2020 Black & Veatch
Strategic Directions

Water Report

About This Report

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Based on a survey of roughly 300 stakeholders in the North American sphere of water and wastewater, the Black & Veatch 2020 *Strategic Directions: Water Report* examines the issues and trends impacting today's water industry at a time when matters couldn't be more complex.

The water sector continues to be plagued by multiple challenges underlined by aging infrastructure in combination with an aging workforce that puts our systems at even greater risk due to the loss of critical expertise. Increasing natural disasters impacting water systems, including wildfires, floods and drought, highlight the rising impacts of climate change on the resilience of our water systems and the need for significant investment. A global pandemic and the resulting financial havoc has multiplied the pressure on utilities to be resilient in their services and make the sorely needed investment in supply, treatment, conveyance and storage facilities. COVID-19's spread forced federal, state and local governments to halt businesses and industries, leaving tens of millions of Americans jobless and unable to pay utility bills in a time when clean water and sanitation is foundational to stopping the spread of the virus.

While the added complication of COVID-19 has further strained the bottom lines of many water utilities, this moment of crisis provides the opportunity to accelerate innovation in strategy, operations and funding. Utilities will need to unleash the value of data in their operations by using analytics and other technologies to drive better decision-making, optimize and prioritize system investments, and drive cost efficiencies that propel sustainable and resilient systems.

This year's report dives into these issues and many more, providing in-depth analysis by leading industry experts. We welcome your questions and comments regarding this report and/or Black & Veatch services. You can reach us at **MediaInfo@bv.com.**

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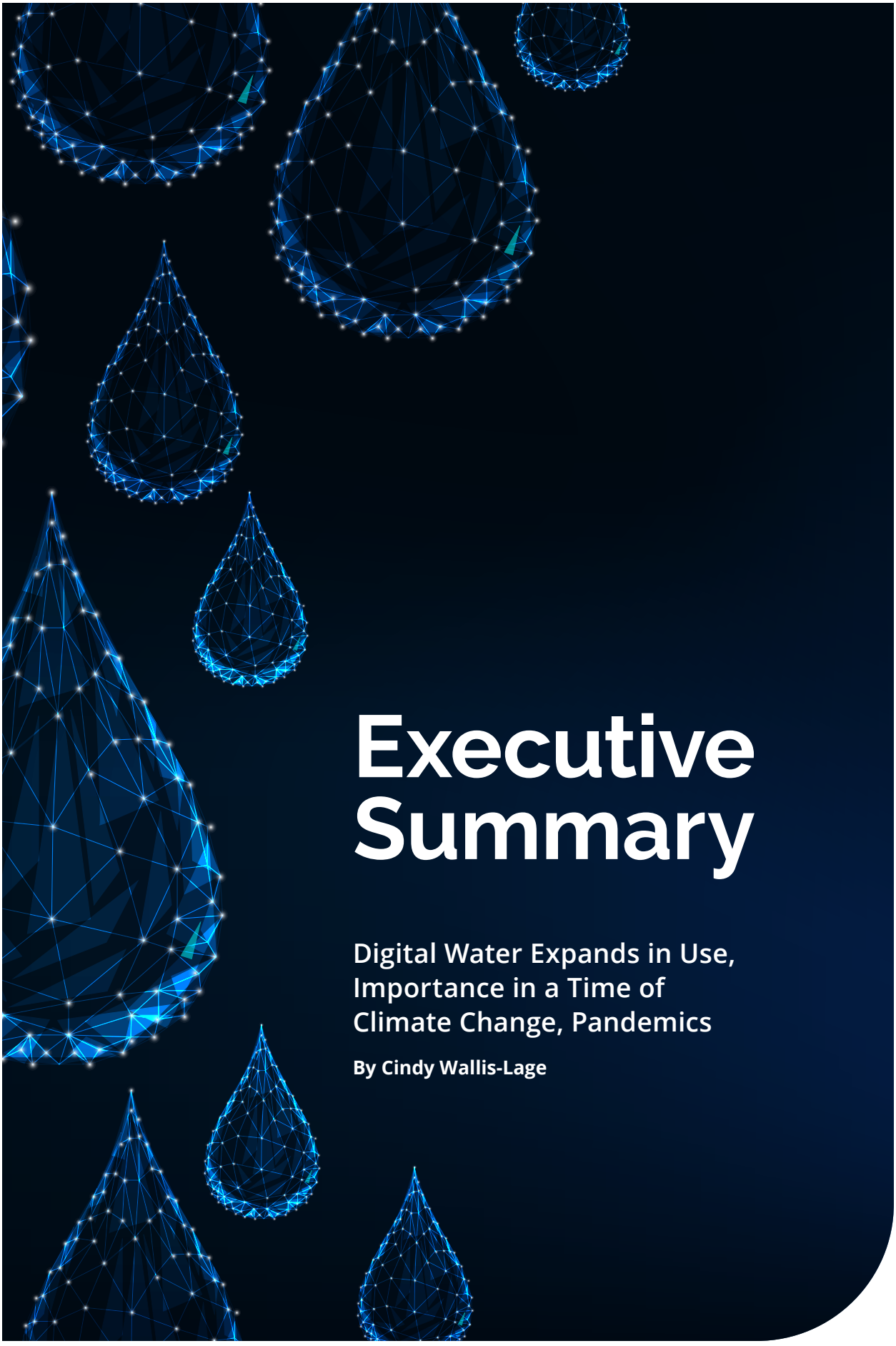


Executive Summary

Digital Water Expands in Use, Importance in a Time of Climate Change, Pandemics

By Cindy Wallis-Lage

ABOUT THE AUTHOR

Cindy Wallis-Lage *is President of Black & Veatch's water business, leading the company's efforts to address water infrastructure needs around the world. A global champion for the world's water resources, she advocates understanding water's true value and promoting its resilience so that communities may achieve their social, economic and environmental sustainability goals. Wallis-Lage has been involved in more than 100 projects worldwide, helping public and private entities successfully, develop, enhance and manage their water, wastewater and stormwater facilities and infrastructure.*

Across the spectrum of water utilities, the churn of challenges has seldom been more glaring, squeezing stakeholders and forcing them to think outside the box.

Aging infrastructure and the graying of the industry's retirement-bound workforce remains a vexing issue, decades in the making. Climate change continues to assert itself in dramatic ways — from a "megadrought" gripping a large swath of the western United States to intense flooding elsewhere — that test the ability of water utilities either to provide enough water or effectively handle historic inundations.

All of this is compounded by a global pandemic. Beyond its tragic death toll, COVID-19 unleashed a worldwide financial meltdown fanned by government-ordered shutdowns of businesses and industries. Unsurprisingly, U.S. water utilities are taking an operational and financial hit as some of their biggest clients — commercial and industrial users — have halted operations and tens of millions of laid-off U.S. workers have stymied the ability of households to pay their utility bills, undercutting revenue to water and energy providers.

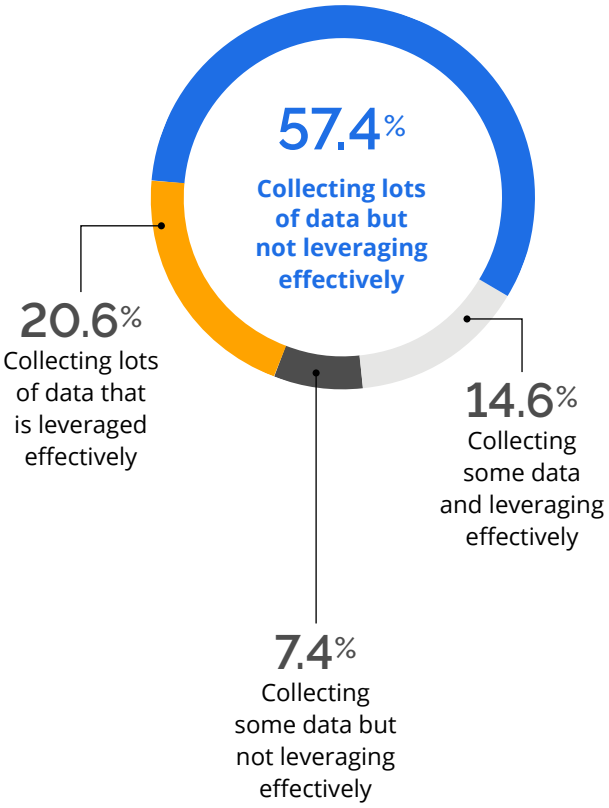
Welcome to a transformative time in the world of water, where government and water industry decision-makers around the globe continue to absorb how climate impacts and increased financial constraints threaten our supply's resilience.

Now more than ever, stakeholders faced with such complexities continue to embrace the promise of "digital" or "smart" water. That means harnessing data to precisely track consumption, drive customer engagement, optimize performance and prioritize investment dollars. Increased sustainability and resilience through informed asset management (AM) and planning are the rewards, along with the invaluable, holistic view of the water system.

Figure 1

In terms of data volume versus its usefulness, which of the following statements best describes the current data management practice at your organization?

Source: Black & Veatch



Digital Water: Solutions in the Numbers

To little surprise, U.S. water utilities — the municipalities and private companies that provide the tens of thousands of community water systems that are the backbone of this nation's water sector — are doing more with less. Eighty percent of the nearly 300 North American respondents to Black & Veatch's 2020 *Strategic Directions: Water Report* survey cited aging water and wastewater infrastructure as the industry's chief challenge. That's an overwhelming alignment which is independent of the size or region of the utility and easily eclipses other issues such as justifying capital improvement programs, managing capital costs or system resilience.

Enter the power of data to gain insight about when, where and how much to invest in our systems. The opportunity to gather and integrate data using our current data collection systems — combine with evolving next-generation, cost-effective sensors and smart devices — provides the input to allow for the predictive analytics to detect leaks, forecast usage, reduce costs and everything in between. Some 15 percent of respondents report having a robust, fully integrated approach to data, encouragingly up from just 5 percent a year earlier. Some 56 percent say their data-management efforts are strengthening but not fully integrated, consistent with 2019's results. Nearly 30 percent — a slight decrease from one-third a year earlier — say their data remains largely unintegrated in silos.

Asked separately about their data's meaningfulness, nearly 60 percent respondents reported that while they were collecting "lots" of data, it wasn't being leveraged to actionable information. Just 20 percent said they were making the most of their data, with only 15 percent admitting they were corralling "some" data and using it effectively *(Figure 1)*.

Siloed data amounts to lost opportunity, costing operators the vast benefits of expansive data harvesting that can give meaningful insights about their entire water ecosystem. Better date use also can guide them to higher operational efficiency, performance predictability, maintenance planning and optimized workforce needs. If you think of the utility's components as its nervous system, maximizing data collection through digital tools can give utility managers the clearest picture of its overall health — a forward-thinking approach.

Siloed data amounts to lost opportunity, costing operators the vast benefits of expansive data harvesting that can give meaningful insights about their entire water ecosystem. Better date use also can guide them to higher operational efficiency, performance predictability, maintenance planning and optimized workforce needs.

In addition to digital water's influences and climate change impacts on the water industry, and other key issues, our report examines:

- **Aging infrastructure:** For the water industry, the pursuit of sustainability has been challenged in recent decades by insufferable headwinds involving the aging of both the industry's infrastructure and its workforce. With the water system in urgent need of repair, maintenance and restoration, we look at how sizable the sector's concerns about each of these are — and to what extent they're dealing with them. What strategies should be deployed?
- **Water reuse:** Weighty issues such as population growth, climate change, regional droughts and floods are pushing the availability of freshwater— and the need to mitigate effluent discharge — to the forefront of water management. As more utilities take a circular economy approach to water resource management and sustainability, what are the latest trends in water reuse, including reclaimed water? What measures can utilities take to overcome cost and public acceptance barriers to implement more water reuse solutions?
- **Water affordability:** Customers expect that when they turn on the faucet, they will get potable water at adequate pressure and enough of it for their on-demand needs. They expect to pay for this level of service but at reasonable prices. The question then becomes, "Is water affordable?" The answer may become more elusive against the backdrop of the COVID-19 pandemic, which could challenge a utility's reserves, how rates are structured and how a utility looks to manage its customer services and operations.

Figure 2

What are your most significant resilience concerns?
(Select up to three).

Source: Black & Veatch

83.5%
Natural or man-made disaster

55.7%
Infrastructure catastrophic failure

38.1%
Extended drought/ supply restrictions

34.0%
Cyber attack

30.9%
Impacts from climate change

12.4%
Terrorist attack

5.2%
Other

Climate Change a Key Concern

Discussed separately at length in this report, climate change — and the increasingly worrisome predictions about it — continue to grab attention among water utilities as one of the great water challenges of our time. More than 80 percent of respondents to Black & Veatch's survey listed natural or man-made disasters as their top resilience concern. Catastrophic infrastructure failure was a distant second (56 percent), followed by another climate change-related category — extended drought and supply restrictions — at 38 percent *(Figure 2)*.

Asked separately which elements are included in their water supply plan, 85 percent of those surveyed said water conservation or drought management. Nearly 70 percent said "scenario planning," with climate change and variability closing out the top three at 55 percent.

Just half of respondents declared they were "somewhat more confident" about their supply forecasting model now than in recent years. Twenty-five percent said their confidence is unchanged, while an identical amount said they were "somewhat less confident" today.

A Pandemic Affects the Water Sector

Because the online survey for this report was conducted during a three-week span ending on March 30, 2020 — a time when the COVID-19 pandemic was accelerating — it's difficult to discern how much of an impact that global outbreak had on the responses. Or whether the data would be dramatically different if the survey was done later during the height of the virus' spread.

Undeniably, as also discussed in this report, the pandemic has rattled the water industry. Beyond the universal need for reliable access to clean water for public health -- regardless of one's ability to pay -- the outbreak forced many commercial and industrial customers to halt operations. In turn, that has strained utilities' revenues and cash flows. Tens of millions of U.S. workers were laid off during the outbreak, rendering many of them unable to pay their water bills. Around the country, water providers suspended water and wastewater shutoffs to delinquent accounts, in both the interest of humanity and as affirmation of the importance of water and sanitation in trying to contain the virus.

At the time of this report, questions lingered about whether the federal government planned to direct taxpayer aide to municipalities, given COVID-related revenue shortfalls that likely would impact whether investments in water infrastructure go forward, or if the industry will face belt-tightening challenges akin to the financial crisis more than a decade earlier.

The National Association of Clean Water Agencies (NACWA) led a joint water sector request to Congress on May 14, 2020, to address the coronavirus pandemic's impacts on drinking water systems, clean water systems and water recycling systems. Current predictions estimate a $16.8-billion impact to clean water utilities and a $13.9-billion impact to drinking water utilities due to lost revenue. NACWA warned that without taxpayer help to the industry, the revenue loss from forgiving customer debts and providing services without payment during the pandemic ultimately would be passed on to water customers in subsequent years and lead to future rate increases.

