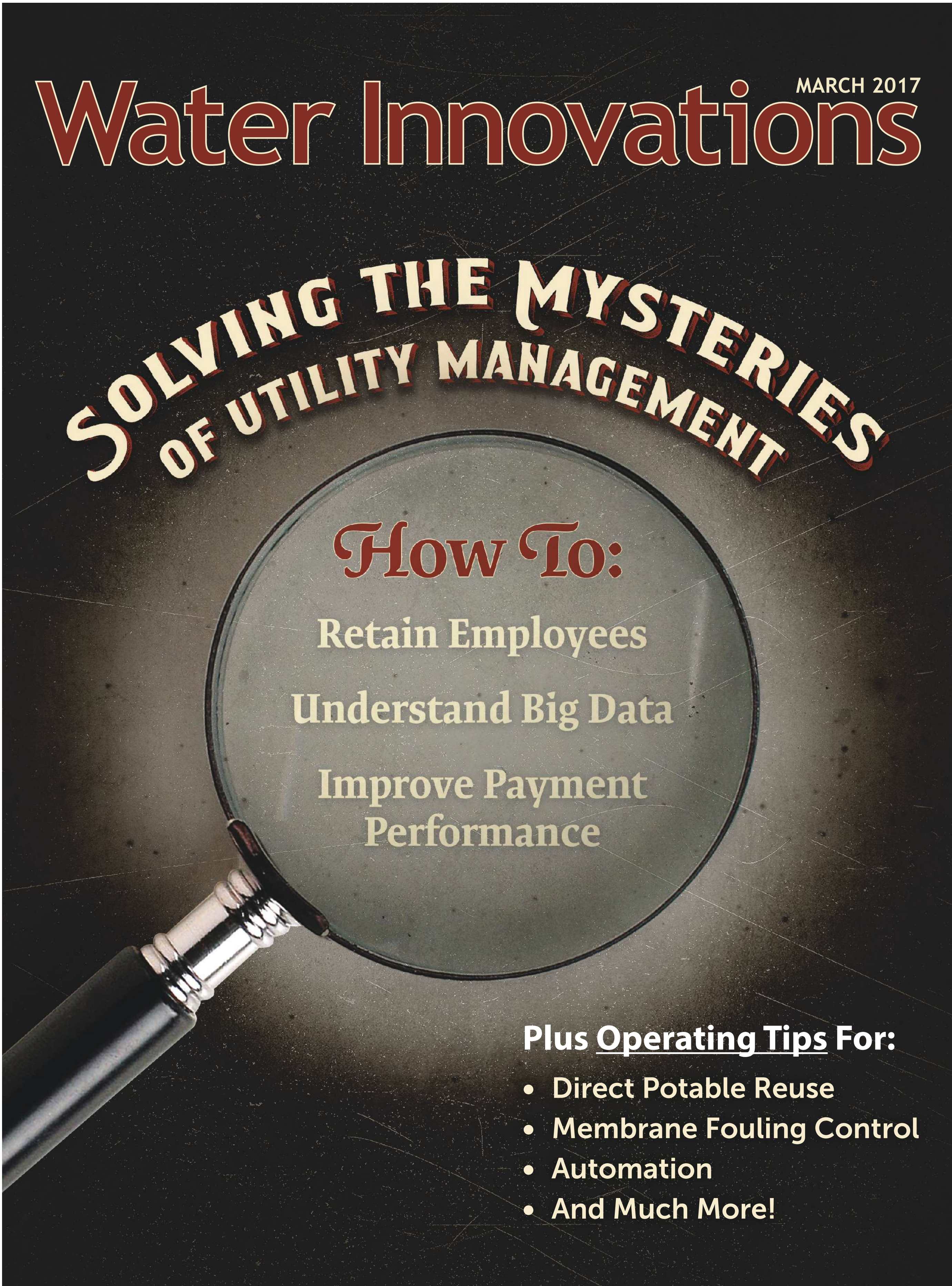
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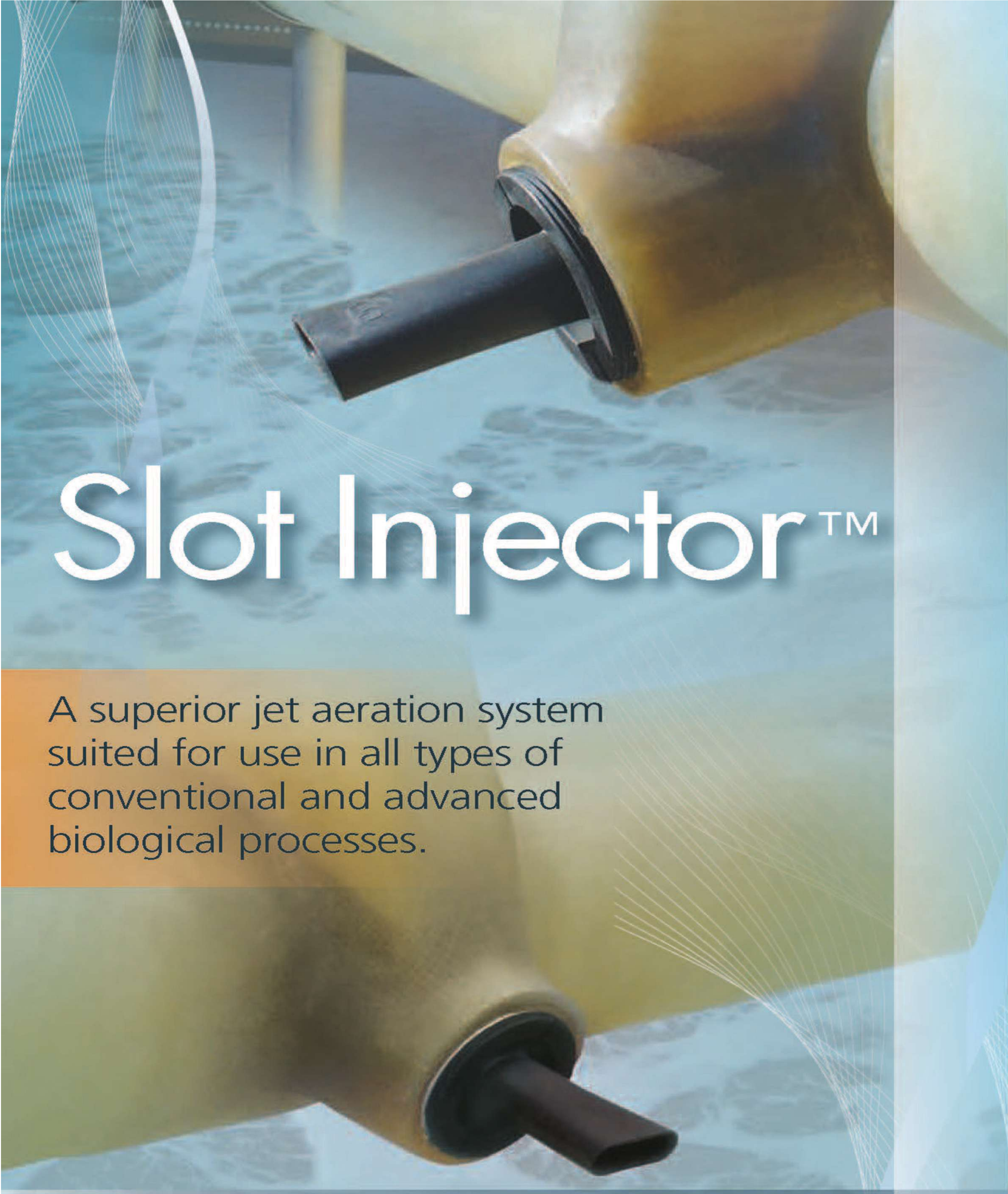

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EDITOR'S LETTER

By Kevin Westerling
Chief Editor, editor@wateronline.com

Making America's Water Utilities Great

This January, a national leader emerged with a plan to shake up the status quo, touting a "business" approach to rectify historic "inadequacies" of our system. And we should all be on board with the plan, because it means potentially great things for the water and wastewater industry.

That leader, of course, is George Hawkins (who else?), general manager and CEO of the District of Columbia Water and Sewer Authority (DC Water). And the plan is Blue Drop.

What Is Blue Drop?

A spinoff of DC Water, Blue Drop is a nonprofit organization that markets its biosolids soil amendment product, as well as consulting and "shared" services, to help finance DC Water operations, thereby reducing the need for rate hikes. Meanwhile, fellow utilities benefit from services honed through DC Water's scale of operation and its evolution from ambitious early adopter to expert practitioner of innovative ideas — an evolution that ratepayers financed in the first place. Blue Drop, then, is a cyclical and symbiotic venture. As Hawkins stated:

For me, developing a "business" model for a public agency that can generate significant revenue from the technology, skills, and experience that have been developed at ratepayer expense is a critical element of a structural response to the inadequacies of the historic public utility model. I do think we have a very special moment to do something unique at DC Water and have the potential of providing real relief to our ratepayers while simultaneously advancing this industry.

Hawkins also noted that DC Water isn't the first utility to do this. That distinction belongs to Clean Water Services outside of Portland, OR, and its nonprofit offshoot called the Clean Water Institute, which provides expertise in resource recovery, watershed management, and organization strategies. It's a model that can and should be duplicated whenever possible, wherever leading-edge utilities can package their abilities to benefit their own ratepayers, their peers in water and wastewater management, and the communities and environments they look after. Blue Drop does this through the following goods and services.

When much-needed services can't be adequately fulfilled by smaller utilities with tight budgets, shared services can fill the gaps.

