to lead," Cuppett said. "Linings and coatings should be considered one of the tools in the toolbox when dealing with lead service line replacement issues."

Winning Solutions

The project identified three particularly promising lead-abatement technologies and suggests them as the best options for utilities.

"PET [polyethylene terephthalate] lining, epoxy coating, and polyurea/polyurethane coating are deemed especially promising and are therefore recommended for consideration," said Cuppett.

The research also yielded some recommendations for utilities thinking of applying the technology.

"During the planning process, public water systems should identify potential needs and/or opportunities for use of linings and coating to reduce short-term and/or long-term exposure to lead, such as avoiding disturbances of historic sites or structures, environmental damage, traffic disruption, and interference with or damage to other utilities," said Cuppett.

With so much buried infrastructure residing beneath private property, LSL replacement and rehabilitation programs will only be as effective as utility collaboration with the public will allow. Choosing a coating technology is only half the battle; the remaining half is establishing an effective consumer outreach effort.

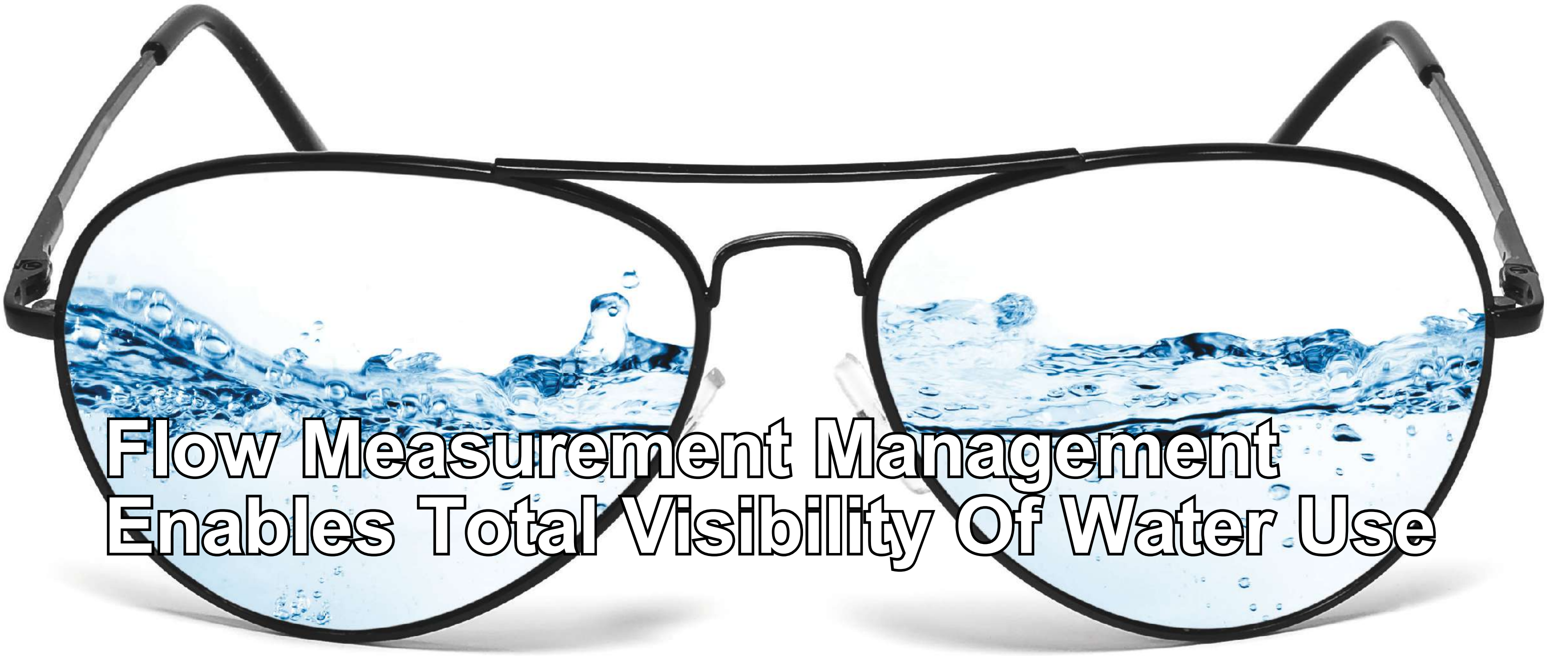
"Public outreach will be an extremely important means of informing consumers and property owners about their 'shared responsibility,' including financial responsibility for replacing privately owned portions of LSLs," according to the research report. "Public water systems should provide information for consumers and property owners that emphasizes the importance of shared responsibility for minimizing exposure to lead, engages them in the planning process for the service area, clearly informs them about plans and progress to date, recommends actions they can or should take, and starts a dialog about possible financing options."