"As the nation grapples with the COVID-19 response, the nation's public clean water agencies are at the front lines of ensuring Americans have reliable, critical clean water services," said Adam Krantz, NACWA's chief executive. "The impacts of coronavirus for clean water agencies will be enormous."

This is a time of great challenge, and with it comes an opportunity to drive change; change that can be fueled by innovation in strategy, operations and funding to protect human health and our environment and to facilitate the economic engine that comes from infrastructure investment.

As Infrastructure Ages, ‘Digital Water’ Drives Optimization

By Jeff Stillman, Jeff Buxton, Andrew Chastain-Howley and James Strayer

Water utilities take on the difficult job of ensuring that water always will be safe and that capacity always will be available — whether delivering drinking water or treating wastewater. This is becoming an increasingly difficult task, given unforeseen events such as the COVID-19 pandemic that compound the chronic issues with aging water infrastructure and an aging workforce taking its institutional knowledge into retirement with it. Finding the right balance of resource allocation and operations activities is vital.

The water industry is an asset-intensive, rate-restricted industry that requires informed decision-making to effectively balance capital investment and rising operational expenses with resistance to rate increases. This makes the water industry notoriously complex, variable and uncertain. The industry, therefore, is an ideal candidate for a technological overhaul and transformation that would build new, data-driven solutions for effective asset management, efficient operations and remote system management, reducing operating costs.

This overhaul will rely on better use of existing data coupled with new sensors, information integration and data analytics to achieve a sought-after result called “digital water.” However, most utilities have a long way to go with digital sensors, communications and data analytics before they can reach the desired future state as a digital water utility.

Digital transformation of water utilities is not based on the implementation of a single technology but a collection of operational technologies. Those including field sensors, communications backbones, computer models and assessments coupled with predictive software, supervisory control and data acquisition (SCADA) systems, geographic information systems (GIS), flow and/or water quality data analysis, computerized maintenance management systems (CMMS) and operations management systems (OMS), as well as customer information systems (CIS). The right combination of these technologies, when properly integrated, will fuel digital water transformation.

The Beginning of the Utility Data Analytics Pipeline

Today, service providers generally are in at least the early stages of implementing some element of digital water technology, according to Black & Veatch's annual survey of industry stakeholders for its 2020 *Strategic Directions: Water Report*. This means they are collecting data in an attempt to drive smart decision-making. However, few utilities can say they are fully digitized despite their data collections growing ever larger.

When asked to describe current data management practices, 15 percent of survey respondents indicated that they have a robust, fully integrated approach. This achievement is worthy of further study to characterize best practices among the high-performing utilities. Most water utilities — 56 percent — indicated that their efforts are strong and getting stronger, but they still are not yet fully integrated. Finally, a significant minority of utilities (29 percent) noted that their data is still largely isolated in silos and not integrated *(Figure 3)*.

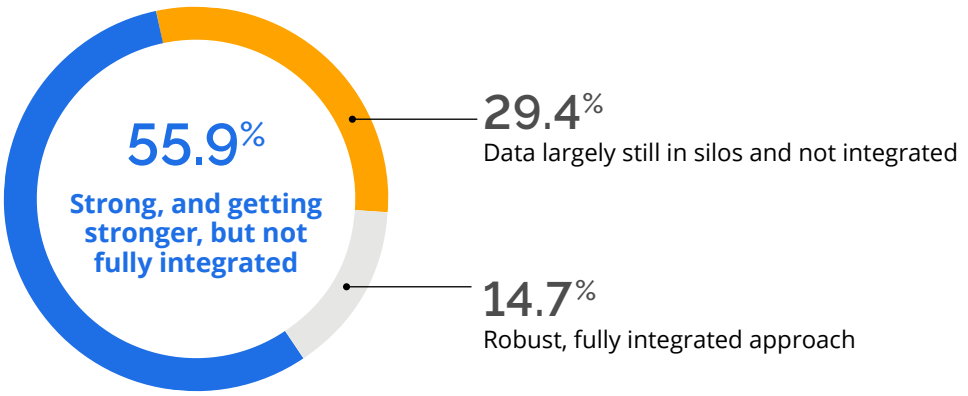
The efforts made vary significantly depending on utility size. While 24 percent of utilities serving 500,000 or more customers reported that they have a robust, fully integrated approach to data management in place, only 7 percent of smaller water utilities said the same.

Most water utilities — 56 percent — indicated that their efforts are strong and getting stronger, but they still are not yet fully integrated.

Figure 3

Which of the following statements best describes the current data management practice at your organization, in terms of integration? *(Select one)*

Source: Black & Veatch



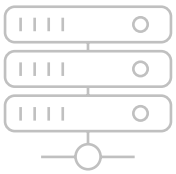
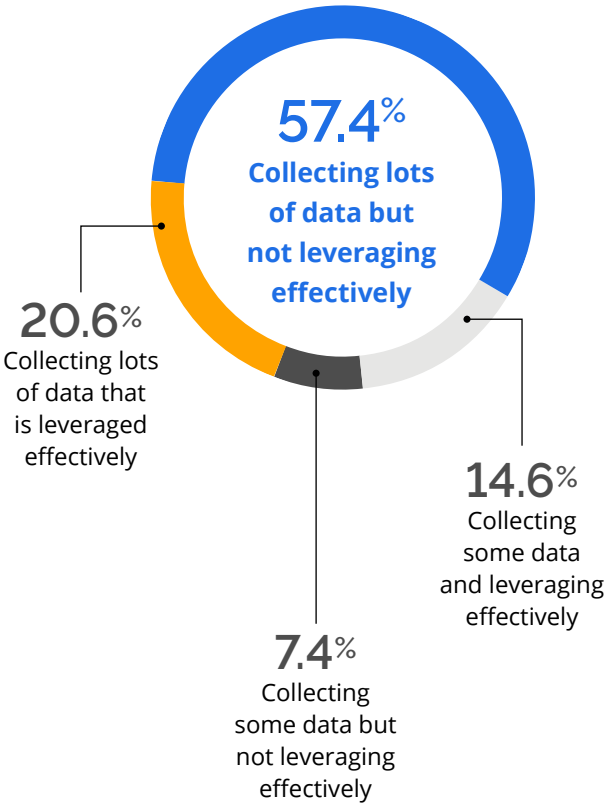


Figure 4

Which of the following statements best describes the current data management practice at your organization, in terms of data volume versus usefulness?

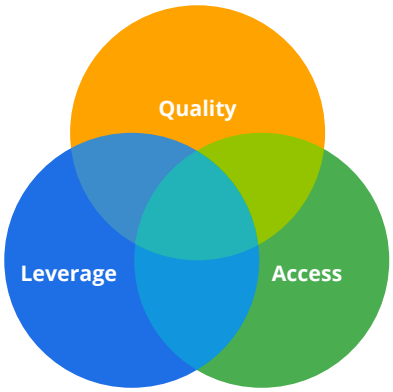
Source: Black & Veatch



Data, But Not Insight

The vast majority of water utilities reported they are collecting lots of data. Still, only roughly 20 percent of respondents say they are leveraging it effectively for digital transformation, meaning that most utilities have a long way to go in their push to optimize their utility data analytics *(Figure 4)*. Collecting data is a critical first step, but it can be a significant challenge to use that raw data to yield actionable intelligence, improve digital water utility operations, and effect digital transformation.

Knowing where to start can be a challenge. As water utilities are highly asset- and infrastructure-oriented, one of the best first steps toward digital water is the adoption or improvement of asset management business practices. Additionally, a rapidly growing subset of data collection is in remote system monitoring. Water utilities often carry high field services costs that can be addressed through increased remote system monitoring, which is a major step in digital water transformation.



The Quality-Access-Leverage Equation: Without having all three, a utility is not fully optimized for digital water.

The Quality-Access-Leverage Equation

Success as a digital utility hinges on the quality, access and leverage of available data throughout the organization. Survey results showed that significant numbers of water utility professionals — more than 90 percent — are positive on their views of their data quality, labeling it "very good" or "good" and either "all correct" or "mostly correct," but this may not be the full picture. Quality may be excellent in specific areas, but it is unlikely across the whole utility. Furthermore, access to data and effective leverage of that data are key elements of a successful digital utility.

- **Quality:** The first element in achieving digital water efficiencies is ensuring the data being collected is of the highest possible quality and is appropriate to the needs of the organization.
- **Access:** This involves not only having the data and ensuring that it's correct and complete, but ensuring it is available and secured within technology platforms and across all business areas that measure and manage the utility's assets and operations.
- **Leverage:** The utility must implement appropriate tools, analytics, and workflows to make the best use of the data and leverage it for deeper insights throughout the organization — not necessarily just the original purpose it was collected for.

Utilities with properly structured and vetted data policies can collate, organize and leverage it across systems and workgroups to ensure integration and effective management of the infrastructure to enable good digital water utility data-centric decision making.

The Elements of Digital Water

When asked which functions or elements they see as being included in a digital water initiative, few commonalities exist. The "digital water" definition seems to be unclear for many *(Figure 5)*. Some of the best-established systems that are widely utilized — such as SCADA, GIS, flow and water quality data, and CMMS — were less likely to be considered as part of a digital water initiative. This may be partly because they have been in use for a long time already, but it also may be that these systems are viewed as important for a particular "silo" in the organization. In practice, each of these systems are data-rich and are important foundational elements for a digital water utility.

The top systems identified as part of a digital water initiative were also some of the least widely utilized systems, such as energy management, document management, business intelligence and enterprise resource management. This may reflect an understanding that a digital water initiative is an effort to implement new systems. While this may be true — and some new systems may be required — integration of existing systems is also a key element in optimizing a digital utility.

Figure 5

Which elements do you see as being included in a digital water initiative, and which elements does your utility currently use? *(Select all that apply)*

Source: Black & Veatch

	Included in a digital water initiative	Currently used
SCADA (Supervisory Control and Data Acquisition) System	19.1%	83.8%
GIS (Geographic Information System)	19.1%	82.4%
Flow and/or water quality data	20.6%	77.9%
CMMS (Computerized Maintenance Management System) or Operations Management Sytem (OMS)	17.6%	69.1%
Customer information	17.6%	69.1%
Static datasets (in-house Excel models)	20.6%	63.2%
Computer models and other assessment/predictive software	29.4%	63.2%
Automated Meter Reading (AMR) or Advanced Metering Infrastructure (AMI)	25.0%	63.2%
Mobile workforce solutions	22.1%	61.8%
Weather data (rainfall, temperature etc.)	26.5%	58.8%
LIMS (Laboratory Information Management System)	19.1%	57.4%
Dashboards and tools for accessing/ displaying info (PowerBI, Tableau, etc.)	26.5%	51.5%
Document Mgmt System (DMS) or Information Mgmt Systems (IMS)	27.9%	48.5%
Energy management systems	29.4%	41.2%
Data analytics and/or business intelligence systems	27.9%	35.3%
ERM (Enterprise Resource Management System)	25.0%	29.4%

Barriers to Digital Water, Utility Transformation

The most challenging issue to water utilities today is aging water and wastewater infrastructure, with nearly 80 percent of water utilities of all sizes identifying this as their biggest problem. Utilities will have a more difficult path to a digital water initiative if their equipment and technologies are not optimized for smart water utility practices, costing them an opportunity to be more targeted in addressing aging infrastructure and prioritizing investment dollars.

Additionally, many organizations report mixed success when it comes to getting top-level management to commit to a culture of innovation. Only 37 percent of organizations report that management is fully committed to innovation, and only 28 percent report that their organizations have a clear vision and goals established for more sustainable models of operations in the future. Only 13 percent of utilities reported that the use of resources is clearly mapped and documented to provide transparency.

Going forward, water utilities will need to properly deploy digital data acquisition and wield data analytics in utility operations and maintenance. That would preserve their existing infrastructure, address burdensome O&M costs, reduce water waste, determine where new investments in infrastructure would be most effective, and reap the benefits of smart water analytics and data sharing to drive intelligence-based decisions in operations and infrastructure investment.

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James Strayer *is the department head for Black & Veatch's planning and asset management team in North America. He has 27 years of experience spanning planning, design, construction, programs, and asset management applications.*

Aging Infrastructure and Workforce: Vexing Challenges Remain

By Rob Knee, Will Williams and Joe Zhou

This isn't news. In fact, it's an old and long-standing problem.

America's water infrastructure is deteriorating quickly, causing increasing failures because adequate investments haven't been made in rehabilitation or replacement. Not surprisingly, aging infrastructure is the major worry for respondents to Black & Veatch's 2020 *Strategic Directions: Water Report* survey. Nearly 80 percent of the water, wastewater and stormwater professionals who took the survey named aging infrastructure as the most challenging issue they face today *(Figure 6)*.

Many also report that the experienced workers who have kept their water flowing for decades are reaching retirement age. These dual problems are forcing utilities to focus on asset management, shift hiring practices and adopt new strategies for the workforce of tomorrow.

Figure 6

From your perspective, what are the most challenging issues facing the water, wastewater and stormwater industry?
(Select up to three)

Source: Black & Veatch

Making the Grade

According to the bi-annual infrastructure report card issued by the American Society of Civil Engineers (ASCE), the 2019 edition again gave America's drinking water infrastructure a grade of "D" — unchanged from 2017 but an actual, albeit marginal, improvement from the "D" of 2009.

This worry has been years in the making. Water utilities start in small, centralized locations and grow as the communities they serve expand. Investment typically has gone into keeping up with municipal growth and daily operations.

Meanwhile, as the water system grows and grows, the pipes that have been in the ground generally only get attention when they're close to failure *(Figure 7)*. Replacing that pipe is costly and disruptive.

How old is our water infrastructure? That depends. When journalists at Circle of Blue — a water-oriented online news venue — queried public works departments of U.S. cities, they found that half of Philadelphia's mains are at least 90 years old, with some mains pre-dating the Civil War. The average water main's age in Baltimore is 75. Whereas in San Antonio, half the pipes were installed after 1985.

In another study, Utah State University researchers who examined some 200 water utilities in the United States and Canada in 2018 found that 16 percent of their mains were beyond their useful lives. Six years earlier, only 8 percent of mains had reached the end-of-life stage. And because a larger proportion of pipes are reaching or exceeding their life spans, pipes break more, resulting in a 27-percent increase in ruptures during the six years between the two Utah State studies.

This, of course, shows up in those American Water Works Association and ASCE report card statistics: An estimated 240,000 main breaks happen annually, and 6 billion gallons of treated drinking water go to waste each day due to leaking pipes.