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101 Gibraltar Road, Suite 100
Horsham, PA 19044
PH: (215) 675-1800
FX: (814) 899-5587
Email: info@wateronline.com
Website: www.wateronline.com

CHIEF EDITOR
Kevin Westerling
(215) 675-1800 ext. 120
kwesterling@vertmarkets.com

PUBLISHER
Travis Kennedy
(215) 675-1800 ext. 122
tkennedy@vertmarkets.com

ASSOCIATE PUBLISHER
Patrick Gallagher
(215) 675-1800 ext. 129
pgallagher@vertmarkets.com

PRODUCT MANAGER
Bill King
(215) 675-1800 ext. 100
bking@vertmarkets.com

MANAGING EDITOR
Angel Clark
(814) 897-9000 ext. 285
aclark@vertmarkets.com

PRODUCTION DIRECTOR
Lynn Netkowicz
(814) 897-9000 ext. 205
lnetkowicz@vertmarkets.com

PRODUCTION MANAGER
Susan Day
(215) 675-1800 ext. 101
sday@vertmarkets.com

DIRECTOR OF AUDIENCE DEVELOPMENT
Martin Zapolski
(814) 897-7700 ext. 337
mzapolski@vertmarkets.com

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George Hawkins (center), DC Water's CEO/general manager and chairperson of the Blue Drop board of directors, with Blue Drop President Alan Heymann and Vice President Gloria Cadavid

Bloom Soil Amendment

Bloom is a Class A U.S. EPA-certified Exceptional Quality (EQ) biosolid, suitable for commercial soil blending, landscaping, and urban gardening, created through the Cambi thermal hydrolysis process (THP). DC Water was the first North American utility to adopt this brand of THP (from Cambi, a Norwegian company), which "pressure cooks" sludge to generate higher biogas yields for cogeneration while decreasing sludge volume and hauling costs. Importantly for Blue Drop, the pathogen-free byproduct is a nutrient-rich, moisture-retaining, and weed-resistant soil amendment. Bloom also saves energy and reduces carbon emissions better than conventional petroleum-based fertilizers.

Consulting Services

Blue Drop offers four types of peer-to-peer consulting services. The first, ***stakeholder engagement***, counsels utilities on how to "Seize an emotional connection with your customers." As utilities are forced to raise rates and close roads to fix failing infrastructure, public support becomes increasingly important and yet harder to earn. Winning it starts with a plan and is carried out through caring and responsive communication, both from afar (e.g., social media, telephone) and in person through community events. DC Water launched its very successful community outreach campaign in 2010, and if you've ever had the chance to hear George Hawkins speak, you understand effective utility communication.

While it starts at the top (à la Hawkins), ***utility leadership*** is critical throughout the workforce. Attracting and inspiring employees to serve what DC Water calls the "mission of public health and environmental protection," in addition to earning support from regulators and political leaders, is an asset that Blue Drop, by leaning on DC Water's own experience, can help others to cultivate.

The experience and organizational know-how that allows DC Water to efficiently manage 600 vehicles has also equipped Blue Drop to consult on ***fleet operations***, with instruction for acquisition and disposal, program management, and integration of fleet technology.

Finally, and perhaps most critically, Blue Drop offers consulting on ***emergency management/security services***, which prepares utilities for accidents, natural disasters, and terrorist attacks. Serving 15 million or so people in and around the nation's capital, DC Water is obviously well versed on the topic.

Shared Services

Because DC Water works at such a huge scale and with abundant resources — uncommon among its peers — Blue Drop can extend those resources to other utilities. Fleet management and emergency response services are available, as are technology solutions and third-party applications. When much-needed services can't be adequately fulfilled by smaller utilities with tight budgets, shared services can fill the gaps. And, sometimes, it's simply cheaper to lease than to own.

To be on DC Water's side of the equation (making the money), it begins with a question: "What do you do so well that other utilities would pay you for it?" If you don't yet have an answer, Hawkins has your starting point. "Focusing relentlessly on improving within was/is the critical first step," he stated upon announcing Blue Drop, adding "Now, off to the races. ..."

DC Water has always been ahead of the pack, but now that leadership position is being used to benefit and inspire fellow utilities.

Great leaders make others great.

Construction Management At Risk: Rebuilding Infrastructure Through Collaboration

What's so great about construction management at risk (CMAR)? The story of Fremont, OH – and a description of four key CMAR benefits – sheds light on the alternative delivery method.

By Blair Lavoie

Substantial reductions in state and federal funding for public infrastructure projects is the new reality facing municipalities and utilities across the country. At the same time, aging infrastructure continues to be a key topic for municipal leaders and remains a critical concern for communities and residents. In fact, according to a 2016 survey from MWH Global, now part of Stantec, 35 percent of Americans think that their community's current water infrastructure will last less than five years. With the need for updates and rebuilds to major infrastructure projects, many communities and utilities are looking for new options to help with funding and building.

The construction management at risk (CMAR) delivery method has become a go-to choice for large-scale infrastructure projects thanks to start-to-finish collaboration between the agency/owner, the design firm, and the CMAR firm. Using this efficient and cost-effective method, the CMAR firm serves as a consultant during the design phase, then acts as the general contractor during the construction phase.

The Challenge: City Of Fremont, OH

The city of Fremont, located in rural northwest Ohio, turned to the CMAR approach when it faced aging water infrastructure along with financial constraints and federal compliance requirements. The Sandusky River, which travels through the heart of the city before emptying into Lake Erie, has important recreation and economic value to the community and is a spawning area for Lake Erie walleye game fish. It's also the source for Fremont's drinking water and the destination for its treated wastewater and combined sewer overflow (CSO) discharges.

Fremont relied on an aging and increasingly ineffective wastewater and stormwater collection system with many sections originally constructed more than 100 years ago. The city-owned wastewater treatment plant, the Water Pollution Control Center (WPCC), was constructed in 1949, with the last significant upgrade in 1988. This combined sewer system conveys dry weather flow to the WPCC at approximately 6 MGD. The plant was sized to effectively process the dry weather flow, but during heavy rain or snowmelt the combined raw sewage and stormwater volume far exceeded the collection system and plant capacities, causing a regular overflow of this discharge into the Sandusky River. This occurred 70 times in 2013 alone.

Pollutants from these CSO discharges can include bacteria and other pathogens, organic loading, solids, floatable debris, and nutrients. Yearly summer algae blooms in Lake Erie fed by farm runoff and nutrients released from the aging wastewater collection and treatment systems were identified as a significant environmental threat.

Under the Clean Water Act, the U.S. EPA issued a policy in 1994 requiring municipalities to make improvements to reduce or eliminate this type of CSO-related pollution. The implementation and enforcement of this policy was furthered by the National Pollutant Discharge Elimination System (NPDES) permit program administered by state environmental agencies, including the Ohio EPA.

After years of sidestepping compliance, in 2012, Fremont was required to take action by state and federal agencies imposing NPDES discharge permit requirements that the liquids treatment phase of the WPCC be rebuilt by the end of 2015 and other costly long-term control plan improvements to the collection system be completed by 2028. Because no long-term asset management plan for water and sewer systems had previously been developed, Fremont faced a number of hurdles.

For Fremont's leaders, paying for the project was a significant challenge. The diminished presence of manufacturing companies — a previous driver of the local economy — had negatively impacted Fremont's income tax base, which once helped subsidize water and sewer operations. State allocations for infrastructure projects had also been reduced substantially. To further complicate funding, Fremont's construction of a new reservoir to store water taken from the Sandusky River went tens of millions of dollars over the initial project budget by the time it was completed in 2012.

This situation required Fremont to implement a plan for substantial yearly increases in water and sewer rates for local residents, who have a median household income 30 percent below the state average. An Ohio EPA Sewer and Water Rate Survey showed a 20 percent increase in Fremont's annual residential water rates from 2010 to 2011 and a nearly 30 percent hike in sewer rates over the same period.

Expansion and enhancement of the WPCC became the focus for a newly elected city administration and city council. The project would become the largest public project ever undertaken by the city.

The Solution: Fremont Turns To CMAR

With just a couple of years to meet regulatory requirements and significant budget concerns, Fremont established project parameters for the WPCC:

1. It needed a construction management partner to oversee completion of the project from design through construction.
2. It wanted separate contracts to handle design and construction as a means to improve project oversight.
3. It wanted a procurement process that was quick and supported the selection of locally based subcontractors and suppliers.
4. It needed a guaranteed maximum price to avoid cost overruns.

The CMAR delivery method was identified as the best approach to meet the city's desired parameters. As compared to the more traditional design-bid-build delivery method, CMAR relies on close collaboration between the agency/owner, design firm, and construction firm, resulting in well-managed or reduced costs and timely project completion.

The CMAR method has become a go-to choice for large-scale infrastructure projects. In fact, within the last 10 years, 54 percent of all major water and wastewater project agency/owners are trying an alternative delivery method like CMAR. According to a survey by R.W. Beck, 96 percent of owners would select an alternative delivery method again.

Since 2011, most public authorities in Ohio, including municipal corporations, townships, school districts, and counties, are permitted to use the CMAR method for planning and constructing public works projects. Under state law, the CMAR contractor is selected in accordance with a competitive and open process based on the value they can bring to all phases of a project. The process is initiated with a broadly distributed request for qualifications (RFQ) and the application of a scoring process in reviewing proposals received from responding companies.

Key Benefits Of CMAR

As a result of the selection process, Fremont chose Colorado-based MWH Constructors (MWHC) as the CMAR contractor for the WPCC project. The benefits, which helped meet the overall project parameters, were:

- Greater transparency and collaboration between firms, leading to efficiencies in design and constructability reviews, cost tracking and development, value engineering, and sequencing and scheduling;
- Accelerated schedules and cost savings thanks to early input from the construction firm during the design phase; and
- Increased local economic impact by allowing participation from locally based vendors, consultants, designers, contractors, and labor.

Clarifier at Fremont's Water Pollution Control Center

Fremont's project success was largely due to a willingness among local officials to engage in the design and planning of the project and the development of a close working relationship with the design firm and MWHC. A few examples of how this was accomplished, including best practices and key learnings from the WPCC project, include the following:

"Open Book" Collaboration

The CMAR method fosters transparency with the procurement process and with cost expenditures. Communication is facilitated by the "open book" nature of the parties' relationship, whereby information concerning the costs, risks, and available design and material alternatives associated with the project are jointly known and managed by the parties throughout the project. Because the agency/owner, design firm, and CMAR contractor work in informed collaboration, the costs of project components are clearly determined and known by all parties. If the cost of a project component seems likely to increase, the CMAR contractor is in a better position to explain the reasons for the expenditure and offer alternatives that will meet the wants or needs of the agency/owner while minimizing a charge to the contingency built into the guaranteed maximum price (GMP).