Choosing a coating technology is only half the battle; the remaining half is establishing an effective consumer outreach effort.

Some utilities that can find the funding may decide that complete replacement is a better option, but for those that need to tackle lead contamination fast, without prolonged disruption of service, consider WRF's report. ■

About The Author

Peter Chawaga is the associate editor for *Water Online*. He creates and manages engaging and relevant content on a variety of water and wastewater industry topics. Chawaga has worked as a reporter and editor in newsrooms throughout the country and holds a bachelor's degree in English and a minor in journalism. He can be reached at pchawaga@wateronline.com.



Flow Measurement Management Enables Total Visibility Of Water Use

Advancements in submetering and cloud-based data analytics help reduce consumption, lower costs, and improve operational efficiency.

By Robert J. Fehl

Today, there is an urgent demand for accountability and water conservation. To meet these challenges, facility owners need more data — intelligent data. And they need it delivered quickly.

This article describes solutions for total visibility of water use at commercial and industrial sites. The latest technology advancements in submetering, including flow measurement dashboards and cloud-based analytics, provide the means to ensure proactive leak detection and detailed consumption information, conserve resources, reduce lost water, and improve operational efficiency.

Due to climate change and population growth, there is a critical need to use water more efficiently.

Introduction

Water is an essential substance in the modern world. It is used for heating, ventilation, and air conditioning (HVAC) systems, manufacturing, irrigation, sanitation, and more. However, there is a common misperception that water supplies are abundant thanks to plentiful precipitation and that storage is unlimited. Due to climate change and population growth, there is a critical need to use water more efficiently.

Studies have shown that global water demand will increase 55 percent by 2050.[1] For this reason, national and local governments are mandating strict water conservation measures. For example, U.S. government agencies must reduce their potable water consumption by 2 percent yearly through 2020 over their 2007 baseline.[2] The State of California has enacted a 20 percent reduction in water use by 2020 over its 2005 baseline.[3]

According to a recent United Nations report, up to 65 percent of reduction in water and energy use is possible in some American cities via efficient water appliances, leak reduction, and use of dry landscaping.[4]

Importance Of Submetering

Fast, easy access to powerful water-use information is imperative for organizations of all sizes. In fact, increasing government regulations, natural resource scarcity, emerging environmental concerns, and growing cultural awareness make it essential.

Most facility owners/managers are interested in reducing water consumption on their properties, although they lack information on how to accomplish the desired reductions and — particularly at the smaller facilities — the time to develop and maintain efficient systems.

With increased water rates in many regions, commercial and industrial sites are motivated to reduce usage levels and, at the same time, identify leaks and equipment malfunctions. They

Commercial and industrial sites are motivated to reduce usage levels and, at the same time, identify leaks and equipment malfunctions.

require accurate systems to assess overall water consumption patterns and help identify areas for improvement and water-efficient best practices. These efforts can contribute to the broader sustainability goals of an organization.

With traditional submetering, water supplied to a facility or property first goes through the primary meter (also known as the master meter), which measures and provides information on the total volume of water consumption. The limitation of a master meter is that it does not reveal how much and where water is consumed within the location.

In some cases, submeters are installed to measure the consumption of specific, water-intensive fixtures such as boilers and irrigation systems. This approach allows facility owners and/or managers to collect the water consumption data of each fixture on their property and thus identify water conservation opportunities.

However, large properties, such as buildings, resorts, and factories, can present unique submetering and cost-recovery challenges. The common barriers to this technique include:

- Installation cost and high, recurring maintenance expenses
- Monthly service charge for specialized assistance with meter reading and allocation
- Regulatory issues involving permits, inspections, and fees for submetering equipment
- Liability concerns related to system malfunction, leaks, etc.

Despite these issues, there are significant incentives for implementing an effective submetering solution. Submetering throughout a facility, property, or campus empowers everyone from management to operations staff to make more knowledgeable decisions for more efficient use of valuable fluid resources. It can help facility management address both corporate sustainability goals and rising water costs by monitoring usage levels and implementing water-saving changes to their operations (see Figure 1).