Figure 7

Once a need for infrastructure improvement has been identified, how do you know when to take the next step and execute the project? *Rank the following from 1 (most impact) to 5 (least impact).*

Source: Black & Veatch

	1 Most Impact	2	3	4	5 Least Impact
When we suspect something is about to break/fail	**60.0%**	24.7%	10.6%	4.7%	0.0%
When regulatory bodies demand action	21.2%	**44.7%**	24.7%	7.1%	2.4%
When public opinion demands it	5.9%	18.8%	**43.5%**	24.7%	7.1%
When we see other communities taking action	0.0%	8.2%	17.6%	**62.4%**	11.8%
Other	12.9%	3.5%	3.5%	1.2%	**78.8%**

Getting Smarter

The water system's age and frailty are forcing utilities to increase efforts related to asset management. Some are choosing to augment these endeavors with analytics.

England's Anglian Water supplies water to more than 6 million customers and manages infrastructure for the largest water-utility territory in the country. This past year, the utility commissioned Black & Veatch to develop a digital representation that mirrors the region's water treatment and distribution infrastructure. This "digital twin" will have embedded artificial intelligence capabilities that enable predictive analysis to support decision-making and failure-prevention efforts. The digital infrastructure also is in constant dialogue with its physical counterpart, which allows Anglian Water to simulate and test options before implementation in the real world.

Such technology is a huge addition to utility intelligence and also serves to address the threat to organizational knowledge: retiring workers.

On average, survey respondents report that 26 percent of their workers will be eligible for retirement within the next five years *(Figure 8)*. Twenty-five percent say that at least more than 30 percent of their most experienced workers will hit retirement age in that five-year window.

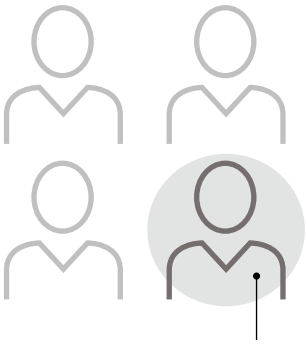
If a utility's most experienced people suddenly leave en masse, what happens when crews need to fix a pipe that's been in the ground for 50 years? It's the experienced workers who know the quirks of the system, and that institutional knowledge will follow them out the door.

26 percent of their workers will be eligible for retirement within the next five years.

Figure 8

What percentage of your workers are eligible for retirement in the next five years?

Source: Black & Veatch



1 out of 4

workers will be eligible for retirement within the next five years

Only 44 percent of survey respondents could agree that their utilities had robust documentation processes in place. Most — 83 percent — agreed that some tribal knowledge is lost when someone leaves. Sixty percent of respondents agreed with the statement, "Our system has some peculiarities that only a small group know about" *(Figure 9)*.

It's not unusual to hear water utility workers admit that they only have a handful of people who could go to an older part of town and understand where to go on the line to redirect the water or how to work on that specific type of pipe. Even worse, water utilities face recruiting challenges because the work is difficult and not necessarily appealing to a new generation of workers. It takes a special commitment to rush to fix a ruptured pipe at 1 a.m. when it's 28°F degrees outside and water is gushing all over the street.

The same is true for treatment systems. In recent discussions with utilities about risk and resilience assessments under America's Water Infrastructure Act, we asked the question, "If you were without access to digital control systems or data, how well could you operate the system?" A number of utilities would struggle to find the operations manual and have fewer experienced workers who could operate treatment works without advanced online control systems.

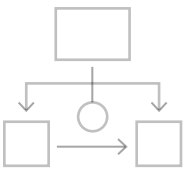


Figure 9

Please indicate to what extent you agree or disagree with the following statements relative to workforce knowledge and process documentation. *(Select one for each row)*

Source: Black & Veatch

	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
Some tribal knowledge will naturally be lost when someone leaves	33.3%	**49.4%**	10.3%	4.6%	2.3%
Our system has some peculiarities that only a small group know about	12.6%	**48.3%**	19.5%	16.1%	3.4%
We rely on technology to standardize many operational processes	14.8%	**39.8%**	27.3%	17.0%	1.1%
We have adequate succession planning processes	8.0%	**40.9%**	22.7%	18.2%	10.2%
We have robust documentation that covers all necessary responsibilities	8.0%	**36.4%**	25.0%	22.7%	8.0%
If we rely on too much data we risk losing the human element	5.7%	35.2%	**36.4%**	12.5%	10.2%

Despite the grittiness of many water utility jobs, water providers still have had to change what they look for in new hires, too.

Nearly 80 percent say digital savviness has become more important. That's likely because water utilities increasingly are using mobile workforce management systems, meaning workers must navigate that software on a laptop or tablet. They also may need to be able to use a content management system to access the documentation held within it *(Figure 10)*.

Communication skills also are considered more important now, according to nearly three-quarters of respondents. That makes sense, given that the people out in the field fixing a broken pipe or meter are also the public face of the utility: If they have poor communication skills, it can reflect poorly on the organization.

Analytic skills are equally important, according to nearly three-quarters — 72 percent of respondents — because these new workers will need to learn quickly, before their more experienced teammates retire.

Figure 10

When thinking about the qualities your organization looks for in a new hire, how have those qualities changed from five years ago? *(Select one for each row)*

Source: Black & Veatch

	***Much more* important today**	***Somewhat more* important today**	***Same* importance today**	***Somewhat less* important today**	***Much less* important today**
Digital savviness	31.0%	**48.3%**	20.7%	0.0%	0.0%
Communications skills	19.5%	**54.0%**	26.4%	0.0%	0.0%
Analytical skills	18.4%	**54.0%**	24.1%	2.3%	1.1%
Engineering background	10.3%	36.8%	**46.0%**	4.6%	2.3%
Experience in the industry	11.6%	34.9%	**50.0%**	2.3%	1.2%
College degree	10.6%	22.4%	**56.5%**	9.4%	1.2%
Ability to work odd hours	4.6%	18.4%	**64.4%**	9.2%	3.4%

Figure 11

To what extent are you making changes to attract and retain your employees?

(Select one for each row)

Source: Black & Veatch

	Currently doing	Planning to do	No plans to do
Adjusting compensation and benefits packages	**58.0%**	20.3%	21.7%
Improving work/life balance	30.1%	28.8%	**41.1%**
Adding perks to the workplace (food, drink, etc.)	24.3%	17.1%	**58.6%**

To attract these skills, water utility managers are raising their recruitment efforts by increasing compensation (78 percent), improving work/life balance (59 percent) and adding workplace perks (41 percent) *(Figure 11)*.

The data reflects the combination of aging infrastructure assets, quirks and all, coupled with critical workforce elements often closer to the end of their careers than the beginning, that creates a unique challenge for any essential service provider. Yet, technology and an increasing recognition of the value of water services may provide the key resources necessary to ensure the reliability of systems for decades to come. Sensor deployments, metering and increasingly smart data modeling, digital twins and analytics provide new levels of insights that can complement institutional knowledge (before it leaves) to create a permanent record of critical system functions that can be studied, refined and improved.

While maintaining water and wastewater infrastructure will never be considered easy work, deploying technologies that both reduce operational inefficiencies like leakage and non-revenue water while reducing the likelihood of asset failures of the type that disrupt service (and sleep) definitely lighten the load.

ABOUT THE AUTHORS

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Utilities Increasingly Rely on Planning, Forecasting to Mitigate Climate Change Impacts

By Jim Schlaman and Jon Dinges

Climate change and the resulting fluctuations in weather events are changing the game for utilities as increasing numbers of devastating floods, droughts, snowpack changes and ferocious wildfires alter our assumptions about water security and supply.

The climate change picture is bleak. According to the *Center for Disaster Philanthropy*, there were 14 billion-dollar weather and climate change disasters in 2019. The Atlantic hurricane season continued its four-year streak of above-average storms, *with a record 18 named storms*. Flooding impacted *14 million people*, with 200 million deemed "at risk." And 2018 was the most *devastating wildfire season ever* in the United States, with six states breaking wildfire records.

In 2018, the United Nations' Intergovernmental Panel on Climate Change (IPCC) issued a *special report* that estimates human activities have caused approximately 1.0°C of global warming above pre-industrial levels, and it projects that at the current rate we will see global warming increase temperatures by 1.5°C between 2030 and 2052. The U.S. Environmental Protection Agency (EPA) warns that these impacts are likely to affect the hydrologic cycle, impacting everything from the flow of water in watersheds to the quality of aquatic and marine environments, not to mention the programs designed to protect water quality and public health and safety.

The U.S. Department of Defense (DoD) considers global warming to be *an existential threat to security*, insisting to Congress in a 2015 memorandum that "climate change is an urgent and growing threat to our national security, contributing to increased natural disasters, refugee flows and conflicts over basic resources such as food and water. These impacts are already occurring, and the scope, scale and intensity of these impacts are projected to increase over time."

Figure 12

What are your most significant resilience concerns?
(Select up to three).

Source: Black & Veatch

83.5%
Natural or man-made disaster

55.7%
Infrastructure catastrophic failure

38.1%
Extended drought/ supply restrictions

34.0%
Cyber attack

30.9%
Impacts from climate change

12.4%
Terrorist attack

5.2%
Other

The current COVID-19 situation also is demonstrating firsthand the critical need for water utilities to continue to evaluate and plan for vulnerabilities and potential system failures to mitigate against a changing and uncertain future. Whether it's a global pandemic, catastrophic droughts, raging wildfires or destructive floods, utilities must make their systems reliable and resilient to meet the needs of the 21st century.

Black & Veatch's 2020 *Strategic Directions: Water Report* survey of qualified utility, municipal, commercial and community stakeholders looks at how today's water industry is addressing and adapting to climate change.

Addressing Resilience Concerns

Survey data shows that climate change and its impacts are driving significant concerns around resilience. Natural and/or man-made disasters rank as the No. 1 threat to resilience efforts — not surprising, given the increase in the number and intensity of severe weather events over the past decade *(Figure 12)*.

Catastrophic infrastructure failure ranks second, indicating a concern that likely correlates to why more and more utilities are turning to robust asset management programs to mitigate these risks. Extended drought and/or supply restrictions — also tied to climate change — ranked third, followed by cyberattack, impacts from climate change and terrorist attack.

Utilities recognize the critical need to invest in infrastructure improvement projects. Still, their limited resources require striking the right balance between addressing emerging needs and executing repair and rehabilitation of existing assets. Having a well-defined asset management and assessment program in place allows utilities to analyze systems for vulnerabilities and catastrophic failures and mitigate those risks in a balanced and proactive way.

Figure 13

Once a need for infrastructure improvement has been identified, how do you know when to take the next step and execute the project? *Rank the following from 1 (most impact) to 5 (least impact)*

Source: Black & Veatch

	1 Most Impact	2	3	4	5 Least Impact
When we suspect something is about to break/fail	**60.0%**	24.7%	10.6%	4.7%	0.0%
When regulatory bodies demand action	21.2%	**44.7%**	24.7%	7.1%	2.4%
When public opinion demands it	5.9%	18.8%	**43.5%**	24.7%	7.1%
When we see other communities taking action	0.0%	8.2%	17.6%	**62.4%**	11.8%
Other	12.9%	3.5%	3.5%	1.2%	**78.8%**

Most respondents (60 percent) said asset health is the key driver of capital project prioritization *(Figure 13)*. This is particularly true for smaller utilities: Of those that serve fewer than 500,000 people, 70 percent are working to stay ahead of breakage and failure, compared to 47 percent of larger utilities. This suggests that larger, more equipped utilities — armed with robust asset management programs and targeted teams focused on condition assessments often facilitated by stronger financials — have these situations under control, allowing them to look farther down the road. Smaller utilities often are at a disadvantage here and remain focused on meeting basic level of service goals.

If utilities have an asset considered vulnerable, they will work to fix it immediately and not wait for regulators to step in. When it comes to addressing emerging issues, the industry largely is driven by regulators, with two-thirds of respondents waiting to execute infrastructure improvement projects until instructed by regulators. It is admittedly a nuanced situation, and utilities often are reticent to spend money unless instructed. The data does indicate that when there are resilience projects to be studied and built, the industry doesn't appear to be building projects they aren't "told" to build. For the industry to get better at resilience, more leaders are needed who are willing to invest when times are good and independent of regulatory demands, to help offset impacts when times are hard.

When looking at the results parsed by population served, larger utilities are more likely to seek assistance from the federal government than smaller utilities.

Paying for Resilience

When it comes to funding these resilience and hardening measures, three-quarters of respondents look to the tried-and-true method of using rate increases to generate revenue, 55 percent consider federal grants, 53 percent look to state revolving funds (SRFs), 40 percent plan to pursue loans, and one-quarter are interested in public-private partnerships (PPPs).

These results reinforce the idea that respondents see value in diversifying their funding, but funding still remains a substantial challenge. To address this growing client need, InfraManagement Group, LLC (iMG), a wholly-owned subsidiary of Black & Veatch, works to identify innovative financing structures for the water industry. This includes looking to new and innovative funding opportunities from the Water Infrastructure Finance and Innovation Act (WIFIA), SRF, the Federal Emergency Management Agency (FEMA), the U.S. Army Corp of Engineers and the U.S. Economic Development Administration.

When looking at the results parsed by population served, larger utilities are more likely to seek assistance from the federal government than smaller utilities — 66 percent versus 48 percent. Larger utilities also are more interested in public-private partnerships (37 percent compared to 17 percent). This is because larger utilities, which often execute large, community disruptive infrastructure projects, have more resources to investigate these opportunities and have significant public pressure to reduce the rate impacts, and must build stakeholder buy-in through creative partnerships to successfully execute these efforts successfully.

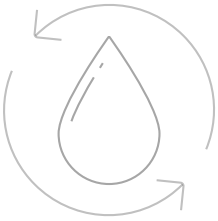


Figure 14

Which of the following elements are included in your water supply plan?
(Select all that apply)

Source: Black & Veatch

85.1%
Water conservation and/or drought management

68.1%
Scenario planning

55.3%
Climate change/ variability

31.9%
New surface water supplies

31.9%
New reservoir storage

8.5%
We do not have a water supply plan

Planning for the Future

Climate change is playing a larger role in water supply planning, with 55 percent of respondents including it in their future forecasting *(Figure 14)*. This shows a shift in thinking over years past. Water conservation and/or drought management — which can also be a byproduct of climate change — ranked No. 1, followed by scenario planning and climate change variability, with new surface water supplies and new reservoir storage tied for fourth.