Contract Cost

CMAR contractor proposals should include firm costs for preconstruction services and the administration of the construction phase of the project under a CMAR contract form that is being used for the project. There will also be a contingency amount and a contractor's fee typically expressed in percentages of the final construction costs. From this, the proposals will then include a projected overall project cost. Several states have forms that are required to be used so the information is presented in a uniform manner for the objective evaluation and ranking of proposals.

Procurement Planning

The procurement plan is an essential tool in the preconstruction phase, serving as a central source for managing project costs and reducing uncertainty in eventual negotiation of the GMP amendment(s). A well-developed plan will have a number of bid packages for the procurement of labor and materials. These packages are provided to subcontractor firms that have been prequalified by the CMAR contractor. It is a best practice, required under the law in several states, that if the CMAR contractor wishes to self-perform any work it must compete in the bidding process.

Cost Savings

Significant savings can be met when the CMAR firm participates in value engineering workshops, creates updated schedules and cost estimates, conducts constructability reviews, prepares all front-end bidding documents, and maintains regular communication with the entire project team. In the case of Fremont's WPCC project, this type of collaboration led to savings of $5.5 million during the design phase and more than $500,000 in the construction phase.

For example, one of the initial tasks for MWHC leaders was to use 30 percent of the design documents and create a projection of additional necessary work and project components to provide a construction cost estimate. From this work, it was determined that the project was going to be substantially more expensive than the $57 million project cost estimate. In response, further value engineering sessions with the agency/owner and design firm were conducted to adjust the design to lower the cost incurred at 60 percent and 90 percent of project design. This process yielded the cost savings noted above.

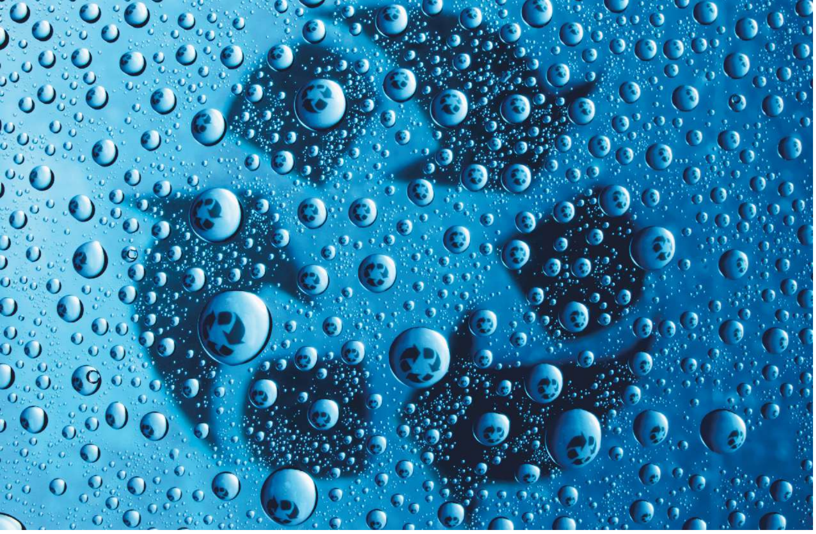
Another cost savings opportunity is the agency/owner's insistence that the CMAR contractor employ a quality control/quality assurance program (QC/QA) that requires input from the complete project team throughout the project. This allows a reduction in the scope of the design firm's construction phase services. Rather than the normal construction phase services, Fremont and the design firm developed a scope of work that supplemented the MWHC QC/QA program, while allowing the design firm to meet its legal responsibilities. Also, once construction commences, the CMAR contractor is constantly involved in the oversight of the subcontract companies, helping to manage costs and solve problems as they arise. For the city of Fremont, this collaborative approach produced a further savings of $1 million.

Conclusion

As with any project, a variety of factors influences the effectiveness of the CMAR method, including size, scope, timeliness, and the number of phases in a given project. As municipalities and utilities continue to face increasing pressure to address large-scale infrastructure projects, including upgrades, new builds, and renovations, CMAR has the potential to provide major benefits to budgets, schedules, and the local economy. ■

About The Author

Blair M. Lavoie is president of MWH Constructors, a subsidiary of MWH Global, now part of Stantec. With full responsibility for global operations, he is currently the principal-in-charge on more than $2 billion (USD) of construction management at risk (CMAR), design-build, and CM-as-agent projects in the U.S. Lavoie brings nearly 30 years of engineering and construction experience on a broad range of municipal, industrial, and federal projects. Prior to becoming president, he led the municipal division of MWH Constructors as the director of U.S. operations.



Overcoming Operations Challenges For Direct Potable Reuse

The Water Environment & Reuse Foundation introduces a "bundle of research" to help direct potable reuse and its practitioners reach full potential.

By Justin Mattingly

As communities in water-stressed regions look to pursue new and more sustainable water supplies, direct potable reuse (DPR) is expected to become an increasingly common option. DPR is the introduction of advanced treated water from a wastewater treatment facility directly into a drinking water treatment facility or distribution system without the use of an environmental buffer. The advanced treatment used in a DPR system will include processes such as reverse osmosis (RO) that are largely uncommon in conventional wastewater and drinking water facilities. Understanding how to manage these processes is a critical component for making DPR a reality.

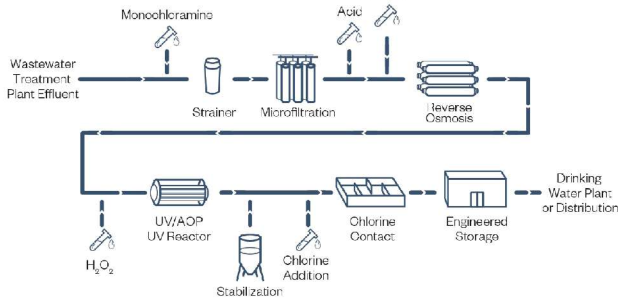
Recent research from the Water Environment & Reuse Foundation (WE&RF), led by Troy Walker and Dr. Ben Stanford of Hazen and Sawyer, breaks down the treatment trains expected to be part of DPR systems to identify the operational points of most importance, as well as strategies for effective maintenance (see below). This research is part of WE&RF's Direct Potable Reuse Initiative aimed at supporting efforts in California and elsewhere to advance DPR.

Safety First: Ensuring Water Quality

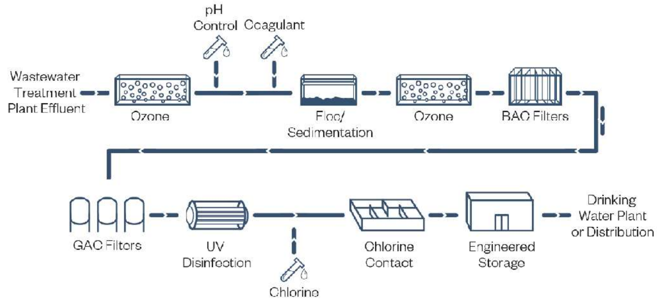
The first project in this bundle of research, *Critical Control Point Assessment to Quantify Robustness and Reliability of Multiple Treatment Barriers of a DPR Scheme* (Reuse-13-03), used the hazard analysis and critical control point (HACCP) method to identify the critical control points (CCPs) of two advanced treatment trains for DPR. Originally developed by the food industry, the HACCP method is a means of controlling microbial hazards. It is used to develop operational controls to detect and correct deviations in quality at the earliest possible opportunity before a health hazard occurs, which is accomplished through a focus on monitoring and maintaining the barriers of treatment, rather than on end-of-pipe sampling and testing.

For this research, a CCP is a point in a treatment process whereby controls to reduce, prevent, or eliminate process failure can be applied, and whereby monitoring is conducted to confirm that the control point is functioning correctly. The ozone-biological activated carbon (BAC) based treatment train is an example. Initially, BAC could not be considered a CCP because there was no control mechanism to adjust its ability to achieve pathogen reduction or contaminant removal. Yet, by modifying the process to incorporate a coagulation step ahead of filtration, BAC became a control point. BAC effectively reduced turbidity and hence levels of microorganism removal if operated as a biological filter. The HACCP method facilitated this decision, although it was straightforward from a process design and selection viewpoint.

On top of identifying the CCPs in DPR treatment trains, the robustness of those treatment processes was also evaluated. The researchers conducted a Monte Carlo simulation with full-scale data to model contaminant removals across the multiple barriers for both treatment trains studied. The two treatment trains exceeded the current California regulations for groundwater injection of 12-log removal of viruses, 10-log removal of *Cryptosporidium*, and 10-log removal of *Giardia*, the results confirmed. The only exception was removal of *Cryptosporidium* in ozone-BAC treatment. However, the processes in that treatment train could be further optimized within a specific facility to reach the removal targets. This research is clear in its determination that non-RO based treatment is adequate for removal of *Cryptosporidium*, bringing DPR another step closer to reality in many communities.



RO-based treatment train



Ozone-BAC treatment train

A third element of this research explored the reliability of monitoring systems for advanced treatment processes. Where there is risk that a critical process may fail, monitoring needs to be in place to inform operators of needed adjustments. The reliability of these monitors is a critical component of a DPR system to ensure that operators are aware of process upsets, ensuring that public health is not at risk. The results indicated that trace organic compound (TOC) analyzers have the highest risk for failure to measure the true value. It is notable that the TOC analyzers seem to have the highest risk of failure to provide an accurate measurement, but the disinfection processes and associated monitors had the greatest impact on potential risk. This is important, as it can help identify where calibration and verification need to be high-priority functions, and it may indicate where redundant monitors may provide additional security.

Ops Detail: Ensuring Operator Know-How

The second research project in this bundle, *Development of Operation and Maintenance Plan and Training and Certification Framework for Direct Potable Reuse Systems* (Reuse-13-13), looked at O&M protocols in DPR systems as well as operator training and certification programs. As previously mentioned, unlike conventional wastewater and drinking water treatment facilities, DPR facilities deploy a greater variety of advanced treatment processes. Because of greater public scrutiny of DPR, operators will have different requirements for performance, thereby necessitating the need for comprehensive training and operations procedures. To develop this operational framework, the researchers first completed a gap analysis to determine the important operational and maintenance requirements for integration into a permitting structure for DPR. They focused on California.