Latest Technology Developments

Submetering is normally the best way to get a handle on water consumption. While simply installing submeters is effective alone, using advanced water data management technology can quickly optimize any submetering program, making current, exact usage data available to appropriate stakeholders. This, in turn, can reduce water consumption by:

- Raising awareness of how much water is consumed over time
- Ensuring compliance with local water usage restrictions
- Stemming waste from malfunctioning systems

By providing facility managers with real-time, automatically generated data, cloud-based software solutions can make monitoring, billing, and reducing water use far easier than with traditional, manual submetering systems. The latest metering systems can analyze consumption on a real-time basis, making it simple not only to track where and when small leaks occur, but also to track patterns of water consumption. In either instance, it allows facilities to be more proactive in addressing consumption-related issues.

The current generation of web-enabled flow measurement management system packages advanced software with proven flow measurement technologies and leverages existing cellular network infrastructure for improving management of facility water resources, including domestic hot and cold water, irrigation systems, recreational usage, tenant submetering, HVAC systems, etc. Users often integrate the software platform with other operations and process systems via an application programming interface (API), utilizing secure encryption to ensure data is reliably transmitted and received.

Advancements in targeted metering analytics bring new optimizing information to light and put interval meter data to work to address requirements for actionable intelligence and improved operations. New analytic tools offer an overview of the water system through a standard web browser and provide robust status and trend information.

The latest end-to-end software solutions include an integrated "dashboard" format with key performance indicators (KPIs) to provide displays, graphs, and charts with crucial data. In addition to delivering fully time-synchronized reads on water consumption, they can generate immediate priority alarms for minor and major flow events, as well as continuous leaks. O&M (operations and maintenance) personnel can view and track water usage online via a computer or mobile device. System displays provide analytics and graphs that incorporate historical data, such as temperature and rainfall overlays, to create a clear picture of how water is currently being used throughout the facility.

Intelligent data and analytics applications also empower users at various levels of an organization to identify and quickly address flow inefficiencies, equipment problems, or wasteful

With increased water rates in many regions, commercial and industrial sites are motivated to reduce usage levels and, at the same time, identify leaks and equipment malfunctions.

behaviors. Their data tools make detailed consumption statistics easily accessible, enabling fast response to inquiries and quick resolution of issues.

Finally, the use of cellular endpoints minimizes the need for complicated infrastructure. Such endpoints may be set up to automatically broadcast meter-reading and event data to system software on a predetermined schedule. This information helps identify potential anomalies in water use. Alert conditions can even be created to monitor and notify users of system exceptions, including continuous flow for faster leak detection. Facility operators are able to determine the number and percentage of endpoints reporting with and without issues, as well as view a list of endpoints with reported issues.

Benefits To Facility Owners

The submetering of commercial and industrial sites, through the refined measurement of water usage, provides the O&M transparency necessary for more efficient management of valuable resources. Furthermore, submetering has proven to drive behavioral change related to conservation efforts. Each of these potential benefits can dramatically improve operational efficiency and sustainability and lead to significantly decreased consumption levels.

For facility owners and managers, a detailed record of water system performance data is useful to not only detect malfunctions, but also to focus future design and retrofit activities on the most cost-effective improvements.

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The specific benefits of deploying advanced submetering technology include:

- Fast leak detection
- Identification of problematic equipment
- Cost reduction via efficiency gains
- Recognition and correction of wasteful behaviors
- Reduction of risk and liability of major leaks

The new breed of flow measurement management systems allows facilities to manage, monitor, and troubleshoot a variety of field-based assets via any web-enabled device while storing data in a cloud-based data warehouse. By integrating remote management, flow measurement, and leak detection capabilities, they are able to provide a comprehensive water management capability for facilities' professionals.

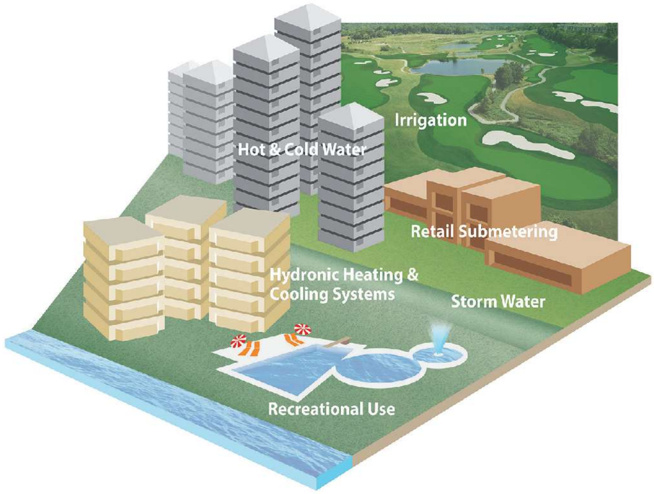

Figure 1. Submetering can address both corporate sustainability goals and rising water costs by monitoring usage levels and implementing water-saving changes to operations.