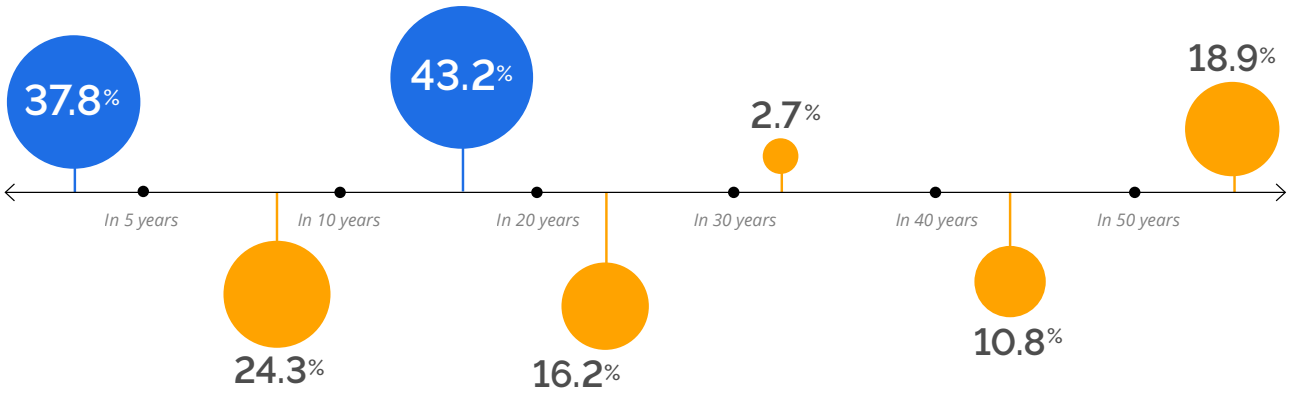
In terms of timing, 43 percent of respondents are looking 11 to 20 years out, 24 percent are looking at the next six to 10 years, and 38 percent the next five years *(Figure 15)*. Longer-term planning horizons play a significant role in utilities' planning efforts, particularly for stressed regions or those with rapidly expanding populations. For example, in large urban water-stressed areas such as Denver, Colorado — where water rights limitations and water system limitations are the norm — utilities are looking 50 years out; otherwise their growth could be restricted by supply or inability to secure adequate water rights. In arid areas in the West and Southwest, longer-term planning horizons will be critical to maintaining development and community growth.

Data also shows that the industry has been busy scenario planning for the future. Confidence in recent water planning and forecasting efforts is growing, with 60 percent of respondents more confident today than in recent years that their water supply plan is robust enough to meet upcoming challenges. These responses indicate that investments in planning technology are paying off. Survey data also shows utilities are beginning to favor the sensitivity/vulnerability (S/V) analysis approach, which lets utilities play out scenarios to identify vulnerabilities and possible points of failure that can then be mitigated to reduce risk and increase reliability.

Figure 15

What is/are the planning horizon(s) of your water supply plan? *(Select all that apply)*

Source: Black & Veatch



For example, Colorado Springs, Colorado, recently completed such an analysis as part of its Integrated Water Resources Plan (IWRP). The city relies on multiple reservoirs along the Continental Divide and a complex network of pipelines, tunnels and pumping stations to deliver water to the population hub of the Front Range. An S/V analysis examines the "what if" scenarios. If a catastrophic wildfire destroyed a watershed and the water quality of a reservoir, could the utility still supply to the necessary levels of service? If a major pump station failed, could the utility reroute water through its system to continue to meet demand even as it works to repair the asset? A combined 40 percent of respondents are "definitely" or "probably" pursuing the S/V analysis approach, while 26 percent are considering it.

A supplemental approach also could be a "digital twin," an integrated digital representation of physical assets that provides historical, current and predictive analysis in near real-time. By combining information technology (IT) and operations technology (OT), users can simulate scenario options before actioning them in the real world, helping enhance customer experience by optimizing performance of existing assets.

Integrated water resources planning methodologies can guide utilities in the development of resilient water supplies and realize multiple benefits to ratepayers, citizens and stakeholders. Winter Haven, Florida, for example, is developing a "One Water Master Plan" for a 50-year planning horizon. For its medium-sized utility serving approximately 80,000 customers, Winter Haven's planning is watershed scale and considers all water, regardless of form, to be a valuable resource to be managed sustainably, allowing planners to think holistically and work to optimize management of water resources to satisfy multiple objectives, some of which may conflict.

Winter Haven is driving resilience in its solutions by developing optimization tools to manage water across a spectrum of hydrologic conditions, from drought to flood and in between. In addition, the "One Water" planning approach in Winter Haven is evaluating the full scope of benefits provided by nature-based solutions. Working to restore the natural hydrology of the watershed will provide benefits for water supply, flood control, water quality, natural systems, recreation and even improved quality of future development.

The topic of climate change may be highly politicized, but the effects are being felt today, and without action, we expect to feel them even more tomorrow. The world is also now grappling with the impact of COVID-19, which may affect how water utilities prioritize their infrastructure improvement projects going forward. A sudden shift in environmental and climate change regulations would have a long-term impact on how utilities approach projects.

Black & Veatch survey data shows that climate change is driving significant concern around resilience, and it is playing an increasingly important role when it comes to water supply planning. Innovative new planning and resilience approaches such as integrated water resources planning methodologies can offer a path forward for utilities, helping them to develop new water supplies while benefiting rate payers, citizens and stakeholders.

No matter which route they choose, utilities must act now to embrace and address climate change as they work to mitigate an increasingly uncertain future.

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Addressing Resilience and the Scramble for Water

By Karen Burgi, Jo Ann Jackson, Kevin Laptos, Ed Rectenwald and Jim Schlaman

Access to clean water remains a critical component of any community, but unfortunately, water stresses are a reality for far too many, particularly those in the arid West and Southwest. Concerns over funding, aging infrastructure and resilience are not new, echoing the worries and priorities of years past.

The reach and scope of resilience continues to evolve. The Global Water Forum defines infrastructure resilience as "the ability to reduce the magnitude and/or duration of disruptive events" and measures effectiveness by the ability to recover rapidly from such an event. But while the basic concept of resilience remains the same, global events continue to shift and evolve, introducing newer and bigger threats.

Twenty years ago, the events of 9/11 caused regulators to focus on bioterrorism and cybersecurity. Then the focus shifted to climate change, which science suggests is driving a variety of conditions including: more frequent arid conditions, drought cycles, higher rainfall intensity events, sea-level rise and lateral or upward migration of higher salinity water into aquifers used for groundwater supply, and other conditions that will challenge water systems.

This shift helped drive utilities and municipalities in water-stressed areas to get more aggressive on reuse, collection and storage. But now the world is grappling with an unprecedented situation — a global health crisis brought about by COVID-19, which is driving new concerns around health and safety planning, workforce continuity planning, financial and capital reprioritization, as well as reassessing vulnerability planning. Aside from concerns about sourcing and securing appropriate water supplies, does resilience in the time of COVID-19 mean that utilities should now incorporate pandemics into their resilience planning?

Black & Veatch's 2020 *Strategic Directions: Water Report* survey of qualified utility, municipal, commercial and community stakeholders looks at how today's water industry has been addressing resilience to date and introduces new insight into how the industry can move forward.

Supply Remains Top Concern

Survey data shows that water utilities consider their water treatment plants to be the most resilient of their three main systems — treatment, distribution and supply. Nearly two-thirds (62 percent) of respondents see their treatment systems as "highly or moderately resilient" to adverse events *(Figure 16)*.

When it comes to distribution, respondents were slightly less certain, with 56 percent considering these systems resilient and 44 percent considering them susceptible. Responses around supply were even closer, with 53 percent reporting confidence and 47 percent considering this the weakest link, and "highly or moderately susceptible" to adverse events.

When it comes to bolstering water supply, 43 percent of respondents are seeking groundwater resources and 27 percent are seeking new surface water sources. These answers are most likely regional in nature, but it does reinforce that utilities desire to diversify their supplies for greater resilience and are more broadly looking for sustainable groundwater sources to do so *(Figure 17)*.

Meanwhile, 39 percent are looking to reuse, which is more common in water-stressed areas — in fact, Arizona, California, Florida and Texas are all leading the charge in treating wastewater for beneficial uses, including looking increasingly at potable reuse opportunities to address water supply resilience needs. A small number (12 percent) of respondents said they are seeking new desalination/brackish sources, a solution that is more common in coastal states that are dealing with saltwater intrusion into their groundwater supplies.

In the arid West and Southwest, the simpler solutions for supply have been exhausted, requiring utilities to reach deeper into their pockets to consider more substantial projects such as water reuse and desalination/brackish solutions.

Figure 16

Thinking about resilience in your community's water system, which components are most and least susceptible to adverse events? *(Select one for each row)*

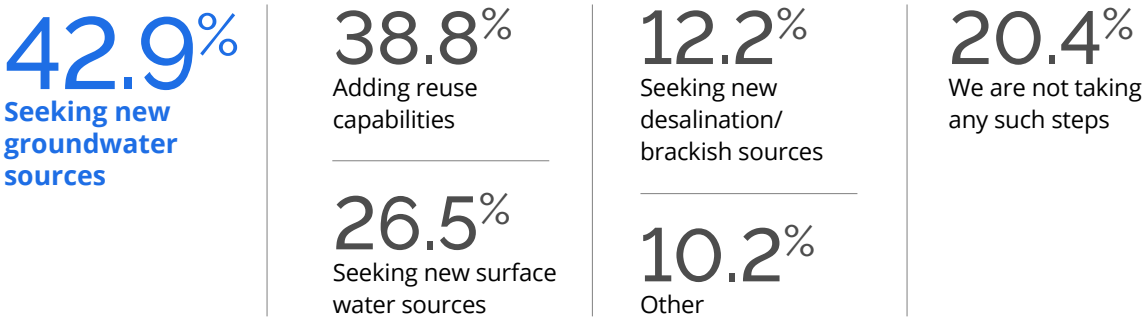
Source: Black & Veatch

	Highly susceptible	Moderately susceptible	Moderately resilient	Highly resilient
Stormwater	16.9%	**38.5%**	32.3%	12.3%
Supply	19.1%	28.1%	**34.8%**	18.0%
Distribution	12.4%	31.5%	**37.1%**	19.1%
Treatment	12.2%	25.6%	**41.1%**	21.1%

Figure 17

What steps are you taking to bolster water supply resilience? *(Select all that apply)*

Source: Black & Veatch



A trend across the industry — no matter where the utility is located — is to become more proactive when it comes to sourcing and building resilient water supplies, and to invest in a future need that has not been quite realized yet.

Embracing New Models of Collaboration

A trend across the industry — no matter where the utility is located — is to become more proactive when it comes to sourcing and building resilient water supplies, and to invest in a future need that has not been entirely realized yet. Many of these efforts are regional in nature, and organizations are coming together and embracing collaboration as they work to address water scarcity, thereby sharing the proverbial burden. For example, the Water, Infrastructure and Supply Efficiency (WISE) program in central Colorado demonstrates the strides that can be made when different communities partner together to solve their problems.

WISE is a regional partnership that provides new supply by combining unused capacities from Aurora Water's Prairie Waters Project and Denver Water. When Denver and Aurora have excess supply, 10 entities in nearby Douglas County can buy the extra water. WISE involves a total of 12 entities working together to supply customers with water while minimizing the expenses required to develop new infrastructure and water rights. Similar programs also are happening in southern Colorado, Arizona and California.

Figure 18

Have you conducted vulnerability assessments since those required by the Bioterrorism Act of 2002?
(Select all that apply)

Source: Black & Veatch

38.0%
Yes, currently conducting

16.0%
Yes, in the past year

22.0%
Yes, in the past 2-3 years

12.0%
Yes, 4+ years ago

16.0%
No

Responding to Mandated Assessments

After 9/11, the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (Bioterrorism Act of 2002) was passed, requiring some 8,400 community water systems to assess vulnerabilities and prepare emergency response plans. Originally, the act was designed to address vulnerabilities due to bioterrorism, but today, utilities recognize that vulnerability is more than bioterrorism or cybersecurity and must address internal threats and climate change.

Survey data shows that water and wastewater utilities are actively responding to the mandates by conducting resilience and vulnerability assessments, with a combined 54 percent having done so within the past year, and 22 percent having done so within the last two to three years *(Figure 18)*. This shows that utilities are taking threats seriously and addressing vulnerabilities to become more resilient.

Another piece of legislation — America's Water Infrastructure Act (AWIA), signed into law in October 2018 — requires all community water systems and utilities that serve more than 3,300 people to conduct risk and resilience assessments and develop or update their emergency response plans. AWIA and market conditions are driving utilities to assess and implement strategies that mitigate vulnerabilities

Survey results show that the AWIA mandate has led to at least one-third of survey respondents to make system changes to address identified vulnerabilities — 22 percent reported that they had to expedite plans, and 8 percent had to make even more substantial changes, as they were not planning to conduct vulnerability assessments before AWIA. A combined half said the mandate had "little to no" or "minimal" impact on their plans, as they had already planned to conduct assessments, while 20 percent anticipated no impact at all.

Addressing Public Health

When it comes to the status of system improvements projects, three-quarters of survey respondents said they have either completed or are working on system improvement recommendations from previous vulnerability assessments. An additional 17 percent are planning and scoping projects now, while 8 percent said they have no projects underway.

Looking at combined No. 1 and No. 2 rankings, which denote the highest priority as assigned by the question, results show that utilities prioritize projects that have the most significant impact on public health — water/quality, condition/ replacement and operations/efficiency ranked most important, followed by capacity/growth and then resilience *(Figure 19)*.

Results show that utilities prioritize projects that have the most significant impact on public health.

Figure 19

How are the following types of projects being prioritized by your organization?

Rank the following from 1 (highest priority) to 5 (lowest priority).

Source: Black & Veatch

	1 Highest Priority	2	3	4	5 Lowest Priority
Water quality	**40.7%**	14.3%	19.8%	15.4%	9.9%
Condition/ replacement	**30.8%**	18.7%	20.9%	18.7%	11.0%
Operations/ efficiency	3.3%	**36.3%**	24.2%	20.9%	15.4%
Capacity/growth	16.5%	15.4%	18.7%	17.6%	**31.9%**
Resilience	8.8%	15.4%	16.5%	27.5%	**31.9%**

Condition/replacement remains a top concern as aging infrastructure starts to require more maintenance and upkeep, spurring increased involvement in rehab and replacement programs. Operations/efficiency was the third-highest priority, as that keeps systems running — a particularly important concern during this time of COVID-19 disruption. Capacity/growth was more evenly split.

Of the five areas, resilience ranked last, which was unsurprising, given that the first four areas all are driven by regulatory requirements and are fundamental to the mission of a utility. Unlike water quality and public health, resilience is not mandated besides the studies recently required by AWIA. Although critical and necessary, resilience shores up the other systems, but as a result, often ends up taking a backseat to these higher priorities and may be perceived as an added expense to those associated with basic operations.

The data shown in *Figure 20* — where 27 percent said they have no formal process to prioritize projects but defer to those that are required for health and safety reasons and regulatory requirements — validates this conclusion.

Condition/replacement remains a top concern as aging infrastructure starts to require more maintenance and upkeep.

Figure 20

Do you have a process for including and prioritizing resilience projects in your capital improvement program? *(Select one)*

Source: Black & Veatch

59.5%
Yes, these projects are evaluated along with other capital projects using a formal prioritization process

27.0%
We have no formal process, but projects that are required for health & safety reasons and regulatory requirements take top priority

3.4%
Addressing resilience needs would be great, but we have other needs that are of greater importance

10.1%
No, no we have no process for including/prioritizing resilience projects

The reach and scope of resilience continues to evolve as communities pursue access to clean and sustainable water, particularly for those in water-stressed areas. Concerns over aging infrastructure, funding and resilience are deeply familiar, but today we see new threats, such as COVID-19, that are challenging water systems in new ways.