In California, current permitting practices for water reuse contain regulations regarding cross-connection control and backflow prevention to prevent contamination of potable water systems from wastewater and recycled water systems. The need for this is obvious, but because DPR purposely creates a link between recycled water and drinking water systems, changes are necessary. To help mitigate potential risks from this change, strong O&M safeguards need to be in place. Additionally, there will likely need to be modifications to source control programs to accommodate more impaired water sources, staffing and operator certifications, and monitoring and reporting requirements. In addition, while current regulations in California do not specifically address DPR, the California State Water Resources Control Board has released a final report stating that it is feasible to develop regulations for DPR. As California moves forward with criteria for these regulations, issues in O&M are expected to be addressed.

With the HACCP system already defined, the O&M framework developed in this second project takes the next step to define further the key elements required for successful operation. The elements include:

- integrating CCP monitoring parameters into SCADA systems,
- alert and alarm levels that trigger specific response procedures,
- assessment management practices to properly manage assets and protect the CCPs of a treatment train, and
- a DPR operations plan with
    - elements of occupational health and safety for operators,
    - recruitment and training of qualified staff, and
    - emergency management.

Case studies are also included in the final research report as examples of actual facilities that utilize advanced treatment processes.

The last element of this research is a recommended operator training and certification framework for DPR. Current certification programs typically target wastewater operators and drinking water operators. However, because DPR has elements of both wastewater and drinking water, operators in advanced treatment facilities do not explicitly fall into either category. In California, the focus of existing certification programs is on conventional wastewater and drinking water treatment trains. While this will be important for DPR operators, the programs do not address advanced treatment technologies such as membrane treatment or ozone in depth. There is certification in California for nonpotable water reuse, but it exists as a subset to wastewater requirements, and there are significant gaps. Having training on advanced treatment processes available to operators will help overcome these gaps and further facilitate implementation of DPR.

For most existing indirect potable reuse facilities that employ advanced treatment processes, facilities have operators with a combination of wastewater and drinking water certifications along with supplemental training provided for specific processes. For example, the Orange County Water District in California requires operators to have wastewater treatment certifications along with additional training in membrane and advanced oxidation processes. This approach may work in large utilities that have the capacity to train operators properly themselves, but smaller utilities or those with fewer resources may not be able to do so. The research report provides an assessment of operator certification and training needs for DPR using examples from throughout the U.S. and Australia.

In anticipation of a need for qualified DPR facility operators, the California-Nevada section of the American Water Works Association is working with a broad coalition — including WE&RF — to develop a new certification program for advanced water treatment. This new program will include advanced treatment processes and help ensure operation of DPR facilities to a high standard, which consistently protects public health. In addition, WE&RF has new research underway with the Hazen & Sawyer team, along with the Santa Clara Valley Water District and other stakeholders, to develop DPR operator curriculum and training materials for utilities, educational institutions, and other interested organizations. When combined with our vast portfolio of completed, ongoing, and planned research on DPR, WE&RF will be at the forefront of the effort to ensure that DPR becomes a sustainable, reliable, and safe source of drinking water for communities nationwide. ■

About The Author

Justin Mattingly is a research manager at the WE&RF focused on treatment systems for potable reuse, industrial reuse, and water economics and finance. Prior to joining WE&RF, he completed a four-year fellowship at the U.S. EPA in the Clean Water State Revolving Fund program, working with states and communities to develop innovative financing tools and strategies to fund a diverse array of water quality projects. During this time he also focused on stormwater management and combined sewer overflows, helping communities develop management plans and financing programs to promote the use of green infrastructure. In his current role at WE&RF, Justin has presented at multiple conferences, authored several papers and articles, and participated on several working groups and advisory committees related to water reuse. He is also engaged with decision makers at the state and federal level to overcome the regulatory and financial barriers related to water reuse. Justin graduated from the University of Delaware with a Bachelor's degree in Biological Sciences and a Master's degree in Environmental Science from American University.

6 Ways To Improve Payment Performance

With rising regulatory and infrastructure costs, it's more important than ever for water and wastewater utilities to collect what they're owed from ratepayers. But how can they go about improving collection?

By Peter Chawaga

Water utilities are in a tough spot. They're asked to provide a crucial service, one that can even be considered a miracle of modern engineering, and yet they are constantly struggling to collect payment for these services from those who benefit.

WaterSmart Software wanted to help. The technology company provides engagement and analytical tools that utilities can use to communicate with ratepayers and stay on top of payments. It recently hosted a "WaterSide Chat" webinar to provide utilities with best practices they can employ to improve collection performance.

"As you go through, think [to] yourself, 'Am I penny-wise and pound-foolish by not investing in my collection process or finding out why my collection process is not as effective as I want it to be?'" Tom Hulsebosch, the presenter and a senior manager with West Monroe Partners, a business and technology consulting firm, told attendees. "We've seen collection issues upwards of 10 percent at some utilities. That's a lot of revenue that can pay for a lot of staffing."

Am I penny-wise and pound-foolish by not investing in my collection process or finding out why my collection process is not as effective as I want it to be?

From there, Hulsebosch moved on to enumerate the six primary ways that utilities can improve their collection processes and hopefully put more revenue toward the vital work that they do.

1. Collect And Maintain Customer Data

A natural first step for improving collections is to know who you are collecting from.

"One of the key things … is making sure that you've got your customers uniquely identified," Hulsebosch said. "Not the brother of someone, but your actual customer identified, and that you can actually do a credit check on."

When customer service agents act as the go-between for utilities and ratepayers, it's important to make sure they are on the same page when it comes to collecting payment.

"We're always incentivizing our customer agents for something," Hulsebosch said. "What you want to make sure you're not doing is accidently incentivizing them to help the client find a way around paying the bill on time. Helping them to find ways to resolve past payments, as well as old debts, is really important."

Lastly, Hulsebosch stressed the importance of keeping utility systems in sync and making sure all the data points they are collecting align.

"This is a really tricky one, and it gets trickier as we add more technology to our water network," he said.

2. Utilize Premises-Based Billing

It sounds simple, but it's critical to ensure that the person who owns a property is the one who is accountable for its water bill.

"We see a very big difference between water utilities that practice premises-based billing and those that do not," Hulsebosch said. "[Utilities that do not are] trying to go after, if you will, the renter or the tenant, as opposed to the building owner. Those that have this concept of premises-based billing, where in the end the owner of the building is primarily accountable for the bill, well, it turns out they really don't have a problem. This can go from one of your biggest headaches to not so big a headache."

3. Employ Customized, Risk-Based Processes

Some innovative utilities employ customized processing that segments customers and improves collections, according to Hulsebosch.

"I like the idea of segmenting your customers, looking at the potential impact of taking that deposit or not taking that deposit, especially for low-risk customers, and then making the determination of whether that's really an effective way to get people to pay their bill," he said.

Hulsebosch also encouraged attendees to consider rethinking how they approach customers who have missed a payment.

"Do you go after them too aggressively when they miss a bill payment, or do you send them a nice, friendly reminder?" he asked. "I would recommend the friendly reminder."

4. Keep Customers Satisfied

Hulsebosch cited a poll he conducted on behalf of a utility, in which he found that the correlation between customer satisfaction and how easy it was to complete a payment was nearly one to one. He found that if customers are satisfied, they will more readily make payments, even in the face of higher costs.

"Regardless of the type of service or transaction, we saw that if it was easy, they were happy," he said. "This particular utility was not the lowest-cost utility in the area. It was the most expensive, actually. We tend to think that it has to be low-cost — 'cheap' — and that's where the satisfaction with the customer comes. But that's not what the data showed us."

5. Leverage State Laws And Local Ordinances

Perhaps the best way that utilities can empower themselves to collect payments is to become familiar with the local rules that are in place to help them. For instance, some municipalities prevent property owners from selling if their water bills aren't paid.

"Taking a look and thinking about what the opportunities are within your municipal code that you can enforce makes it easier to do business," Hulsebosch said. "Being predictable and enforcing the boundaries that are in your existing ordinances actually makes it easy [for customers] to predict how they should do business with you."

6. Make Yourself Accessible

Similar to his points about knowing customers and keeping them satisfied, Hulsebosch emphasized the efficacy of customer assistance programs that let ratepayers know that utilities want to make it easy for them to pay their bills on time.

"Making it easy for your call center agents or your billing and collection folks to follow up with customers … is really helpful, because not everyone knows about [customer assistance programs]," he said. "Then, once you interface with the customer who has some payment challenges, make sure it's easy for that customer assistance program to pay on their behalf."

Hulsebosch also emphasized the importance of reducing the number of delinquent customers.

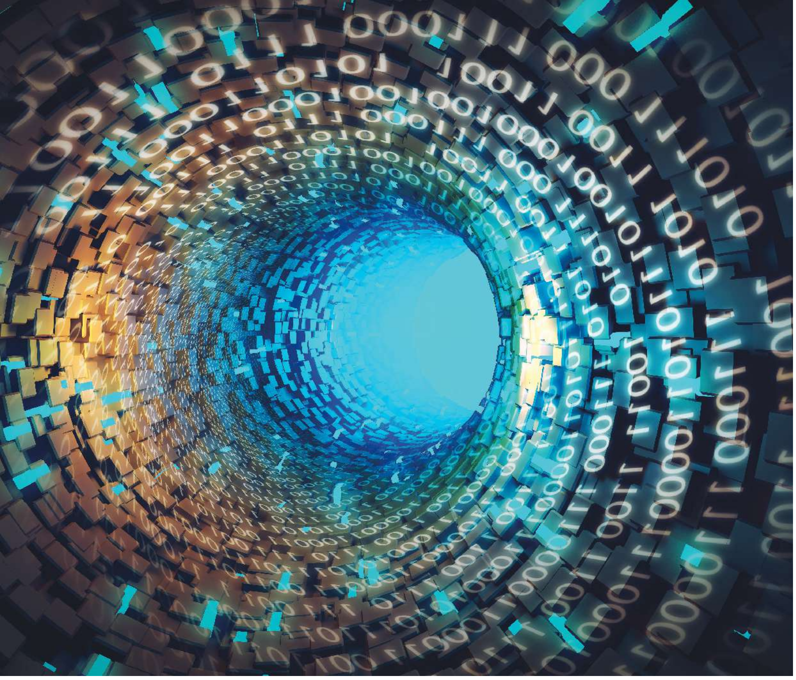
"This is one that can become a real challenge if you don't have a dashboard showing what percentage of your customers are late-paying," he said. "Keeping an eye on all of those [delinquent] customers and trying to use the appropriate mechanisms to move people off that late-pay list is really important."