Conclusion

Water submetering at commercial and industrial sites represents an important first step toward quantifying over time the point sources that can drive resource efficiency and conservation activities. It is an enabling technology with significant potential value in new design or upgrading existing facilities.

Today's advanced, cloud-based software solutions are a valuable tool for supplying facilities with real-time water performance data, highlighting variations over time or in comparison to other facilities, providing accurate and real-time information to automation systems, and supporting behavioral and operational changes by facility operators and occupants. ■

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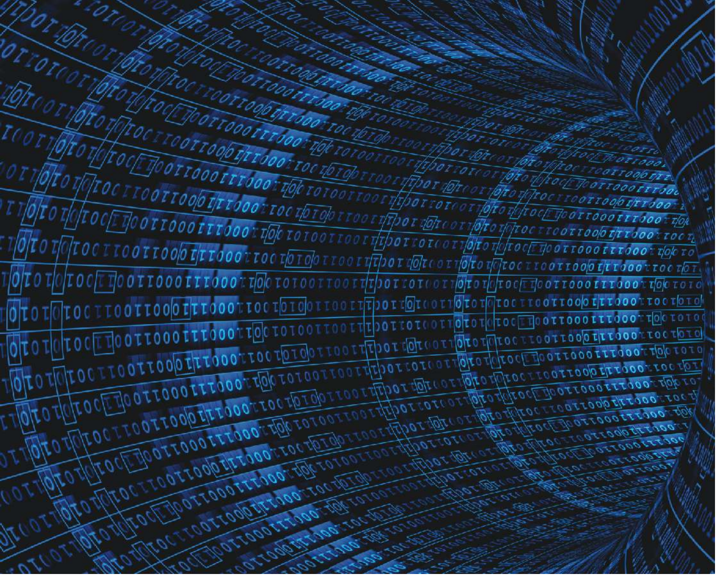
About The Author

Rob Fehl represents The Water Council — a nonprofit collaborative between public, private, and academic sectors that drives economic, technology, and talent development in the water industry — through his work at member company Badger Meter, Inc. Rob began his career at Badger in 1991 and is now marketing product manager for the commercial and industrial product line. He earned an associate's degree in mechanical design from Waukesha County Technical College, as well as business and engineering training from the University of Wisconsin-Milwaukee and the Milwaukee School of Engineering.



How To Use Big Data To Plan For Sewer Assets

As wastewater systems have access to more data than ever, questions remain about how to put it all to good use. A new tool uses analytics to predict the needs of sewer lines over a 20-year span, helping utilities make cost-effective choices and protect their infrastructure.

By Peter Chawaga

We are living in a world of Big Data.

Everything from shopping preferences to lifestyle habits is being recorded on some level, with that information collected and put to use in all kinds of ways. It's a trend that may make many of us uncomfortable and others feel better served, but it is one that is not going away. It's something that the country's water and wastewater systems have to work to embrace.

The 2017 *Water Industry Report* from global engineering and consulting firm Black & Veatch reveals the treatment industry has done their part to collect data but has been too slow to put it to good use.

"Water and wastewater systems are increasingly outfitted with data-producing instruments, but that information is too often siloed or out of sight, like much of the infrastructure itself," Black & Veatch reported.

Putting Big Data To Work

It's an issue that engineering firm AECOM is helping wastewater systems address. Working with software provider SEAMS, it has introduced an Enterprise Decision Analytics (EDA) tool that can model the future condition of sewer lines, predicting necessary interventions, costs, and performance over a 20-year period against a number of business and regulatory drivers. It's a way for utilities to make better use of the data that is collected through instrumentation and in the field.

"Effectively, it uses data trends from asset condition, failures, and consequences to predict consecutive years of failures," said Andy Gibson, AECOM's technical practice leader for wastewater networks planning in Australia and New Zealand.