ABOUT THE AUTHORS

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Water Resilience: When Too Much of a Good Thing Isn't Great

By Laura Adams, Mark Fountain, Prabha Kumar, Ed Rectenwald and Andrew Smith

During the spring of 2019, record-breaking floods inundated the Midwest, causing some of the biggest inland waterways — the Illinois, Missouri, Arkansas and Mississippi rivers — to overflow their banks, disrupting lives and submerging farms, businesses and homes across more than a dozen states, from North Dakota and Minnesota to Mississippi and Louisiana. In at least 400 counties across 11 states, the floods overwhelmed the water and wastewater treatment facilities.

That searing experience, coupled with increased recognition of the vulnerability of low-lying coastal areas to seawater surges, has spurred concerns about the resilience of our nation's water infrastructure, according to industry stakeholders surveyed for Black & Veatch's 2020 *Strategic Directions: Water Report*.

Building Resilience

In the survey of nearly 300 respondents, natural or man-made disasters (nearly 84 percent) and catastrophic failure of infrastructure (56 percent) were the two most significant resilience concerns they cited *(Figure 21)*. An interesting finding also is that respondents appear to rank the impacts of climate change much lower, and they do not necessarily correlate changes in climate with natural or man-made disasters.

Concurrent with resilience concerns, respondents indicated that all aspects of their systems — from stormwater to water supply and water distribution, and water and wastewater treatment systems — are susceptible to adverse events. More than half of respondents — 55 percent — reported their stormwater systems to be highly or moderately susceptible to adverse events. In contrast, more than 60 percent of respondents considered their treatment systems to be highly or moderately resilient *(Figure 22)*.

Figure 21

What are your most significant resilience concerns? *(Select up to three).*

Source: Black & Veatch

83.5% **Natural or man-made disaster**

55.7% **Infrastructure catastrophic failure**

38.1% Extended drought/ supply restrictions

34.0% Cyber attack

30.9% Impacts from climate change

12.4% Terrorist attack

5.2% Other

Figure 22

Thinking about resilience in your community's water system, which components are most and least susceptible to adverse events? *(Select one for each row)*

Source: Black & Veatch

	Highly susceptible	Moderately susceptible	Moderately resilient	Highly resilient
Stormwater	16.9%	**38.5%**	32.3%	12.3%
Supply	19.1%	28.1%	**34.8%**	18.0%
Distribution	12.4%	31.5%	**37.1%**	19.1%
Treatment	12.2%	25.6%	**41.1%**	21.1%

Utility leaders express significant concerns over resilience, and they understand which of their systems are most susceptible. Yet the planning and execution of initiatives doesn't align with these perspectives. With respect to the timing of executing infrastructure improvements, the respondents indicate that execution is primarily driven by an impending failure, a regulatory driver and/or customer demand — in other words, largely reactive rather than proactive resilience building measures *(Figure 23)*.

However, the tide of reactive management may be changing as a more proactive programmatic approach to planning and building resilience is gaining ground consistent with the concept of "One Water." This concept means water planning with a view of the complete water cycle, often watershed-based, and recognizing the interconnections between various uses — both human and ecological.

Utilities are embracing programmatic ways to be more resilient through features such as integrated planning and community-based partnerships. The survey indicates that nearly half of the respondents — 49 percent — are "actively trying" to evolve toward such an approach. More than one in five said they already have a programmatic approach that enables a holistic planning and effective leveraging of resources. While 20 percent said they would like to follow this approach but haven't prioritized it, 9 percent declared that they do not yet see a value in a programmatic approach *(Figure 24)*.

Figure 23

Once a need for infrastructure improvement has been identified, how do you know when to take the next step and execute the project? *Rank the following from 1 (most impact) to 5 (least impact)*

Source: Black & Veatch

	1 Most Impact	2	3	4	5 Least Impact
When we suspect something is about to break/fail	**60.0%**	24.7%	10.6%	4.7%	0.0%
When regulatory bodies demand action	21.2%	**44.7%**	24.7%	7.1%	2.4%
When public opinion demands it	5.9%	18.8%	**43.5%**	24.7%	7.1%
When we see other communities taking action	0.0%	8.2%	17.6%	**62.4%**	11.8%
Other	12.9%	3.5%	3.5%	1.2%	**78.8%**

Perhaps not surprisingly, the survey shows, utilities serving populations of more than 500,000 have been more proactive in adopting programmatic approaches to resilience planning.

Practitioners at utilities serving more than 500,000 customers were more than twice as likely as smaller utilities (32 percent vs. 14 percent) to have already implemented a programmatic approach to resilience. Although these larger utilities are evolving toward a defined approach, mid-size and smaller utilities — those that serve fewer than 500,000 customers — tended to respond that either they didn't see the value of a programmatic approach to resilience planning, or that while they would like to implement such an approach, they don't consider it a priority *(Figure 25)*.

Figure 24

To what degree is your organization moving toward a programmatic approach to resilience planning (e.g. EPA integrated planning, community-based partnerships, etc.)? *(Select one)*

Source: Black & Veatch

Figure 25

To what degree is your organization moving toward a programmatic approach to resilience planning (e.g. EPA integrated planning, community-based partnerships, etc.)? *(Select one by population served)*

Source: Black & Veatch

	Less than 500,000	500,000 or more
We already have a programmatic approach to resilience	13.7%	**32.4%**
We are actively trying to evolve toward a programmatic approach	49.0%	**50.0%**
We would like to but it's not a priority for us	**23.5%**	14.7%
We do not see the value in a programmatic approach to resilience	**13.7%**	2.9%

Organizational Capacity

In the United States, there are tens of thousands of water and wastewater systems, and similarly numerous municipalities managing stormwater programs. Such a highly fragmented system constrains organizational capacity and makes proactive resilience planning, execution of initiatives and adequate funding an ongoing challenge, especially for many small and mid-size utilities.

Digital transformation and multi-agency collaborations are valuable tools that utilities can leverage to enhance organization capacity and build resilience.

Two-thirds of respondents said they would definitely or probably be open to cooperative agreements with peer organizations to collaborate on digital information processes, plans and standards. About 30 percent were ambivalent, responding they "might or might not" be interested in such a collaboration *(Figure 26)*.

In our experience, available resources and organizational culture are two chief reasons for the gap between respondents' openness to multi-agency resilience planning and the actual implementation of collaborative initiatives to mitigate vulnerabilities of their systems. It's a troubling disconnect, but not one limited to the water industry.

Despite the broad openness to collaboration on digital transformation, the realities of organizational culture and "who pays for what?" too often impede making multi-agency agreements a reality. Barriers such as limited trust, diverse demographics, local politics and attitudes on ownership and control, along with the ever-present pressure on funding, impede effective collaboration, leaving communities even more exposed to the next disaster or infrastructure failure.

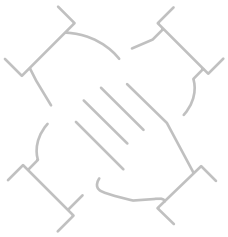

Figure 26

Would you be open to cooperative agreements with similar organizations to collaborate on digital information processes, plans and standards?
(Select one)

Source: Black & Veatch

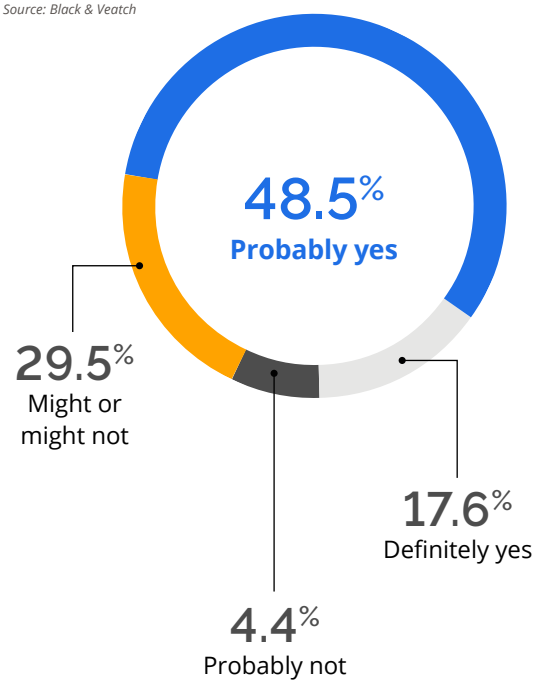

Figure 27

How would you rate your organizational capacity to plan, design, deliver and maintain stormwater management services in your community?
(Select one)

Source: Black & Veatch

43.7%
Adequate capacity

33.3%
Some capacity

16.7%
Limited capacity

6.3%
Very limited capacity

0.0%
Absolutely no capacity

Agency and utility leaders must engage during periods of non-emergency to prepare and upgrade with efforts that benefit their customers and communities.

Trust-building, due diligence in working out the details of collaborative approaches and defining other strategies for multi-agency agreements all are actions critical to enhancing organization capacity and developing resilience to tackle adverse events. The time to engage in these actions is before the river starts rising — or ahead of the time a major distribution system failure occurs. Agency and utility leaders must engage during periods of non-emergency to prepare and upgrade with efforts that benefit their customers and communities.

Strategically investing in multi-agency resilience planning will be repaid several times over the next time a city or county avoids disruption by natural or man-made disasters or a catastrophic failure of infrastructure.

When asked to rate their organizational capacity to deliver stormwater management services, more than four out of 10 respondents — 44 percent — said they had "adequate" capacity to plan, design, deliver and maintain such offerings to their communities. An additional one-third said they had "some" organizational capacity to address the range of responsibilities from planning and design to delivery of services *(Figure 27)*.

Today, there are just over 1,700 user-fee-funded stormwater utilities nationwide. As the ***2018 Black & Veatch Stormwater Report*** indicated, even those municipalities that have established a dedicated stormwater user-fee-funding mechanism indicated inadequacy of funding. A combination of factors that include lack of political will; lack of robust stakeholder education on stormwater issues and risks of inaction; inadequate enabling legislation in some states; and the risk of legal challenges impede a broader adoption of user-fee-funding for stormwater management.

Stakeholder Engagement

At the core, the services that public utilities provide — whether it's water, wastewater or stormwater — are customer-centric, meaning initiatives to build infrastructure, operations, financial resilience and organizational capacity can succeed only if there is buy-in from customers and support from decision-makers.

Utilities are deploying stakeholder education and engagement in their resilience planning in hopes of proactively staying ahead of frequent and more intense wet weather events. Yet, the question lingers whether they're doing enough outreach and garnering engagement — and with the right people. The survey indicates that six in 10 respondents were engaging with decision-makers, who likely would be responsible for green-lighting the development of a resilience plan. Only half of respondents even indicated that they were engaging with their communities. Fewer are working at the city and regional level *(Figure 28)*.

Utility leaders typically demonstrate a higher level of stakeholder engagement when there is a significant change such as a stormwater user fee or a customer assistance program. Similarly, engaging in holistic resilience planning and successful execution of initiatives, robust and consistent stakeholder engagement is critical. There is an opportunity to engage local business groups, neighborhood associations, community organizations, regional partners and other diverse stakeholders to ensure that plans are holistic and provide maximum benefit to the community.

Figure 28

How much stakeholder education and engagement are you including in your resilience planning? *(Select all that apply)*

Source: Black & Veatch

59.8%
Engaging with decision makers

50.6%
Engaging with the community

40.2%
Engaging with the region

34.5%
Engaging with the city

8.0%
None of the above

Through the formal recognition of climate change and the mounting worries it evokes, complacent or slow responding water utilities need to identify new mechanisms to bolster their systems' resilience. Such utilities should step off the sidelines, investigate proactive strategies and seek to implement thoughtful investments to mitigate the potential havoc of future extreme weather events and potential environmental shocks. Driven collaboration may hold the key, recognizing the significant influence of stakeholders and their role in defining a community's vision toward achieving tomorrow's sustainable water infrastructure.

ABOUT THE AUTHORS

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Ed Rectenwald *is a hydrogeology national practice lead for Black & Veatch's water business. With 24 years of technical and management experience, he successfully has managed projects and teams across the globe related to design, permitting, construction, expansion and operation for wellfields, Class V aquifer storage and recovery (ASR), aquifer recharge and Class I injection well systems.*

Andrew Smith *is the national watershed, stormwater and flood management practice lead for Black & Veatch's water business in the Americas. Based in Kansas City, Smith leads the development and delivery of a range of solutions ranging from watershed management and green infrastructure to complex hydraulic modeling and design. He is a recognized leader in the fields of strategic program development and asset management for stormwater.*

PFAS, Lead, Nitrate/Nitrite: Key Concerns for Drinking Water Utilities

By Nicholas Burns, Dustin Mobley, Christopher Tadanier and Emily Tummons

Utilities entrusted to supply sustainable, clean drinking water have their hands full eliminating contaminants of emerging concern and ensuring that reactions in the distribution system do not produce separate contamination issues.

Simple physical and chemical treatment methods that include sedimentation, filtration and disinfection have long been the standard in drinking water purification. As the Black & Veatch's 2020 *Strategic Directions: Water Report* survey shows, dealing with certain contaminants — some at the behest of evolving regulations — are proving increasingly challenging.

Man-made chemicals — notably decades-old per- and polyfluoroalkyl substances (PFAS) known as "forever chemicals" because they don't easily biodegrade — have joined nitrates/nitrites and lead as the water contaminants of greatest concern to drinking water stakeholders surveyed. The results represent a combination of stakeholder concern for removing these contaminants at drinking water treatment facilities as well as the health and environmental concerns from contaminants found in potable water or water sources. Almost 50 percent of stakeholders cited PFAS as a chief contaminant of concern, followed by nitrate and nitrite at 34 percent and lead at 26 percent, with other contaminants all below 20 percent. *(Figure 29)*.

Figure 29

Which of the following contaminants are of chief concern? *(Select up to three)*

Source: Black & Veatch

	Drinking Water
PFAS	48.6%
Nitrate-Nitrite	34.3%
Lead	25.7%
Pharmaceuticals	20.0%
Other (NET)	20.0%
Sediment	11.4%
Arsenic	8.6%
Chromium	8.6%
Legionella	8.6%
Pesticides	8.6%
Ammonia	5.7%
Copper	5.7%
Nitrogen	5.7%
Radium	5.7%
Salts	5.7%
Chloramine	2.9%

PFAS: One Big Family Tree of Chemicals

A large family of more than 5,000 man-made chemicals, PFAS have been used for decades in industrial and consumer products. They are ubiquitous, found in nearly every home and business – in items such as non-stick cookware, firefighting foams, grease-resistant takeout food packaging, waterproof outerwear, stain-resistant carpeting and personal care products.