But Hulsebosch's parting advice to attendees was an amendment to his six-part list as a whole.

"Don't fight everything off at once," he said. "This is a roadmap. This is a multiyear process, but hopefully this will help you think through some tactics and plans to improve your payment performance." ■

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.



Understanding Big Data In The Water Industry

If you feel like you have too much data but not enough understandable or usable information, fine-tuning data collection and funneling it into an integrated data management system may be the way to become more proactive and make better decisions.

By Dr. Andy Shaw

At a very basic level, Big Data just means we have a lot of data. Water utilities see data from supervisory control and data acquisition (SCADA) systems, including flow statistics, online monitoring, dissolved oxygen (DO) measurements, and air flows, as well as data from laboratory information management systems (LIMS) and computerized maintenance management systems (CMMS), to name several examples.

Such data is beneficial, and much of it has been around for years. Unfortunately, the way data is gathered at treatment facilities is often fragmented. There are silos of data in computer systems that don't always talk to each other. The Internet Age has ushered in the ability to funnel disparate data into a single, meaningful pool of information that allows water and wastewater treatment plant operators to understand, manage, and use it to optimize plant reliability and performance. Big Data initiatives and new data management tools enable us to turn all that data into understandable, useful information that helps us become more proactive and make better decisions about plant operations.

The next step – pooling data and using analytical tools to predict where we should be heading to become more proactive – is a big one for the water industry.

For example, Black & Veatch offers ASSET360™, a smart analytics platform to give utilities, cities, and other entities a holistic, 360-degree understanding of their infrastructure-based systems. Although the focus on Big Data in the water industry is relatively new, comprehensive data management isn't new for energy utilities; Black & Veatch has provided asset analytic solutions to utility clients for more than 20 years and has operated a smart analytics monitoring and diagnostics service for more than 10 years. The company's utility analytics include operational intelligence and adaptive planning solutions.

Sometimes You Have To Get MAD To Be Smart

No matter what specific services or tools water and wastewater utilities choose to use, it's important to develop a management plan, pull all important data together, and take advantage of dashboards and smart screens that use that data to perform calculations and identify trends. Then, utility managers can break the information down to answer questions such as "Where am I using energy or spending my dollars?" or "What am I spending on energy and chemicals in different parts of the facility?"

Furthermore, utility staff with such information in hand can proactively identify potential problems before they happen rather than react to something such as a broken pump. Although SCADA systems have real-time capabilities, displaying current status and immediately warning of problems, being able to predict a potential problem through use of smart analytic platforms is a game changer. The next step — pooling data and using analytical tools to predict where we should be heading to become more proactive — is a big one for the water industry. We're getting smarter all the time.

Becoming smarter, however, requires focus on the *quality* as well as the *quantity* of our data, shifting our focus from Big Data to bad data. If sensors are not cleaned, calibrated, or properly used, for example, it doesn't matter what we do with the resulting data. The starting point is to make sure you have good primary measurements.

In *Smart Water Utilities: Complexity Made Simple* (IWA Publishing, 2016), Dr. Pernille Ingildsen and Dr. Gustaf Olsson consider what utilities need to do to be smart. They boil it down to a simple, yet very useful, framework and suggest that water

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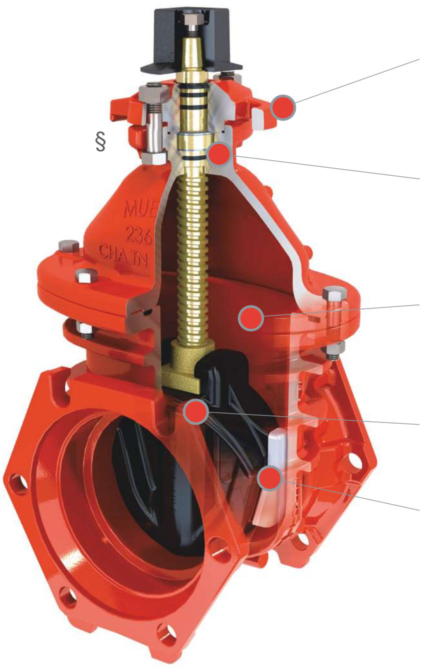

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In Lawrence, KS, where the Black & Veatch ASSET360 system is used to track operating costs, data shows the impacts of wet-weather events on treatment costs. The total cost per 1,000 gallons is shown in purple, the secondary treatment flow rate is shown in blue, and the flow rate to the Actiflo system is shown in green. There is a jump in treatment costs during a storm event due to the extra costs associated with operating the Actiflo process.

utilities have to be "MAD" to be smart.

As they explain, M is for MEASURE, because we have to focus on having good measurements in the right place; A is for ANALYTICS, because we have to understand and analyze the data we collect; and D pertains to the DECISION-making process. Using what we know to make good decisions can be an automated process in some cases. It can be helpful to split Big Data into these three parts.

In terms of accuracy, the instrumentation that we have now is better than ever, whereas sensors were a weak point in the past. People generally understand the need to clean and calibrate instruments, but it can still be an important starting point.

Improved analytics are more the focus today, with the benefits and needs explained above.

Decisions will be the next focus, and fairly soon, as evidenced by research now underway.

Smart analytics — called Smart Integrated Infrastructure (SII) at my company — have been applied to power stations for many years. In SII, a driving question is "How efficient is the plant as a whole?" With the ability to zoom in on specific pieces and ask questions such as "How many dollars per hour does it cost us not to have this part of the plant operating as well as it could?" utilities and cities can use smart analytics to make smarter decisions by proactively identifying and prioritizing improvements.

Black & Veatch has developed tools specifically for combined heat and power (CHP), membranes, and activated sludge. We are working with the city of Lawrence, KS, to refine tools to enable the city's plant managers to optimize operations. Initially these tools will be used at the wastewater treatment plant, but eventually they will also be extended to the city's water treatment facility. Plant operators are already seeing the benefit of being able to visualize information by pulling all operations data together in a consolidated database.

Big Data Basics

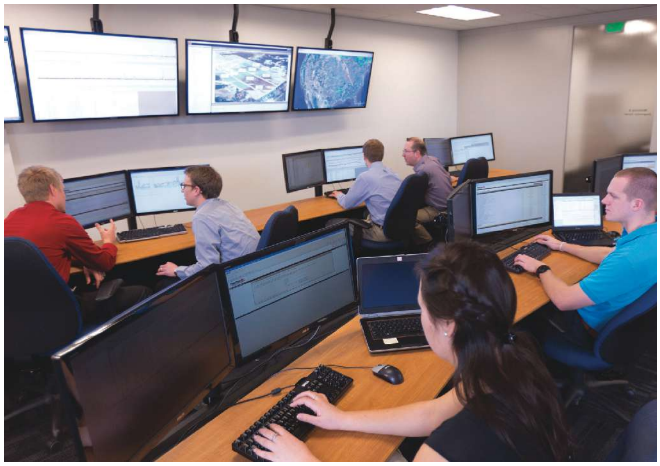
Despite the current focus for many on improving analytics and/or decisions, there's also a lot to be said for making sure our foundations are sound. Below are five keys to making Big Data work and avoiding the pitfalls of bad data.

Focus on data quality rather than quantity. Not even the most sophisticated analytics can overcome measurement errors, whether that's noise, drift, or interferences. If you aren't confident in your primary sensors and analyzers, you could have a lot of bad data that is worthless, no matter what you do with it. For example, a Water Environment Research Foundation (now the Water Environment & Reuse Foundation) decision support system (DSS) project required a research team member to perform data analytics to pick out anomalies that might indicate toxins in plant influent, but distinguishing anomalies due to toxins from anomalies due to measurement problems proved to be a major hurdle.

Confidence in sensors and analyzers can be gained by:

1. ***Cleaning them.*** Wastewater treatment is an especially fouling environment and not the best place to put scientific equipment. Operators frequently underestimate how quickly sensors become fouled. Go for autocleaning whenever possible and avoid installing anything in raw sewage or primary effluent unless you really need the measurement because both areas are particularly prone to fouling. Mixed liquor is an easier place to take measurements, and final effluent is the easiest place of all. Water treatment systems usually are less fouling, but sensors still need periodic cleaning.
2. ***Calibrating them.*** This is generally understood, although the frequency of calibration, particularly for sensors that tend to drift, typically is shorter than ideal.
3. ***Validating them.*** This may be the action overlooked by most instrumentation suppliers. Analytics to validate the measurements, particularly during calibration, frequently need more attention.

Modern instruments are more reliable than they were in the past, but they still need to be cleaned and taken care of.



Tools such as Black & Veatch's ASSET360 system help water utility managers follow in the footsteps of their energy utility colleagues to harness data for improved decisions and operations.

Measure only what's useful to you. What will you actually use to best manage the plant? Some treatment plants lack important and basic measurements (e.g., DO in the aeration basins, airflow to each aeration zone, and electricity use by blowers), but we need to be careful in our enthusiasm not to swing to the other extreme and take measurements that are not especially useful. You can spend serious money measuring ammonia and nitrate all over a treatment plant, but unless you're actually using it for control, the measurements will eventually be ignored and the instruments neglected. It's best to have a handful of good instruments, positioned in locations where you're actually measuring something you can control, and to try to keep those sensors running well.