The software can provide proactive intervention options, characterized by their predicted effects, costs, and applicability for different assets. EDA uses various algorithms to find the most cost-effective combination of these interventions. It provides utilities with a range of options, allowing them to choose the long-term strategy that most closely aligns with customer, regulatory, and business drivers.

"It is all about planning future operational, maintenance, and capital budgets and then figuring out how to maximize the level of service provided by the sewers and minimizing risk of failure," Gibson said. "There is lots of risk with deferring work because you can generate an expenditure peak in the future through many assets reaching the end of their life (and failing) at the same time. There is some truth in the saying, 'a stitch in time saves nine.' It is much better to manage critical assets effectively, through proactive intervention, and understand the relationship between pipe material, age, and pipe failure."

The tool was developed to help utilities in the U.K. meet a national regulatory requirement that calls for precise budget determinations well before anything actually breaks. To help them predict budgetary requirements as accurately as possible, a better method for predicting pipe rehabilitation was needed.

"Underground wastewater infrastructure is always a challenge to manage, given that we can't see it, and surveying pipe condition is expensive," said Gibson. "Therefore, we need these tools to help us optimize the 'where, when, and how' in terms of pipe rehab and replacement. Our tools maximize cost-efficiency and minimize risk at each time step for each asset."

EDA is just one powerful instance of what drinking water and wastewater systems could do if they focused on using the data available to them to improve operations.

"Big Data is not new for water utilities. They have been gathering data at 1-minute intervals for at least the past 30 years in some instances," Gibson said. "As leaders in the industry, we have access to innovative technology practices and, combining this with available data and a strong technical team, can support our clients in making optimized, data-driven decisions in infrastructure investment."

'Iconic' Data Actualization

The benefits of EDA were recently realized by Icon Water, a public drinking water and wastewater utility in Australia. It used EDA to predict pipe condition transition over time, improving blockage rates and engaging customers on the relationship between service and pricing. "The entire system was assessed and a 10-year tactical plan developed," said Gibson. "I can say that [savings] are significant when compared to total expenditure."

When asked how other utilities could make best use of the tool and analytical projections in general, Gibson offers a few tips. Don't get hung up on data, he said, because it will never be perfect. Rather, start looking at analytics and use what you see to drive and improve the collection process. He also recommended looking at large data sets from other regions, as these can shed some insight into a local issue if calibrated the right way. Finally, he urged systems to walk before they run, establishing a sound framework around Big Data collection and its use before attempting an ambitious project.

"Analytics will find relationships between data that humans can't," Gibson said. "We are biased in our decision-making. Math isn't." ■