Two specific PFAS chemicals — perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS) — are of particular concern. Use of those chemicals was voluntarily discontinued nearly two decades ago, but true to their moniker as "forever chemicals" they persist and are still found in surface and groundwater.

Federal and state regulators took steps in 2019 to tighten drinking water regulation of PFAS, with the U.S. Environmental Protection Agency (EPA) expected to amplify oversight this year beyond the EPA's current non-enforceable health advisory (HA) level of 70 parts per trillion (ppt) for the sum of PFOA and PFOS. Some two dozen states have policies that include HAs about PFAS in drinking water ranging from 10 ppt to 40 ppt for individual PFOA or PFOS compounds or a sum of PFAS compounds as low as 20 ppt (i.e., Vermont and Massachusetts). It seems likely that some of these states will move forward with tougher regulations on those substances in 2020 or shortly thereafter, which is what happened with New Jersey in June 2020, when it established maximum contaminant levels (MCLs) of 13 ppt for PFOS and 14 ppt for PFOA, which are some of the lowest in the country.

PFAS Detection, Monitoring Expected to Climb

While PFAS has drawn increasing scrutiny, it is not surprising to see that nitrite/nitrate, metals and biologicals are the most commonly monitored and detected groups of contaminants by drinking water facilities, since these groups include regulated contaminants like lead, copper, iron, heavy metals, coliforms, viruses and nitrification byproducts of nitrite and nitrate.

Nearly half of respondents indicated they monitor and have detected PFAS, which was the highest value for contaminants that are not currently regulated *(Figure 30)*. One-third of respondents said they are monitoring for PFAS but haven't detected any. These monitoring and detection values are expected to increase as PFAS were included in the EPA's unregulated contaminant monitoring rule (UCMR) 5.

Figure 30

Do you routinely monitor for the following contaminants? If so, have you detected them?

(Select one per row)

Source: Black & Veatch

	Monitor and have detected	Monitor but have not detected	Do not monitor
Nitrate-Nitrite	65.7%	28.6%	5.7%
Metals	55.9%	35.3%	8.8%
PFAS	46.9%	31.3%	21.9%
Biologicals	37.5%	53.1%	9.4%
Pesticides	27.3%	51.5%	21.2%
Pharmaceuticals	12.9%	25.8%	61.3%
Micro-plastics	10.3%	17.2%	72.4%

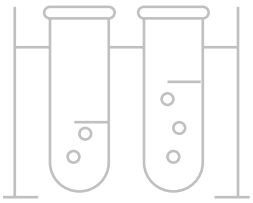


Figure 31

What's the greatest limiting factor for your utility addressing PFAS in your water supplies?
(Select one)

Source: Black & Veatch

57.1%
Regulatory uncertainty

17.2%
Lack of health science guidance

14.3%
Budgetary and/or rate payer considerations

11.4%
Other

Regulatory Questions Make PFAS Efforts Murky

When it comes to removing PFAS from water, regulatory uncertainty abounds. Without clarity on future regulatory limits, it is difficult for utilities to confidently set treatment goals or identify the appropriate treatment technology. Sixty percent of respondents pointed to that lack of clarity as their biggest limiting factor for their utility's quest to deal with PFAS in water supplies. Lacking health science guidance and the cost and recovery of water treatment options are a distant second and third, each garnering less than 20 percent *(Figure 31)*.

Ultimately, drinking water utilities are faced with producing a finished product that meets regulatory standards, while also responsibly disposing of waste streams. It's clear that emergent PFAS chemicals in water sources are posing unique challenges for water utilities as they often necessitate advanced treatment technologies and hinder traditional approaches to handling waste streams. Scientists and regulators remain in an early stage of discerning the effects of PFAS on human health and developing technologies to remove them from water. But as the science progresses, PFAS regulatory activities are expected to accelerate increasing pressure on utilities to remove them.

Confidence Plentiful that Contaminants will be Removed

As for the confidence level of their utility's ability to meet current and still-evolving contaminant levels established by state and federal agencies, responses were varied. One-third voiced extreme confidence in their adherence to dynamic standards for various contaminants, slightly more than those who considered themselves very or moderately confident. No respondent reported lacking confidence in their utility's compliance *(Figure 32)*.

The unspoken caveat behind those responses could come down to money, as is often the case for a utility. Compliance with certain standards could be technologically possible, but at what cost?

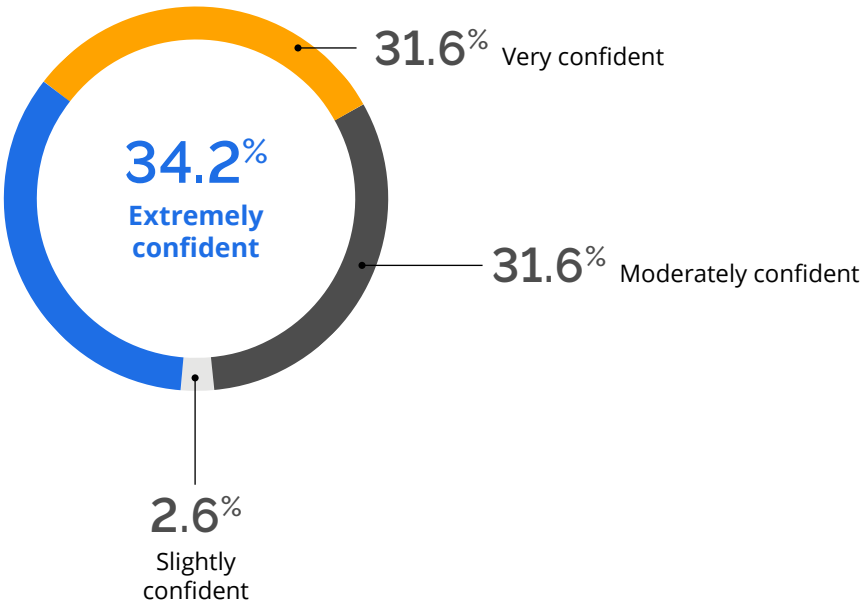
Traditional drinking water treatment plants are very effective at removing biological and physical contaminants such as sediment and organic materials from the influent water, but these facilities are less effective at removing certain chemicals. For that reason, respondents indicated similar concern over the presence of chemicals in their water source as in the treated water.

Drinking water stakeholders cited more concern over biological contaminants in the treated water than in the source water, which could be an indication of the recognition that biological contaminants like coliforms and viruses are regularly present in many upstream water sources and confidence in treatment systems abilities to remove then under normal operation. The level of concern for biological contaminants downstream in a drinking water system encompasses both the recognition of the possibilities of treatment failures and the opportunity for regrowth in the distribution system.

Figure 32

How confident are you in your utility's ability to meet current and future contaminant level requirements set forth by state and federal agencies?

Source: Black & Veatch



If sudden changes are observed in the loading rate of physical contaminants, like sediment and plastics, it can cause upsets in utility operations, resulting in excess solids production or more frequent backwashing of treatment processes to meet treatment goals. This explains the higher concern of physical contaminants in the source water rather than the treated water.

Figure 33

What kinds of contaminants is your organization most concerned about in your community's water? *(Select all that apply)*

Source: Black & Veatch

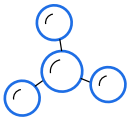
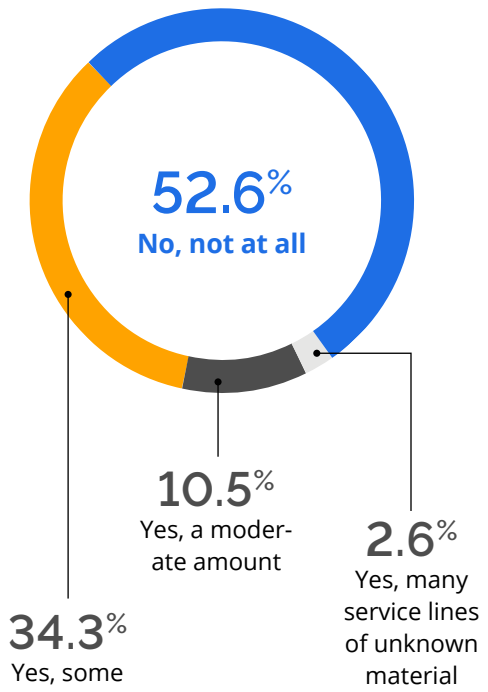
	Upstream (pre-treatment)	Downstream (post-treatment)
 Biological	28.6%	45.7%
 Chemical	45.7%	40.0%
 Physical	45.7%	25.7%
 Other	8.6%	5.7%

Figure 34

Are there unknown pipe materials in your distribution system? *(Select one)*

Source: Black & Veatch



Lead Remains a Priority

With nearly 26% of drinking water respondents listing lead as a contaminant of concern, the third highest result *(Figure 29)*, it is clear that it remains a priority for drinking water providers.

In 2019, the EPA proposed revisions to the Lead and Copper Rule that would increase monitoring requirements and create a lead trigger level that is lower than the current action level based on the presence of lead in drinking water at the tap. These changes primarily impact systems that have remaining distribution piping and components containing lead, such as lead service lines, lead solder and brass fixtures.

Removing lead service lines is mainly a challenge in the Upper Midwest and East Coast, where housing and infrastructure tends to be older than the rest of the nation. Removing lead service lines across the United States could cost more than $30 billion, and many of the service lines cross onto private property and are only partially owned by the drinking water utility.

When asked whether there were unknown pipe materials in a drinking water utility's water distribution system, more than half encouragingly responded "no, none at all" *(Figure 34)*. The high level of "no" responses could be due to greater asset diligence following lead release events in Washington, D.C., in 2004 and in Flint, Michigan, in 2015 and 2016. Those adverse events could have forced water utility managers to identify, with more specificity than ever before, what materials were used for pipes, valves and meters in their distribution systems.

Still, more than 40 percent of respondents answered some variation of "yes" to this question, possibly indicating that detailed asset inventories are under way or will be conducted when required by regulations.

Overall, the contaminants our drinking water facilities are tasked to remove is an everchanging list with ongoing adjustments to regulated levels. These facilities are designed with multiple levels of treatment using a combination of chemical, physical and sometimes biological processes to produce finished water that meets regulatory standards.

The challenge facing regulators and utilities, especially when considering PFAS, is agreeing to a required target treatment level that is both appropriate and achievable. Looking at the survey results in Black & Veatch's 2020 *Strategic Directions: Water Report*, the overall picture that emerges is of an industry confident in its ability to provide high quality drinking water meeting current and future water quality target.

ABOUT THE AUTHORS

Nick Burns *is the director of water treatment technologies at Black & Veatch. He has 19 years of experience with advanced water and reuse treatment technologies, and has worked in Australia and the Mideast, with project experience throughout the United States. He leads a team of drinking water process engineers solving treatment issues across North America.*

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Emily Tummons *is a drinking water process engineer and lead and copper corrosion control leader. She has designed and conducted water quality and corrosion studies for potable water treatment systems involving desktop, bench-scale and pipe-loop evaluations to optimize corrosion control in the distribution system. She also has been involved in process optimization studies and regulatory reviews for municipal drinking water treatment facilities.*

Nutrient Management Drives Wastewater Investment

By Scott Carr, Leon Downing, Patrick Dunlap and Andrew Shaw

The U.S. Environmental Protection Agency (EPA) describe excessive nutrients (phosphorus and nitrogen) in our waters as one of America's most pervasive, costly and challenging problems. An overabundance of nutrients leads to severe problems ranging from toxic algal blooms to complete eutrophication. These problems negatively impact the quality of water used for consumption, recreational waters and aquatic life.

A range of human activities including runoff from agriculture, stormwater, wastewater treatment plant discharges and other nutrient sources into waterbodies are often to blame. But, responses to Black & Veatch's 2020 *Strategic Directions: Water Report* survey — an annual survey of qualified utility, municipal, commercial and community stakeholders — show that wastewater utilities are actively working to improve effluent quality and meet regulatory requirements.

When it comes to planning for future permitting, the data shows that wastewater utilities are planning to act sooner than originally planned.

Growing Adoption

Nutrient regulation has been a "hot topic" for the past 30 years. Historically, the issue was relegated to specific regions around the United States, such as in the Great Lakes, Long Island Sound, Chesapeake Bay and Florida. But today, nutrient management affects more than two-thirds of the country. Activity only continues to grow, ramping up in the Midwest due to the drive to reduce hypoxia caused by the discharge of nutrients in the Mississippi River into the Gulf of Mexico and in the West as California looks at nutrient management in the San Francisco Bay area.

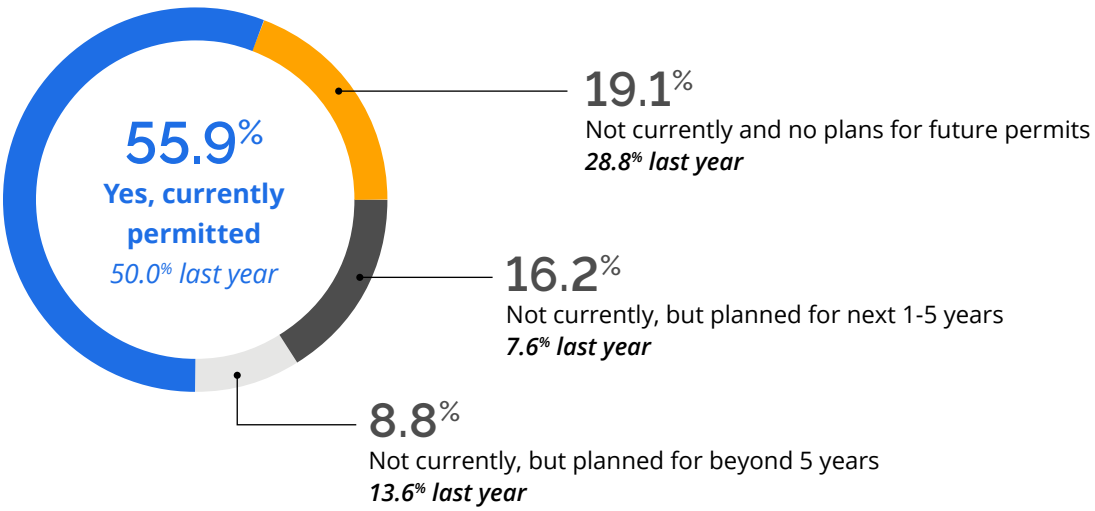
Survey data shows that the number of wastewater utilities whose facilities are permitted for phosphorus, total nitrogen, or both, has increased 6 percent over last year, to 56 percent of respondents. Meanwhile, the number of utilities who are not currently permitted, and have no plans for future permits, dropped 10 percent to 19 percent in this year's survey *(Figure 35)*.

When it comes to planning for future permitting, the data shows that wastewater utilities are planning to act sooner than originally planned, with 16 percent shortening their timelines expecting nutrient limits in their permits within the next five years — double the number of respondents from last year. And 9 percent are planning beyond the five-year mark, down from 14 percent last year. More and more, nutrient removal of some kind is becoming abundant in the United States.