Think dynamics, not steady state. A lot of the design and operational guidance in textbooks and training materials has simple equations into which you plug a single number to get your answer (e.g., sludge age calculation or removal efficiency). Similarly, influent and effluent samples are usually flow-weighted or time-averaged composites. We're used to thinking and talking about average daily conditions. However, the reality is that our treatment plants see significant daily variations in flows and concentrations, and therefore we need to look at them as dynamic systems. For example, an online phosphate analyzer taking measurements at the end of the aeration basin just prior to the clarifiers might reveal daily phosphate peaks of 1 or 2 mg/L every afternoon for just an hour or so, but the effluent composite sample measurements could be consistently below 0.2 mg/L. To understand our treatment systems, we need to measure and analyze their dynamics.

Recognize different timescales. Hand in hand with dynamics is the need to think about different timescales: diurnal (daily) variations, weekly trends (especially weekend versus weekday differences), and seasonal shifts. For each of these, the data analytics needs are quite different and need to be carefully considered. For diurnal variations it can be useful to compare one day to the next by overlaying the dynamic data. For weekly trends we can do something similar over a seven-day horizon. And for seasonal shifts it is often beneficial to plot and compare long-term trends to temperature and maybe rainfall shifts.

In terms of accuracy, the instrumentation that we have now is better than ever, whereas sensors were a weak point in the past.

Consider how to handle outliers and extraordinary events. In data analytics it's common practice to identify and eliminate outliers, assuming they're either bad measurements or not typical and therefore something to ignore. But experience shows that a lot of what is done at water and wastewater treatment plants is trying to keep the process stable in response to abnormal events, such as upsets from shock loads or toxins, or, more typically, responding to wet weather for wastewater plants or major line breaks or droughts for water treatment. We need to identify outliers, but rather than throw them away, we need to decide how to respond.

In a nutshell, Big Data is about taking all the data we now have at our fingertips and turning it into knowledge that we can apply to operate our treatment facilities better. The right data, analytics, and decision framework can drive water (and energy) utilities to optimal performance. ■

About The Author

Andy Shaw, Ph.D., is a global practice and technology leader with Black & Veatch. He is responsible for wastewater treatment and sustainability and has special expertise in instrumentation and computer modeling. He is also a keen user of internet-based knowledge transfer, including his blog http://poopengineer.blogspot.com/. Shaw has led or served on multiple WEF committees and was featured in a WEFTEC 2016 *Water Online* radio interview about Big Data.

The Bells And Whistles Of Automation: What To Expect When You're Commissioning

Getting systems online is tough enough without unnecessary alarms and shutdowns, but the safety and visibility of operations are also paramount. During the commissioning process, balance is critical.

By Paul Brake

We live in a world where automation is now the center of plant engineering. Automation enables better controls, safer operation, environmental compliance, lower manpower requirements, and data logging. It has provided us with nearly hands-free operation of most systems. It gives operators virtually instantaneous reporting, feedback, and control of the process. It warns us when things are not going along with our plans and warns us of dangers to avert catastrophes. Automation is truly a blessing to everyone involved, until we go overboard. Then we curse its inception.

Commissioning demonstrates, quite painfully, that it is very easy to engineer too many sensors, too many alarms, and too many shutdown keys into the process.

It is essential that our automation, controls, and sensors be designed and built to give the operator a real-time, complete, and accurate picture of the entire process. It's also necessary for that automation to identify problems and warn the operator before they escalate. Furthermore, automation must be empowered to take over and control or even cease certain operations based on imminent hazards perceived by the sensors and interpreted by the control program.

Imperfect Starts

Recently we were commissioning an oil/water separation unit with three serial stages and three serial coalescing tanks. The emulsion is pumped through a separator module into a coalescing tank. The recovered hydrocarbon is pumped off the top. The underflow water is pumped from below. Levels are maintained by controlling the pump rates and measured through pressure differentials — three times over. So you have a whole bunch of pumps, a crate or two of flow meters, dozens of automated valves, variable frequency drives (VFDs), level indicators, gas detectors, pressure switches and indicators, temperature sensors, fire monitors, etc., etc. To top it off, the whole system was under a controlled-flow natural gas blanket with a vapor recovery unit because the influent contains hydrogen sulfide gas. A long list of instrumentation and automated equipment is all tied back to the client's distributed control system (DCS).

When the system is up and running properly and tuned in to the flow, temperature, and variations of the process, it hums along beautifully with no problems for years.

The issue, of course, is getting to that perfect running state. That agonizing, sometimes torturous process is called commissioning. Commissioning demonstrates, quite painfully, that it is very easy to engineer too many sensors, too many alarms, and too many shutdown keys into the process. It became almost impossible to commission our system, because during commissioning — while filling tanks and adjusting levels and flows — we were not within the preset program limits. As we were working, lights were flashing, alarms were ringing, and numerous times the system shut down because some sensor's limit had been breached.

We learned our lesson. We learned from our mistakes. It is better, and cheaper, to learn from the mistakes of others.

So now, when you go to design your next system, learn from our mistakes. When setting alarms, care should be taken to alarm only those things that are truly critical to your process.

Get It Right By Setting It Right

There are numerous industry protocols that you can reference and use as your design guides. But to simplify things, try using a Failure Mode Effects Analysis (FMEA) on your system. There are numerous models out there — an internet search will reveal dozens that can help you. The FMEA will help you determine what can go wrong, how it can go wrong, what the possible

Automation provides efficiency but doesn't promise a smooth setup.

ripple effects will be, and how to mitigate or remove the hazards. It is always best to engineer the hazards out, but that can result in too much automation, as described above.

If a failure will not cause an injury, environmental compliance issue, or damage to equipment, then it can be alarmed, but it should not cause a shutdown. Shutdowns should be used only for imminent threats to safety, environment, or equipment. Notice that I left out "process." When commissioning, you won't be hitting your process requirements until you are well underway, so don't let that shut you down.

If it can cause any of those three critical events, will it cause them immediately or is there a buffer time? Take, for example, flow to a pump. How long can the pump safely run in a low flow before damage occurs? How high is the maximum outlet pressure able to reach, and for how long? How full can your tank get before it is truly overflowing? How empty before vortexing your pump? The answers to these questions will determine the setpoints and variables on your alarms for commissioning.

If a failure will not cause an injury, environmental compliance issue, or damage to equipment, then it can be alarmed, but it should not cause a shutdown.

Conclusion

Automation is great, but we have to use it wisely. The operator must be the master of the system. When we write programs we should have a commissioning mode in the operation. During commissioning, there are far more hands on deck than in normal operation. Automation should be programmed to account for this. Also, most of the equipment will not be operating in its optimal range, which needs to be accounted for as well. In this stage of operation your process will not be optimal either. Do not expect an effluent that matches your process requirement, and adjust your automation and alarms to allow for staggering deviations.

The best-engineered system will start like an old tractor the first few times you run it. It will shake and rattle and blow smoke. That is why we commission and don't simply plug and play with large, complex systems. So adjust your automation, sensors, controls, and shutdown keys to match your commissioning conditions, and allow your people to be the brains of the operation. Your operators will love you for it. ■

About The Author

Paul Brake is a mechanical engineer with three decades of industrial experience. He is currently engineering manager at RJ Oil Inc. Environmental Solutions, in Acheson, Alberta, designing and building remediation equipment.

How To Control Filter Cake And Membrane Surface Fouling

Who wants cake? Certainly not treatment plant operators who employ microfiltration and ultrafiltration membranes, and here's what they're doing about it.

By Harold G. Fravel, Jr. and Karen Lindsey

The increasing desirability of microfiltration (MF) and ultrafiltration (UF) membrane systems over conventional water treatment plants is a direct result of their continued success in effectively reducing turbidity, rejecting pathogens and coagulated materials, and, in general, separating particulates from a sourced feedwater. Increasingly, MF and UF are the processes of choice for customers installing new water treatment systems and retrofitting or upgrading older, conventional plants.

Both MF and UF membranes rely on distinct pore sizes to physically reject specific particles. Pore sizes vary deliberately, with MF membranes having relatively larger pores in the range of 0.1 to 0.2 microns and UF having smaller pores in the range of 0.005 to 0.01 microns. If the membranes have not been compromised, they will effectively reject any particle larger than the pore dimension. When the larger particulates are unable to pass through the membranes, they build up and can potentially become pinned to the membrane surface, developing into what is known in the industry as a "filter cake." If left unchecked, this cake will become thicker and thicker as more particulates bind to it. The resulting layer may become so dense that flow to the membranes is inhibited and an increased feed pressure is required to overcome the barrier and effectively pass water through the membranes. When that occurs, the surface of the membranes must be cleaned or treated in some manner to restore the flow of water through the membrane.

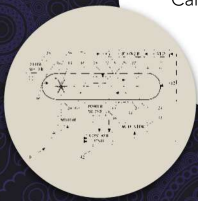
There are several methods of cleaning MF/UF membrane surfaces. In most applications, the cleaning process includes a backwash — a method of applying short bursts of filtrate water from the opposite direction of the feed flow to help dislodge the filter cake and direct particulates away from the membranes and out of the system. An air scour may also be applied to increase the efficacy in dislodging particulates from the membrane surface. Enhanced chemical backwash and clean-in-place (CIP) cycles take these steps further by introducing some type of chemical to help disperse, dissolve, and remove accumulated solids and restore system performance. Any maintenance process that extends the time between backwash or chemical cleaning is a commercial advantage in reducing operating costs and increasing system efficiency.

Getting Particulate: Membrane Bioreactors

The numerous benefits of membrane bioreactors (MBRs) for wastewater treatment have resulted in a growing number of new installations. MBR systems apply MF or UF membranes depending on the system's design and application. This process treats biosolids and provides a higher-quality filtrate with a system that typically has a much smaller footprint than a conventional plant. The membranes are submerged in a mixed biosolids liquor, and the filtrate is drawn through the membrane. Biosolids, bacteria, and some viruses are unable to pass through the membrane's pores and remain in the mixed liquor. Because the feed flow is directed toward the MBR membranes while water is drawn from the mixed liquor to the membrane surface, particulates and solids inevitably accumulate. Combine this process flow with the extremely high solids content common to most MBR feedwaters, and the resulting issues related to filter cakes can be especially significant.