About The Author

Peter Chawaga is the associate editor for *Water Online*. He creates and manages engaging and relevant content on a variety of water and wastewater industry topics. Chawaga has worked as a reporter and editor in newsrooms throughout the country and holds a bachelor's degree in English and a minor in journalism. He can be reached at pchawaga@wateronline.com.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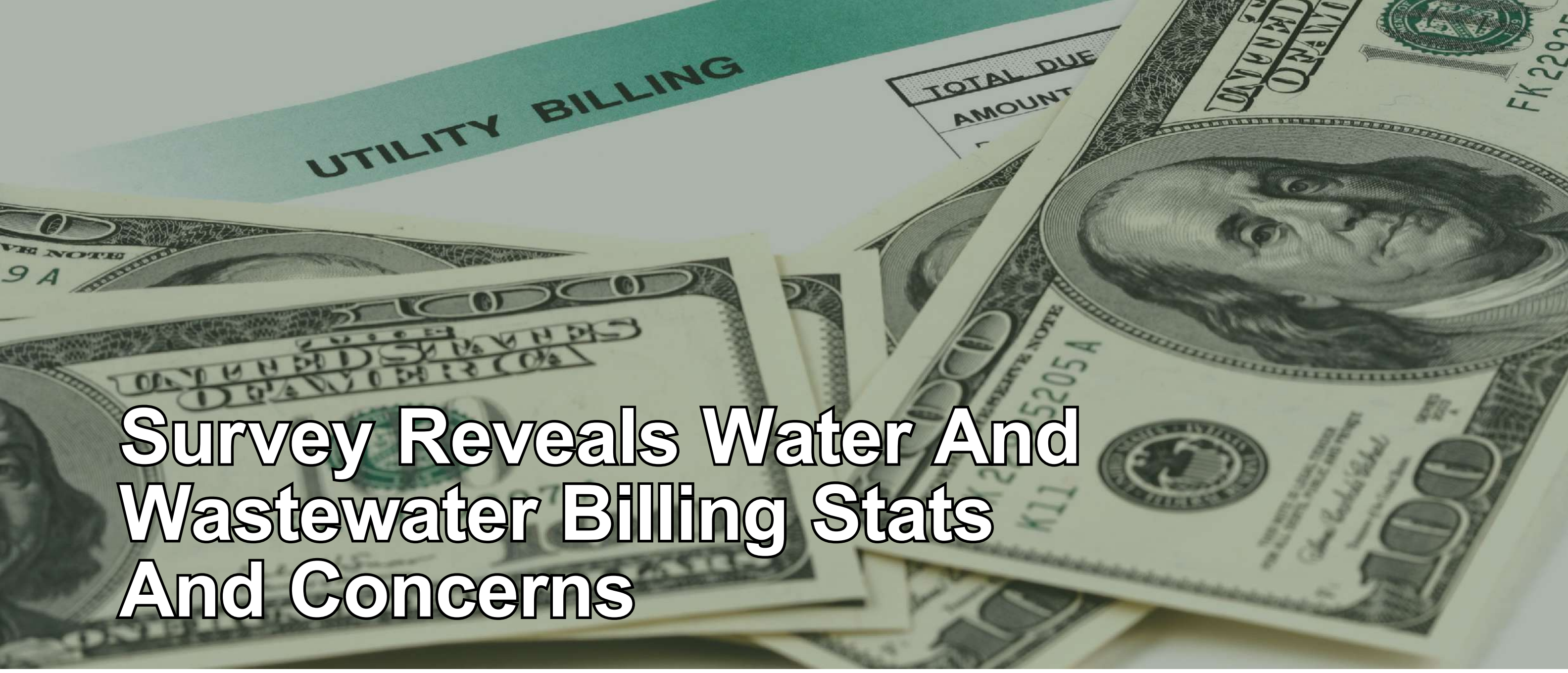


Survey Reveals Water And Wastewater Billing Stats And Concerns

With infrastructure reliability on the brink, utilities are forced to raise rates to fund improvements. It's not a move that is undertaken lightly, nor should it be. The latest AWWA rate survey, produced with Raftelis Financial Consultants, highlights the plight of both utilities and consumers.

By Rocky Craley and Catherine Carter

Clean water represents one of the most basic and essential human needs. When setting rates, utility financial professionals have a lot on their minds — meeting debt service requirements, ensuring sufficient funds to support operations and maintenance needs, and building reserves for future activities. Unfortunately, the infrastructure costs associated with providing water service have increased substantially over the last 50 years, causing increases to water rates and ultimately customer bills. In considering the utility's pricing objectives, however, ensuring adequate revenues to support water service is increasingly causing affordability concerns for residents.

This article utilizes the results of the 2016 Water and Wastewater Rate Survey (Rate Survey) and previous surveys to consider how utilities have responded to the tension between revenue sufficiency and affordability. Beginning with a longitudinal look at water and wastewater rate and bill trends, rates have increased nationally and regionally at a rate greater than the Consumer Price Index (CPI). From there, the authors explore current day drivers, such as affordability, and discuss the potential customer impacts of the ever-increasing water bills. These trends will be considered within the contexts of both geographic regions and utility size.