Figure 35

Are any of your facilities permitted for phosphorous, total nitrogen or both? If not, are there future expectations for such permits? *(Select one)*

Source: Black & Veatch



Anaerobic Digestion

More wastewater utilities also are implementing anaerobic digestion, with 62 percent of respondents responding affirmatively, versus 55 percent last year. There are several drivers for this shift, including pressure on landfills accepting unstabilized solids, as well as regulatory and social pressures on chemical stabilization and thermal conversion processes. Anaerobic digestion reduces the mass of biosolids and the odor potential, which contribute to greater flexibility with biosolids management options. In addition, the process generates biogas that can be recovered for energy production. Anaerobic digestion also is compatible with or necessary for other advanced stabilization processes that will create an even higher quality biosolids product.

The process long has been the mainstay of medium to large utilities because of the benefits of mass reduction, energy recovery, and ability to use the product as a fertilizer and soil amendment.

The process has long been the mainstay of medium to large utilities because of the benefits of mass reduction, energy recovery, and the ability to use the product as a fertilizer and soil amendment. Numerous small utilities also have benefited from incorporating the process. In addition to the drivers previously noted, more utilities now are looking at their digesters as assets that can be exploited for revenue and energy generation using co-digestion with high strength wastes.

Utilities can receive revenues from waste haulers in the form of tip fees and use these organics to create additional biogas that can be used for electric power production or as a renewable fuel for powering vehicles. New regulations at the state level limiting landfill disposal of organics, such as the proposed California Rule SB 1383, also are contributing to the increased interest in using anaerobic digesters to treat a broader range of organic wastes. All these drivers have led utilities to bring back into service mothballed digesters, expand existing digestion capacities or replace stressed processes with new digestion systems.

Nitrogen and Phosphorous

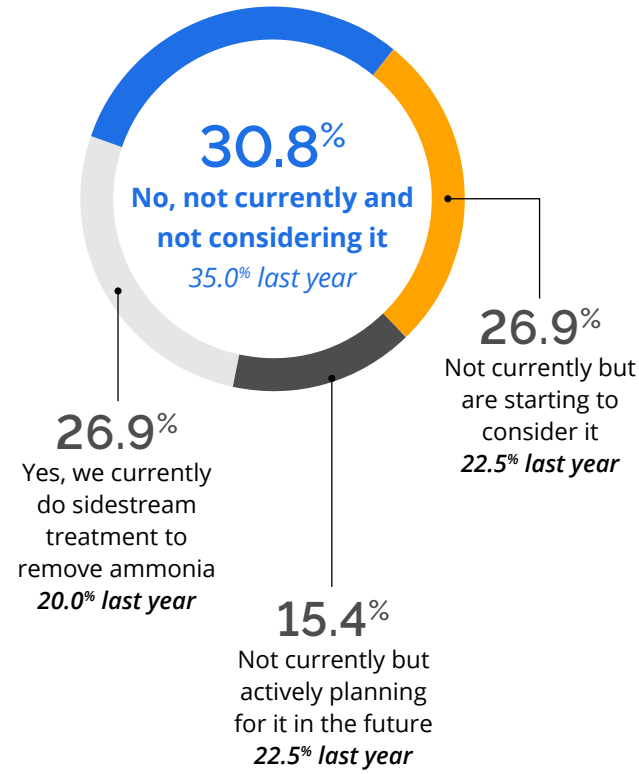
As the use of anaerobic digestion increases, expect to see the use of sidestream treatment rise. Survey data shows that wastewater utilities are increasingly using sidestream treatment to remove ammonia, with 27 percent of utilities stating that they conduct sidestream treatment, up from 20 percent in 2019. A combined 42 percent are either actively planning for or considering integrating the technology *(Figure 36)*.

Dewatering of anaerobically digested biosolids results in a concentrated return flow that can be mitigated using sidestream treatment, which can be a stable, cost-effective way to remove ammonia, helping utilities adhere to ammonia and total nitrogen limits. Deammonification is the most efficient way to remove ammonia-nitrogen for many facilities.

Figure 36

Do you conduct sidestream treatment to remove ammonia or are you considering such a process? *(Select one)*

Source: Black & Veatch



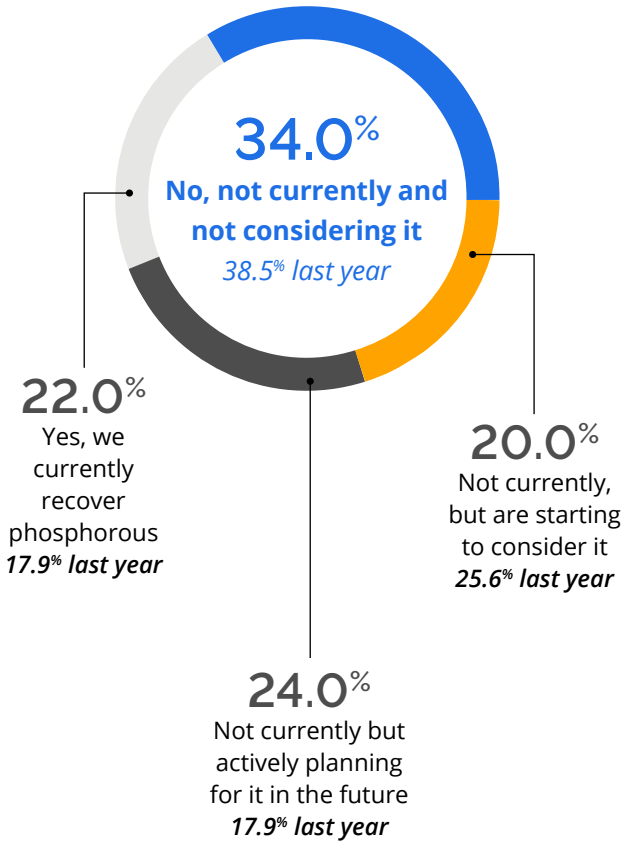
Phosphorous recovery also is increasing. Today, 22 percent report performing phosphorous recovery of some kind, up from 18 percent in 2019. A combined 44 percent either are actively planning for or considering the technology *(Figure 37)*. This reflects a growing interest in recovering phosphorous, and as a result, the increasing adoption of proprietary technologies such as struvite harvesting systems. The number of responding wastewater utilities not conducting phosphorous removal also dropped 5 percent to 34 percent today.

The top operational driver behind phosphorous recovery is the need to reduce struvite buildup in the anaerobic digestor and on the pipes and equipment, helping to prevent damage to equipment and reduction in system capacity. Phosphorous removal also plays a critical role in total nutrient management for the beneficial use of biosolids. When looking at the beneficial use of biosolids in agriculture, the ratio of nitrogen to phosphorous is not favorable and can result in the overapplication of phosphorous. Removing the phosphorous broadens the potential application of biosolids in agricultural areas. Both technologies — sidestream treatment to remove ammonia and phosphorous recovery — will continue to improve, mature and come of age, leading to increased adoption.

Figure 37

Do you recover phosphorous or are you considering such a process? *(Select one)*

Source: Black & Veatch



New Technologies Offer New Opportunity

Like others in the water utility space, wastewater utilities increasingly are embracing advanced control, using sensors and automation technology as they search for new solutions in nutrient management. The survey found that 63 percent of wastewater utilities either are using or planning to use controls, sensors and/or automation to optimize nutrient removal *(Figure 38)*.

Like others in the water utility space, wastewater utilities increasingly are embracing advanced control, using sensors and automation technology as they search for new solutions in nutrient management.

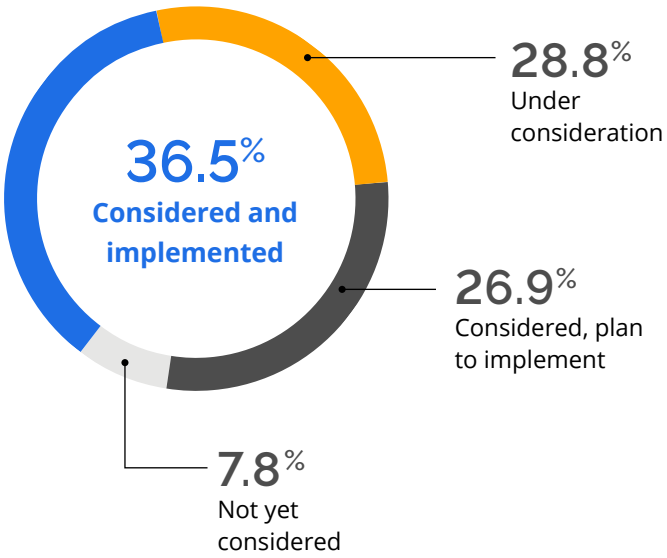
This has not always been the case, with utilities previously hesitant to install online analyzers or sensors in their plants. Back in 2002, a ***Water Environment Research Foundation (WERF) study*** found that " the dependability and accuracy of the primary sensors is still cited ... as the single largest impediment to wide-scale, successful implementation of automation. Participants ... confirmed that sensor accuracy and reliability continue to be a problem area."

Today, the technology has improved, the knowledge base has grown and modern sensors are far more robust, allowing for comprehensive nutrient monitoring that continuously observes and analyzes flows and nutrient data. As a result, utilities are turning to technology as they pursue improved process stability, better effluent quality, increased energy efficiency and improved capacity. These technologies are even driving new approaches such as the ABAC (ammonia-based air flow control) strategy, an advanced air flow control strategy that has grown in popularity over the last few years.

Figure 38

To what degree are you considering controls, sensors and/or automation to optimize removal of nutrients? *(Select one)*

Source: Black & Veatch



Trends in Nutrient Removal

Nutrient removal will continue to advance as regulations tighten, encouraging heightened focus on total nutrient management. Enabled by more sophisticated technology and advanced treatment processes, utilities can now exert a smarter, more targeted approach, backed by better control and automation.

This approach also is offering new, synergistic ways to reduce energy use — always a major cost driver in wastewater treatment — and increase energy recovery. For example, new treatment methods that involve less aeration can remove more nutrients using less energy and less carbon. This enables improved primary treatment to divert more carbon over to anaerobic digestors also in order to create methane gas that can be used for energy recovery.

Another trend that will continue is the increased use of biological phosphorous removal over older chemical removal processes. New approaches to enhanced biological phosphorus removal (EBPR) are being explored and adopted, enabling biological phosphorous removal on projects where it was not previously feasible. Sidestream enhanced biological phosphorus removal (S2EBPR) is a different way of implementing biological phosphorous removal and offers two key advantages: The first is that S2EPBR makes phosphorus removal reliable for plants without enough influent carbon — or influent carbon with the right characteristics — to perform traditional biological phosphorus removal. The second advantage is that S2EBPR offers capital cost savings in retrofits.

For example, a facility may have had capacity constraints where a retrofit for enhanced phosphorous removal and the corresponding process redesign would have been far too expensive. To remedy this, the S2EBPR process can repurpose other tanks on-site, mitigating the issue and allowing a capital efficient upgrade. A current Water Research Foundation project (Project 4975) is being led by Black & Veatch to develop design guidelines, operational tools, and modeling best practices for S2EPBR configurations.

There's no doubt that wastewater utilities are actively working to advance nutrient recovery, improve effluent quality and meet tightening regulatory requirements, as demonstrated by the industry data collected in Black & Veatch's survey.

Enabled by new approaches, utilities are investigating advanced treatment options and more sophisticated technologies. Ultimately, this will allow them to exert a smarter, more targeted approach, expanding nutrient removal and recovery across the United States.

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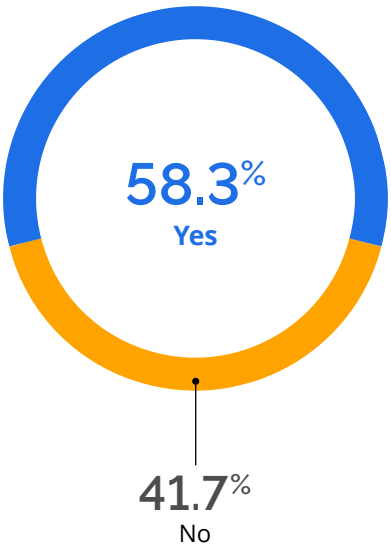
The Future is Bright for Water Recycling Strategies

By Zeynep Erdal, Jo Ann Jackson and Andrew Shaw

Figure 39

Do your sustainability goals and metrics include water reclamation and reuse?
(Select one)

Source: Black & Veatch



Finding more water sources is no longer enough. The future rests in smart strategies that reuse what we've already got.

A survey of nearly 300 water industry stakeholders for Black & Veatch's 2020 *Strategic Directions: Water Report* reveals that utilities increasingly are adopting water reclamation and recycling strategies to bolster their water resilience and reduce effluent discharge in their overall water-management plan — and provide local supply availability even in the time of global pandemics such as COVID-19.

Faced with the specter of climate change and increasingly extreme weather events, the survey's findings reveal that an expanding portfolio of water reuse strategies as a sustainability goal is becoming the norm, with nearly six in 10 respondents saying water reclamation and reuse are part of their sustainability goals and metrics *(Figure 39)*.

This isn't surprising. Water reclamation gives water utilities more options in meeting the needs of growing populations in increasingly strained natural ecosystems.

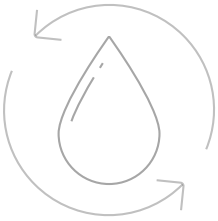


Figure 40

How has reuse utilization changed from five years ago?

(Select one)

Source: Black & Veatch

65.4%
More used today

30.8%
About the same

3.8%
Slightly less used today

Two-thirds of respondents indicated they are exploring water reuse implementation options more today, as compared to five years ago — a strong indicator of how water reuse is becoming much more common. One-fifth of those said they are using reuse solutions "much more" than five years ago *(Figure 40)*.

When it comes to water resilience, adding water reuse capabilities is the most widely used strategy that smaller utilities are taking and ranks as the No. 2 strategy for utilities serving populations of at least 500,000 *(Figure 41)*.

It's all reflective of approaching water management via the "circular economy" theory being adopted by businesses and institutions of all types. Two-thirds of survey respondents indicated they are familiar with core principles of the circular economy, including designing for the future, incorporating technology, collaborating to create joint value and using waste as a resource. Other tenets may involve preserving and extending what's already there, prioritizing regenerative resources and rethinking the model.

Many water utilities have been leaders in this space for decades. Incorporating these principles into water management and reuse strategies requires analyzing the method that works best based by region and size, bringing the public on board and, of course, finding creative ways to pay for it.

Figure 41

What steps are you taking to bolster water supply resilience?