Backwashing is not typically applied to MBR systems, as the particulate loading in the mixed liquors is simply too high to be effective. Instead, system operators apply intense agitation and circulation of the liquor to help minimize solids accumulation. There is also a procedure referred to as the "relaxation" step in which the draw from the mixed liquor is halted for a designated time while the agitation continues. Ideally, this reduces the depth of the filter cake on the membrane's surface.

Air is introduced for scouring the membrane surface.



2013

Energy OptimizIR for Carrousel Systems

U.S. Patent 0256225 A1

2014

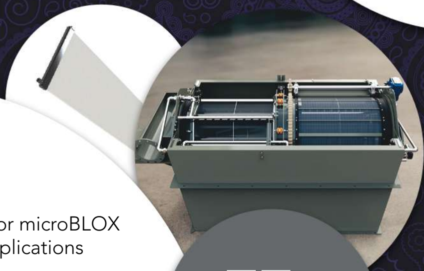
DigitalOPs - dynamic, responsive and interactive operator support

2015

Universal Mounting Kit for Ovivo MBR

OV960 and OV1920 MBR *"Build Your Own Membrane Unit"*

SRD Sludge Return Device
Patent # 14,859,164



2016

Cembrane ceramic membranes for microBLOX
For use in high solids MBR applications

WaterExpert™ App *"Your Water Treatment Hub"*
Manage equipment, monitor data & secure knowledge

microBLOX.build website allows customers to build their own packaged MBR solution online

BLOX design tool for customized equipment design using standardized components

Patent # 9,511,311 for Duet Dual Aperture Screen

2016 *cont.*

Ovivo ePhos® phosphorous & ammonia recovery system

Ovivo BioAlgNyx™ System – Phagotrophic Algae for enhanced sludge digestion.

DigestivorePAD – Anaerobic Digestion + Post-Aerobic Digestion

Licensed with the Danish company Cembrane to distribute their silicon carbide membranes

Granted a U.S. Patent for the Reverse Manifold Device (RMD) technology

Ovivo signs license agreement for North America with Pacques

A Snapshot of Recent Innovations from the Worldwide Experts in Water Treatment

A cassette is lifted from the MBR process to clean off solids.

The most common method to keep membrane surfaces clean and active is to sparge air across the membrane, allowing the resulting air bubbles to dislodge particulates from the surface and thin the foulant layer. It's possible to manipulate the size of the bubbles, and one industry manufacturer has determined that smaller bubbles are more advantageous for its systems. Introducing a continuous barrage of air requires energy, however, and the resulting cost can become significant in the overall operating cost.

To help mitigate the energy cost, another MBR supplier has developed a process that generates random bursts or pulses of air, so that the resulting bubbles are not applied in a continuous stream. The MemPulse® MBR offers a random, rapid pulse of air up the membrane fiber column without any moving parts or valves to control the pulse, providing a constant flow of air to the equipment. In addition to scouring the membrane surface, the subsequent turbulence creates a flotation effect that helps move grease, oil, and other floating particulates to the top of the fiber bundles where they can be minimized or removed.

Beyond "Hairy" Hollow Fibers: Evolving Membrane Technology

Human hair has proven to be particularly challenging for wastewater treatment systems, especially those that employ hollow fiber membranes. Hair does not readily dissolve, and lengthy strands are strong enough to wind around and damage membrane fibers. Recent system designs have addressed this challenge with components that overcome the buildup of hair and other fibrous materials that plagued early MBRs. Eliminating this unique risk helps reduce operating costs and mitigates the unsavory task of disconnecting membrane cassettes to remove materials by hand.

The evolution of hollow fiber technology began with manufacturers potting fibers at both ends of the MF/UF module to hold them in place. Other designs allowed the feed, filtrate, and backwash to be collected at different points, and air was introduced at the base of the module, dislodging solids as it rose up through the fiber bundle. Now some manufacturers have introduced configurations where the top end of the fiber is sealed but is no longer potted in place. This allows the fibers to move freely within the module or cassette in a continuous motion that helps dislodge particulates from the membrane's surfaces. This open configuration also allows aeration to penetrate deeper into the fiber bundle and release solids during air scouring.

Another supplier developed an MBR system with submerged cassettes that gently rock back and forth in a reciprocal motion. The process claims to discourage deep particulate caking, keeping the foulant layer thin, so that longer treatment cycles can be achieved. Low energy, no aeration membrane bioreactors (LENA MBR) allow the fibers to move gently back and forth, and the resulting motion continuously shakes foulants off the membrane's surface. Sludge accumulation between the fibers is also minimized by the reciprocal motion of the cassettes and the pulsating fibers. Eliminating aeration reduces operating costs related to air scouring and recirculation of the streams. There are a number of demonstration plants in the U.S. that are using these operational and design technologies, and several full-sized plants should be installed in the near future, so we can all evaluate their efficacy and advantages.

While only hollow fiber systems were specifically addressed here, both flat sheet and ceramic sheet membrane systems also use similar methods of minimizing the depth of solids buildup on membrane surfaces. As with hollow fiber membranes, surface air scouring helps extend the hours of operation and maintain an acceptable thickness of solids on the surface of flat sheet membranes.

We've recently heard that small plastic balls are being added to the feedwaters of some tubular membrane systems to assist in the scouring process and help dislodge foulants. Adding an innocuous physical component to create turbulence is certainly an interesting concept and may be of value to future MBR developers.

Microfiltration and ultrafiltration processes have proven to be extremely effective in removing solids from high-particulate waters and wastewaters. The ongoing challenge for system designers is developing effective ways to mitigate the accumulation of those same solids on membrane surfaces. As illustrated here, methods exist and continue to evolve, and there can be no doubt that achieving a competitive advantage in longer run times and reduced operational costs will ensure continued innovation.

The American Membrane Technology Association (AMTA) has prepared membrane technical fact sheets on a variety of membrane and related technologies and applications including MBR, MF/UF, reverse osmosis, and more. AMTA fact sheets can be found at www.amtaorg.com. ■

About The Authors

Harold G. Fravel, Jr. accepted the position of executive director for the American Membrane Technology Association (AMTA) after working for Dow Chemical /FilmTec Corporation for 36 years. He has a Ph.D. in organic chemistry from the University of North Carolina and a B.S. in chemistry from Florida State University. He resides in Jupiter, FL.

Karen Lindsey is an executive member of the American Membrane Technology Association (AMTA) board of directors. She is the VP and co-founder of Avista Technologies and has 30 years' experience in the water treatment industry, working with companies that cast cellulose acetate membrane, produced polyamide elements, and formulated specialty chemicals.

Utility Safety Culture: A Hidden Key To Employee Retention

Sound safety policy does more than keep your workforce free from harm. It keeps them around.

By Sheldon Primus

The liquid utility field (water and wastewater treatment plant and field workers) most often falls in the category of unsung heroes or workers who are taken for granted. This professional disconnect can be due to the negative connotation led by the name "wastewater" or the entry-level position's being a high school diploma or equivalent. Many liquid utility workers may be fighting an uphill battle in gaining respect from engineering groups, city and county management, or even support personnel in the management team of the utilities' administration offices. However, all operators must have on-the-job experience and some technical training to obtain a state license. Once operators become licensed, their value increases as current employees age and the job market expands due to regulatory concerns. Some operators leave one municipality for another due to an increase in salary, better schedules, and better working conditions. This article will highlight how having a good safety culture can help the municipality retain promising workers.

The Bureau of Labor Statistics (BLS) projected the need for water and wastewater operators to increase by 6 percent from 2014 to 2024 (the average national rate for all occupations).[1] But are the municipalities filling vacancies at the same rate of attrition due to retirements or workers leaving the industry for better working conditions? Do the operators feel that they are valued as workers and safe on the job? These are core questions that lead to the retention of utility workers.

The BLS notes that utility workers are at a higher risk of injury and illness than most.[2]

There have been a few fatalities making national news that could have easily been prevented by having a better safety culture at the utility.

- "Water Workers Recover Inspector's Body From Municipal Tank" (Massachusetts, Dec. 2016)
- "NYC Contractor Dies After Falling Into Wastewater Tank" (New York, Oct. 2016)
- "Second Worker Dies From Accident At Wichita Falls Treatment Plant" (Texas, July 2016)
- "Wastewater Worker Dies After Falling Into Toxic Sludge Basin" (New Mexico, July 2016)

OSHA notes that worker safety is a key to worker retention, increased productivity, lower workers' compensation costs, and increased revenue. Employers that have an active safety and health program that values safety over compliance with rules or regulations are rewarded with the benefits previously listed. A safety culture is the value system from top management to the new hire that promotes a proactive approach to finding and fixing workplace hazards as a way of doing business. Safety is not "first" as most signs and promotional materials mention, but safety is incorporated seamlessly into operations.

There are seven interrelated elements in creating an integrated safety

Industry[2]	NAICS code[3]	Total recordable cases	Cases with days away from work, job transfer, or restriction			Other recordable cases
			Total	Cases with days away from work[4]	Cases with job transfer or restriction	
Electric power generation	22111	1.4	0.7	0.4	0.3	0.7
Hydroelectric power generation	221111	2.4	1.7	1.6	-	0.7
Fossil fuel electric power generation	221112	1.8	0.9	0.4	0.4	0.9
Nuclear electric power generation	221113	0.2	0.1	([9])	-	0.2
Electric power transmission, control, and distribution	22112	2.3	1.1	0.7	0.4	1.1
Natural gas distribution	2212	2.4	1.7	1.1	0.6	0.7
Water, sewage and other systems	2213	4.1	2.6	1.2	1.4	1.5
Water supply and irrigation systems	22131	4.4	2.8	1.2	1.6	1.6

Table 1. Incidence rates* of nonfatal occupational injuries and illnesses by industry and case types (2015)

**The incidence rates represent the number of injuries and illnesses per 100 full-time workers and were calculated as: (N/EH) x 200,000, where: N = number of injuries and illnesses; EH = total hours worked by all employees during the calendar year; 200,000 = base for 100 equivalent full-time workers (working 40 hours per week, 50 weeks per year).[3]*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culture for any business or utility. Each core element must be developed to its fullest potential for the culture to develop and flourish. The seven elements are as follows (adopted from the OSHA safety and health model[4]):

1. Management Leadership
2. Worker Participation
3. Hazard Identification and Assessment
4. Hazard Prevention and Control
5. Education and Training
6. Program Evaluation and Improvement
7. Communication and Coordination for Host Employers, Contractors, and Staffing Agencies.