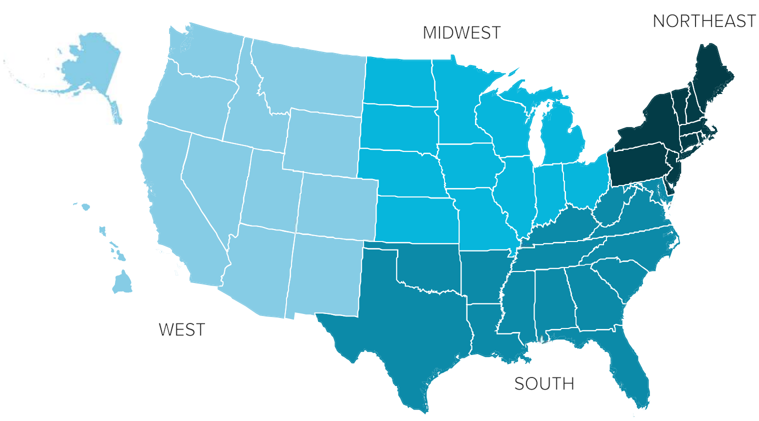


Figure 1. Regions included in the 2016 Water and Wastewater Rate Survey

Data Source

Using rate data from the biennial Rate Survey, which has been coproduced by the American Water Works Association (AWWA) and Raftelis Financial Consultants, Inc. (Raftelis) since 2004, this article considers rate trends on both the national and regional level. The Rate Survey series is one of the most recognized compendiums in the industry and provides information on utility characteristics and charges for a diverse and meaningful sample of U.S. urban, suburban, and rural systems. Analyzing rate trends at a regional level helps utilities to identify appropriate peer organizations, in terms of size, geography, regulatory requirements, and other factors, which ultimately provides a higher-quality comparison. The regions included in this analysis are defined in Figure 1.

The Rate Survey series also categorizes water utilities by size into three groupings: Group A, which includes utilities with water sales of more than 75 MGD; Group B, which includes utilities with water sales of between 20 and 75 MGD; and Group C, which includes utilities with water sales of up to 20 MGD.

National And Regional Rate Trends

Water rates are trending upwards on both the regional and national scale. Rates have increased across the board since 2006, and the magnitude of rate increases tends to outpace the CPI. Figure 2 demonstrates the annual increase for a typical residential customer in national and regional rates. Rate changes represent rate increases from 2006 to 2016, based on the change in median monthly bills for residential customers with 5/8" meters and monthly consumption of 1,000 cubic feet of water. Figure 2 shows rates in the West have changed the most by percent (an increase of 117 percent between 2006 and 2016), while rates in the Northeast have increased the least by percent (an increase of 28 percent between 2006 and 2016). For reference, the CPI increased by 19 percent during this timeframe.

Water rates are also trending up for utilities of all sizes. Figure 3 demonstrates the trend of median monthly bills by utility size.

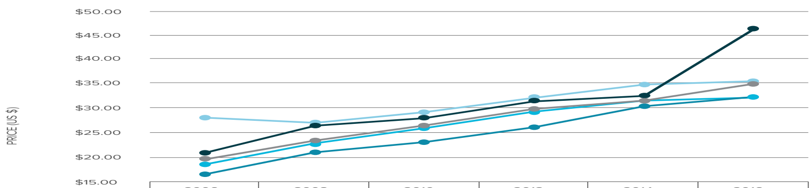
Water Bill Affordability By Region

The median household income (MHI) by utility size tends to be less variable than the regional MHI, with a range of only approximately $3,000 between the highest income systems (Group B), and the lowest income systems (Group A) in 2016. However, as demonstrated in Figure 5, in 2016, individuals getting bills from the smallest water systems (Group C) paid approximately 33 percent more as a percentage of their income than did those receiving bills from midsize systems. In fact, the midsize utility systems have been the most affordable at the median income level for the last decade.

Interestingly, not only do Group C utilities pay the highest percentage of their income for water bills, but almost 15 percent of the Group C utilities already exceed, or are more than 75 percent of the way to, the EPA's 2 percent affordability threshold. None of the Group A systems and only 1 percent of the Group B systems are this close to the threshold. This disparity is likely due to economies of scale. Utilities tend to have high fixed costs associated with operating, debt service, and capital improvement programs. Smaller systems have fewer accounts to spread these costs among.

Discussion

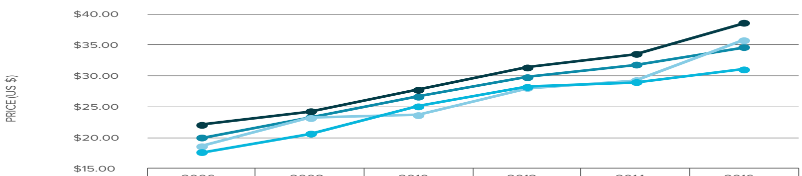
Water rates are increasing in all regions and for all sizes of utilities. However, despite having outpaced the CPI for the last 10 years,



	2006	2008	2010	2012	2014	2016
NORTHEAST	$27.29	$26.88	$29.22	$31.70	$34.72	$34.92
MIDWEST	$16.62	$20.83	$23.20	$25.68	$30.35	$32.48
SOUTH	$18.79	$22.40	$25.85	$29.46	$31.88	$32.42
WEST	$21.22	$26.02	$28.24	$31.47	$32.81	$46.13
NATIONAL	$19.94	$23.26	$26.65	$29.82	$31.79	$34.61

NORTHEAST MIDWEST SOUTH WEST NATIONAL

Figure 2. Water rate change of median typical residential customer bill by region



	2006	2008	2010	2012	2014	2016
All Groups	$19.94	$23.26	$26.65	$29.82	$31.79	$34.61
Group A	$18.60	$23.23	$23.67	$27.99	$29.31	$35.84
Group B	$17.58	$20.60	$25.11	$28.22	$28.93	$31.09
Group C	$22.13	$24.22	$27.80	$31.42	$33.54	$38.56

ALL GROUPS GROUP A GROUP B GROUP C

Figure 3. Water rate change of median typical residential customer bill by utility size

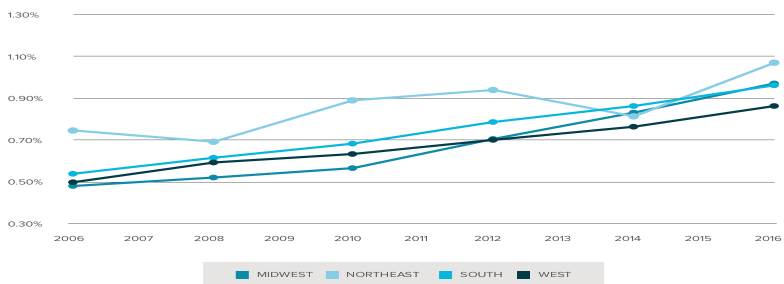


Figure 4. Median water bill to MHI, by region

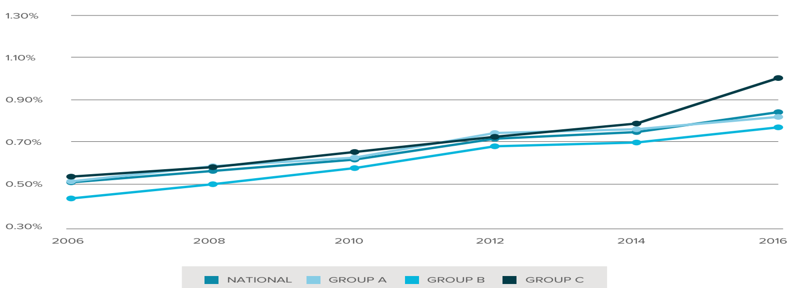


Figure 5. Median water bill to MHI, by utility size

water bills still represent only approximately 1 percent of most customers' incomes. Customers of western utilities or midsize utilities tend to spend slightly lower percentages of their incomes on water bills, while customers of northeastern or small utilities tend to spend slightly higher percentages of their income. These trends have been reasonably consistent for the last 10 years, leading the authors to conclude that water service in the U.S. is affordable, based on the 2 percent of MHI threshold established by the EPA.

While this is a positive finding, by definition, 50 percent of participating utilities have water bill-to-MHI ratios that are higher than those shown in Figures 4 and 5. For approximately 3 percent of the survey respondents, water bills already meet or exceed the EPA's affordability threshold, and another 5 percent of survey respondents are more than three-quarters of the way to the threshold. This is problematic and compounded because 50 percent of individuals have incomes less than the MHI, which drives the water bill as a percentage of income well above the EPA's recommended 2 percent. For low-income individuals or families, water service has already hit an unaffordable level in many utility service areas.

Many utilities are aware of the challenges faced by low-income individuals in obtaining affordable water service and have put programs in place to assist customers with their water bills. Some examples include payment programs, bill round-ups, low-income or elderly discounts, and partnerships with local or regional nonprofits. Given that water rates are likely to continue to rise due to necessary infrastructure investments, utilities may need to increase their efforts to ensure affordable service to all members of their communities. ■

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About The Authors

Rocky Craley joined Raftelis in 2008 and currently serves as a project manager. He specializes in water, wastewater, and stormwater finance, with a focus on financial forecasting, cost of service, and rate structure design. Additionally, Mr. Craley also manages Raftelis' many survey efforts, including the biennial national Water and Wastewater Rate Survey coproduced with AWWA and the INSIGHT Survey produced by AMWA. He is a contributing author for the Fourth Edition of the industry guidebook, *Water and Wastewater Finance and Pricing: The Changing Landscape*, and for the upcoming update of WEF's *Financing and Charges for Wastewater Systems, Manual of Practice 27.*

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