Management Leadership

Utility directors, plant managers, and shift supervisors are all considered managers in some form or fashion. A committed management unit provides clearly defined objectives and goals for organizational safety behavior. They finance the activities of safety through purchases and resource allocations. Every level of management values safety practices and accomplishments as much as regulatory compliance to water quality.

Steps to implement leadership commitment to safety:

- Write or personally sign a clearly defined safety policy that acknowledges that safety and health are as important as productivity, water quality, regulatory compliance, and customer service
- Communicate the policy and values to all levels of the organization
- Visually set examples of safety behavior and demonstrate actions consistent with a safety culture
- Allocate resources for safety and health
- Hold all levels of the organization accountable for safety performance.

Worker Participation

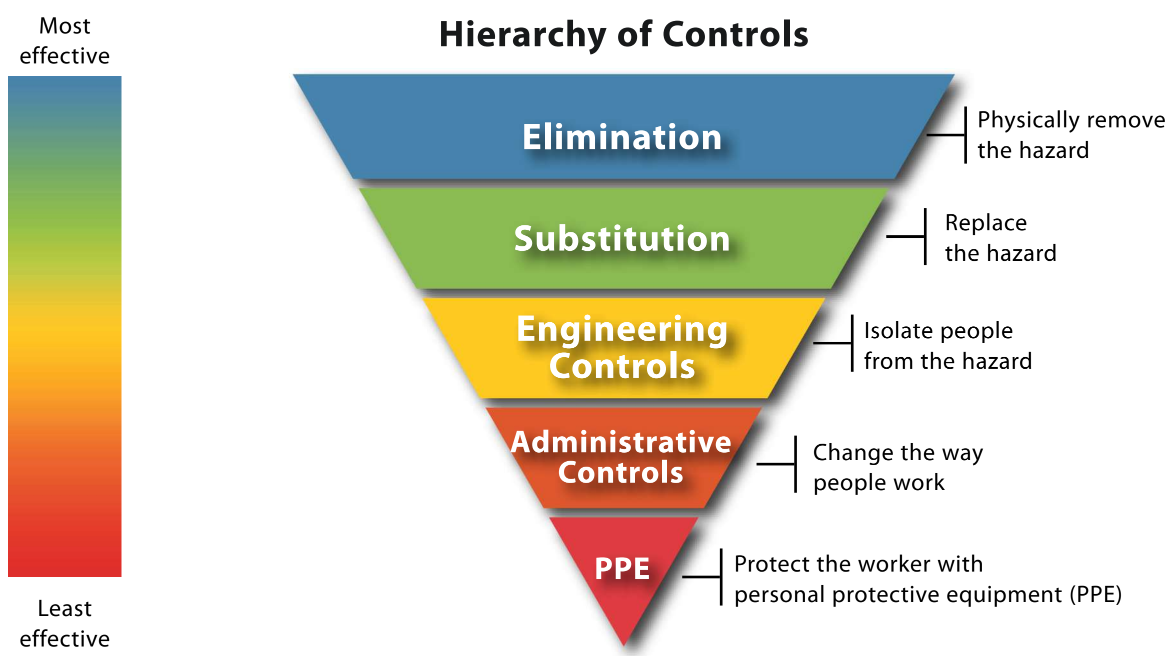
Workers must feel valued in the entire process of developing a safety culture. Without the workers' participation, the transition will be forced and doomed to fail because of the constant reinforcement of rules and internal regulations. Supervisors will then be forced to punish unsafe behavior disproportionately to rewarding safe behaviors. Workers should feel empowered to:

- Access information regarding safety and health policies
- Participate in all phases of the program's design and implementation
- Report injury and illness without retaliation or adverse consequences
- Suggest how to remove barriers to health and safety
- Hold peers and management accountable for safety and health.

Hazard Identification And Assessment

A hazard is any condition or action that can cause an organizational loss. An organizational loss can come in the form of an injury, illness, damaged equipment, or even worker turnover. When a loss occurs, the organization must determine the root cause of the loss and not just the symptoms leading to the loss event. The assessment process must be structured and detailed and deliver actionable measures to address the root cause. Hazard identification and assessment can be accomplished by:

- Worksite analysis of past, present, and predictive data from reports, instrumentation and maintenance logs, and worker injury and illness records
- Worksite inspections for safety hazards
- Investigations of each accident until the root cause is completely disclosed
- Identification of hazards that may arise outside of normal operating conditions, including emergencies, startup, or shutdown operations
- Characterization of the true composition of a hazard — assign a priority value and identify appropriate hazard controls.



Source: National Institute for Occupational Safety and Health

Hazard Prevention And Control

The prevention and control of hazards protects the worker from injury and illness and also gives employees a clear sign that the utility cares about their well-being. Elimination of hazards is the best way to avoid an organizational loss. However, that may not be possible in all situations. Therefore, hazard control is appropriate for some hazards that are still present when workers are performing their daily tasks. Although some utilities are substituting highly hazardous chemicals, such as liquid chlorine for chlorine gas, it is mostly because they are trying to avoid the risk management program regulated by the U.S. EPA and not primarily for worker safety. The hierarchy of hazard controls after elimination and substitution includes:

1. Engineering (physical barrier device, such as a machine guard)
2. Administrative (work rule, such as work rotation)
3. Personal Protective Equipment (protection worn by workers as a barrier to hazards, such as a hard hat).

Tips for implementing hazard prevention and controls are as follows:

- Identify what controls are available for each type of hazard
- Select the proper controls by doing a detailed hazard assessment
- Develop, maintain, and update a hazard control plan
- Select controls that are applicable for all aspects of the organization and conditions
- Implement the selected hazard controls with a priority on elimination and substitution of hazards
- Follow up on all hazard controls for each task to make sure they are protective enough.

Education And Training

Education and training can be thought of as a tool that binds each step together to keep the efforts cohesive. Some utilities have relied on safety training from organizations or even videotapes with outdated material. The role of education and training must be a factor in developing both management and workers to create the overall safety culture. General workers should have safety awareness training with regular operations or maintenance training. However, if they work in a specialized area that exposes them to unique hazards, then training must be applicable to that hazard. Effective training can be done peer-to-peer, in formal classrooms, online, or at the worksite. Some action items suggested by OSHA are:

- Provide program awareness training
- Train employers, managers, supervisors on their individual safety roles
- Train workers on their specific role in the safety program
- Train workers on hazard identification and controls.[5]

Program Evaluation And Improvement

Every program in an organization must be vetted and improved in order to stay viable and productive; safety programs are no different. This effort of program evaluation must be made in a given interval and by a competent group. If there are deficiencies found in a program, then the corrections must be made in a systematic way by high-risk issues being fixed first and lower-risk areas last. Risk can be calculated as Probability x Severity = Risk. The probability of a loss event occurring can be broken down into five categories:

1. Improbable
2. Unlikely
3. Probable
4. Likely
5. Frequent.

Severity speaks of the consequence of a loss event when it does occur:

1. Minor
2. Marginal
3. Serious
4. Catastrophic.

If your risk assessment tells you that a task is a P4 x S3 = R12, then it should get your attention over an R3 item.

Program evaluation and improvement must include the following areas:

- Monitoring performance and progress
- Verifying the program is implemented and is operating
- Correct program shortcomings and identify opportunities to improve.[6]

Communication And Coordination For Host Employers, Contractors, And Staffing Agencies

The utility must take responsibility for all workers, including contract and staffing agency workers. Many utilities are not under the jurisdiction of federal OSHA or even a state OSHA, but the contract companies are under an occupational safety agency that will regulate and cite them for violations. However, local government officials have a moral obligation to make sure that workers of all types that do business with them are protected from hazards. To keep the workers safe, the utility should:

- Communicate with all outside contractors the importance of worker safety
- Coordinate with supervisors, owners, and workers throughout the project to make sure the worksite is safe
- Hold all workers and agencies accountable for operating a safe worksite
- Verify that the bids and contracts specify that safe work practices are a must for working with the municipality.

A safety culture will protect the worker from injury and illness because the utility places a value on the lives of the workers. This is a deposit into the "goodwill" bank of the worker and will be rewarded with loyalty. A deep commitment to a safety culture will lead to worker retention and organizational benefits far beyond regulatory compliance. ■

References:

[1] U.S. Bureau of Labor Statistics (BLS), U.S. Department of Labor (https://www.bls.gov/ooh/production/water-and-wastewater-treatment-plant-and-system-operators.htm#tab-6)

[2] BLS, North American Industry Classification System, NAICS code 221300 (https://www.bls.gov/oes/current/naics4_221300.htm)

[3] BLS (https://www.bls.gov/iif/oshwc/osh/os/ostb4732.pdf)

[4] Occupational Safety and Health Administration (https://www.osha.gov/shpguidelines/docs/OSHA_SHP_Recommended_Practices.pdf)

[5] OSHA (https://www.osha.gov/shpguidelines/education-training.html)

[6] OSHA (https://www.osha.gov/shpguidelines/program-evaluation.html)

About The Author

Sheldon Primus is a certified occupational safety specialist with a masters of public administration with a concentration in environmental policy. He is part of the first class of six operators to receive the Professional Operator (PO) designation from the Certification Commission for Environmental Professionals (C2EP) of the Association of Boards of Certification (ABC). Additionally, he is a trainer for the Certified Occupational Safety Specialist (COSS) program of the Alliance Safety Council-Baton Rouge, LA. Sheldon is owner/CEO of Utility Compliance Inc., its subsidiary OSHA Compliance Help, and the online water/wastewater/safety training school Primus Institute. E-mail: sheldon@utilitycompliance.com or sheldon@oshacompliancehelp.com.