(Select all that apply, by population served)

Source: Black & Veatch

	Less than 500,000	500,000 or more
Seeking new groundwater sources	29.0%	**64.7%**
Adding reuse capabilities	35.5%	**47.1%**
Seeking new surface water sources	25.8%	**29.4%**
Seeking new desalination/ brackish sources	9.7%	**17.6%**
Other	9.7%	**11.8%**
We are not taking any such steps	**22.6%**	17.6%

Implementing Water Reuse Strategies

Balancing the need for more water versus the liability of too much water — plus regional requirements — are influencing what reuse strategies utilities already have started to implement.

Overall, a regional breakdown of water reuse strategies reveals that utilities are implementing a broad portfolio of solutions even though what they are most likely to execute differs by region.

Groundwater recharge is an obvious solution and a means of potable reuse by way of groundwater injection where appropriate to "bank water" for future use. It is widely used, and required, in the arid West in the United States. Not surprisingly, a regional breakdown of the survey showed that respondents from Western states indicated groundwater recharge was a primary strategy in their water recycling portfolio, with urban and agricultural reuse tying for second.

Northeastern utilities picked groundwater recharge, industrial reuse and urban reuse in an across-the-board tie for their most popular water reuse strategy. Midwest utilities also chose groundwater recharge as the strategy they were likeliest to use — with industrial reuse, surface water augmentation, potable reuse and environmental enhancement tying for second. In the South covering U.S. states between New Mexico and Virginia, where the largest portion of utilities by region had yet to adopt any water reuse strategies, the most popular adopted or supported strategy by survey respondents is potable reuse, including surface water augmentation and groundwater recharge.

Overall, a regional breakdown of water reuse strategies reveals that utilities are implementing a broad portfolio of solutions even though what they are most likely to execute differs by region. This reflects, especially for larger and more mature institutions, that they are implementing more than one water reuse strategy to be adaptable to changing conditions. It also highlights the differences in water scarcity versus water abundance as utilities respond to regional influences on water resilience. At the same time, they deal with a multitude of local stressors on their systems.

Figure 42

What is the main reason why your community has a water reuse program? *(Select one)*

Source: Black & Veatch

40.4%
For risk mitigation, resilience and/or water scarcity

27.7%
Effluent disposal

23.3%
To bolster our full sustainability portfolio

4.3%
For nutrient trading

4.3%
Other

Effluent Disposal Plays a Factor in Reuse Efforts

While more than 40 percent of respondents chose risk mitigation, resilience and/or water scarcity as their main reason for water reuse, effluent disposal also is a factor in water recycling strategies. More than one-quarter — 28 percent — of respondents chose effluent disposal as their main reason for their community reuse program *(Figure 42)*.

In the case of Florida, recycling water began as a way of mitigating effluent disposal.

Starting in the 1960s, Florida began water reclamation efforts to divert effluent disposal for Tallahassee agriculture, according to a *University of Florida Institute of Foods and Sciences document*. By the 1970s, those efforts broadened into reclaiming water for landscape irrigation.

Today, the vast majority of Florida counties reclaim their wastewater. Florida citizens reuse wastewater to irrigate their private and public lawns, and roughly 820 million gallons of reclaimed water were used for public benefit purposes in 2019, according to a *Florida Department of Environmental Protection report*.

Now, as Florida grapples with a shrinking groundwater supply, the stage has been set for the state to expand into potable reuse strategies, according to a new strategic plan released by the *Florida Potable Reuse Commission*.

Florida citizens reuse wastewater to irrigate their private and public lawns, and roughly 820 million gallons of reclaimed water were used for public benefit purposes in 2019, according to a Florida Department of Environmental Protection report.

Bringing the Public on Board — It's All How You Market It

The good news is that overall public acceptance of potable reuse programs, while still a significant factor, appears to be increasing.

Engineering and technical advances have improved, ensuring safety, and more private and non-profit organizations are promoting the need for a "One Water" or an integrated water strategy.

Overall, survey respondents indicated that after groundwater recharge, potable reuse was solidly part of their reclamation use portfolio. Sixteen percent of respondents chose potable reuse as a water reclamation strategy, tying with urban reuse and just slightly less than industrial and surface water augmentation, which came in at 17 percent *(Figure 43)*.

But as California learned, a successful potable reuse program hinges on public acceptance, and a thoughtful marketing campaign can make all the difference.

As the University of California-Davis ***Policy Institute for Energy, Environment and the Economy*** has reported, California lawmakers looking to meet state requirements for an increase of one million acre-feet of reused water per year by 2020 and two million by 2030 have mandated that treated wastewater be recycled for drinking by 2023.

Even facing historic droughts, initial attempts for potable water reuse in the state failed to gain public acceptance.

In 2008, however, the Orange County Water District of California, in partnership with the Orange County Sanitation District, began a successful groundwater replenishment system treating 100 million gallons per day of wastewater and replenishing local drinking water aquifers. Bolstered by a decade of emphasis on public education, engagement and smart engineering, and building on their expertise in water recycling going back to the Water Factory 21 project, media coverage was positive and public support widespread. Today, the final expansion of that system is in construction, taking the total capacity from 100 million to 130 million gallons per day. The system has recycled more than 314 billion gallons since inception, and on its 10th anniversary set a Guinness world record for the most wastewater recycled to drinking water in 24 hours.

Other regions can not only learn from — but reap the benefits of — the public acceptance shift in favor of potable water reuse led by successful efforts as seen in California's Orange County.

Figure 43

What types of water reuse/reclamation does your utility conduct and/or support? *(Select all that apply)*

Source: Black & Veatch

29.9% **Groundwater recharge**

17.2% Industrial reuse

16.1% Potable reuse

13.8% Agricultural reuse

4.6% Other

36.8% **None of the above**

17.2% Surface water augmentation

16.1% Urban reuse

13.8% Environmental enhancement

Overcoming the Biggest Barrier to Reuse: Paying for It

Overwhelmingly, survey respondents indicated the biggest barrier to doing more reuse is cost.

In a survey question asking respondents to select up to three barriers to doing more reuse, costs to build and execute easily was the biggest obstacle. Lack of public acceptance was still significant but less than half that of the barrier of costs. Revenue from reused water systems also was considered a barrier, ranking as the third most significant barrier to implementing reuse strategies *(Figure 44)*.

Cost was even more of a factor for utilities serving fewer than 500,000 customers.

Lack of public acceptance was almost twice as likely to be selected by larger utilities than smaller ones. Both groups similarly selected revenue from reused water systems not justifying the program's existence *(Figure 45)*.

Figure 44

What are the major barriers to more water reuse? *(Select up to three)*

Source: Black & Veatch

54.7% **Cost prohibitive to build and execute**

18.6% Revenue from reused water doesn't justify the program's existence

9.3% Technological barriers

11.6% Other

24.4% Lack of public acceptance

12.8% Lack of regulatory support

8.1% Too much regulatory complication

15.1% None of the above

Figure 45

What are the major barriers to more water reuse? *(Select up to three, by population served)*

Source: Black & Veatch

	Less than 500,000	500,000 or more
Cost prohibitive to build and execute	**59.2%**	45.5%
Lack of public acceptance	18.4%	**33.3%**
Revenue from reused water doesn't justify the program's existence	**18.4%**	18.2%
Lack of regulatory support	**14.3%**	12.1%
Technological barriers	6.1%	**12.1%**
Too much regulatory complication	**8.2%**	6.1%
Other	**12.2%**	12.1%
None of the above	12.2%	**18.2%**

In some cases, utilities simply may be overwhelmed by asset management and repairs of existing infrastructure, and not taking a step back to look at the overall picture in water resource management. Investment in water reuse can offset other water utility costs when approached in a holistic framework.

When it comes to costs, utilities may be unaware of increasing grant opportunities that can help to offset water reuse investments as federal and state legislators begin embracing more water reuse as a solution to water resilience.

In February of 2020, the U.S. EPA released the new *"National Water Reuse Action Plan."* Focused on water reuse as "a valuable, perhaps necessary component of integrated water resources on planning to ensure safe and reliable sources of water at the federal, state and local levels well into the future," that new report includes a section on finance support compiling federal funding sources.

Searching for new resources, even aggressively asking potential partners for help, plus positioning for grant-funding and stimulus money for shovel-ready projects is a smart strategy for utilities looking to invest in water reclamation projects.

The bottom line: Black & Veatch's survey results reveal an increasingly positive outlook for water reclamation as a real solution for overall resilience efforts.

Efforts to tighten up the cycle of water through reuse and exploring options for better ways to work with the natural and man-made water cycle are — not surprisingly — a wise water utility strategy in a world increasingly adopting a circular economy framework as the answer for future sustainability and resilience.

ABOUT THE AUTHORS

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The Conundrum of Water Affordability: What Is It, and What's at Stake?

By Mike Orth, Ann Bui and Bruce Allender

For decades, talk of water has rested on philosophical premises, ranging from arguments that it's a human right to insistences that it's a property right or even a commodity. Regardless of the philosophical posture, potable water is anything but free. Utilities incur costs to get the water, treat it to safe drinking standards and then supply it through an often-aging system of pipes and pumping stations to the consumer. Customers expect that when they turn on the faucet, they will get potable water at adequate pressure and enough of it for their on-demand needs. They expect to pay for this level of service but at reasonable prices.

The question then is, "Is water affordable?" That depends on who you ask — and more precisely what defines "affordable."

The COVID-19 pandemic is challenging how we all view what is normal. Pandemics beyond national disasters take utility planning for water utilities to a new level, along with different operational practices to ensure that affordability of supply of service stays in place for its customers. The drop in revenues that utilities experience during a pandemic challenge a utility's reserves, how rates are structured and how a utility looks to manage its customer services and operations.

Only with time will the extent of COVID-19's financial implications on the water industry become clearer. But Black & Veatch's survey of nearly 300 water industry stakeholders for this 2020 *Strategic Directions: Water Report* adds insights about the elusive value of water, beginning with how the decision-makers in that space define it.

Figure 46

What does water affordability mean to you? *(Select one)*

Source: Black & Veatch

67.4%
Charging enough to serve customers AND make improvements

23.9%
Providing a basic level of water at an affordable price to all customers

4.4%
Keeping rates as low as possible

4.3%
Giving a discounted amount of water to fixed-income / low-income customers

Water Affordability: The Industry's Perception

Conventional wisdom would cast water affordability as providing water at a reasonable price to customers. Black & Veatch's survey shows it's not that simple.

More than two-thirds of respondents described affordability as more than merely charging enough to provide customers with safe drinking water or wastewater services. It's also about funding capital improvements or for covering operations and maintenance — a nod to addressing the industry's vexing issue of aging infrastructure. Nearly one-quarter of respondents — 24 percent — consider affordability as providing a basic level of water service *(Figure 46)*.

A scant 4 percent identified affordability as keeping rates as low as possible or discounting the charge to fixed- or low-income customers.

The industry's prevailing, broader definition of affordability isn't necessarily a bad thing. Still, it requires effectively explaining it to ratepayers by educating them that it is about more than simply the charge for water flowing through the tap — and the infrastructure to remove used water. And that needed funding for infrastructure upgrades may be influenced by city councils, boards or other civic overseers who may decide rate increases through the prism of election cycles.

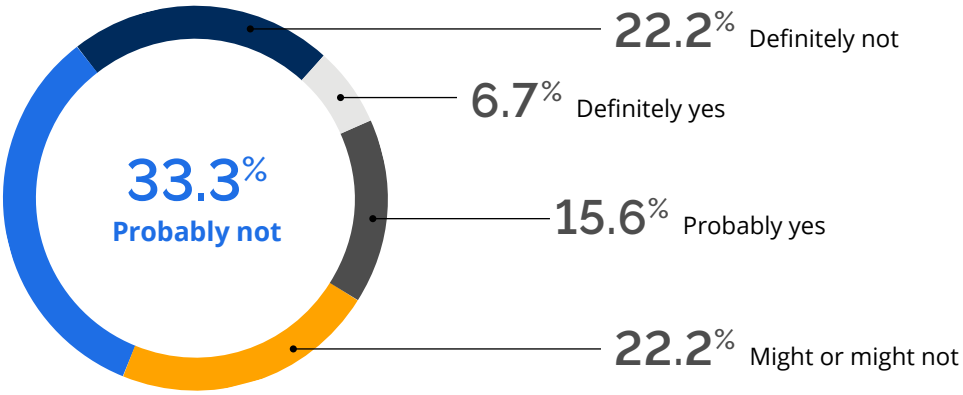
As much as consumers expect wastewater to be removed and safely disposed of to protect the environment, they expect reliable, clean and safe drinking water, making it incumbent on the utility to help customers understand and appreciate the cost involved in providing that resource and service. One-third of respondents to Black & Veatch's survey said their customers probably don't understand what it takes to supply them with clean, potable water, as well as wastewater and stormwater services. In addition, one in five respondents lamented that their customers don't have the baseline knowledge about the service they receive *(Figure 47)*.

Bridging that education divide facilitates utilities making a case for modest rate increases to underwrite long-overdue upgrades of increasingly strained infrastructure — or to save for when that infrastructure fails. In the fallout of the COVID-19 outbreak, many expect significant pressures to further defer rate increases until the economy recovers and the millions of jobs are returned.

Figure 47

Do you think your customers understand what it takes to provide clean, potable water, wastewater, and stormwater services? *(Select one)*

Source: Black & Veatch



Customer Assistance, Discounts

Because the online survey for this report was conducted during a three-week span ending on March 30, 2020 — during which the COVID-19 pandemic was accelerating — it's difficult to discern how much of an impact that global outbreak had on the responses. More specifically, whether utilities either by outside mandates or voluntary gestures of goodwill broaden their customer service when it comes to offering discounts to customers in need.

Through the timing of this survey, 40 percent respondents say they're not compelled by regulators to offer rate-discount programs to seniors or others, so they don't, perhaps, because of the administrative work required. A similar amount — 38 percent — report that in the absence of regulatory guidance, they have such programs. Just 11 percent say they are required to offer discounts or customer aid *(Figure 48)*.

It's unclear whether the COVID-19 pandemic will dramatically influence more water utilities to offer discounted services long-term. Many water utilities — often at the behest of their states or municipalities — are giving customers financially strapped by outbreak-forced layoffs a break by maintaining service to those behind in payments. Some utilities are required to go a step further and turn shut-off customers back on. That's keeping in mind that shutoffs are one of the few enforcement tools utilities have to collect on past-due accounts.

Figure 48

Which of the following statements best reflect any water rate discount programs (e.g., customer assistance programs, discounts for senior citizens, etc.) in your area? *(Select one)*

Source: Black & Veatch

37.8%
No regulation, but we DO offer them

40.6%
No regulation, but we DO NOT offer them

10.8%
Regulations mandate that we DO offer them

10.8%
Regulations mandate that we DO NOT offer them

Figure 49

Which of the following statements best describe your utility's financial resilience situation?

(Select one)

Source: Black & Veatch

51.1%
We have substantial cash reserves should an adverse event occur

31.1%
We have cash reserves but one major event would be detrimental

4.4%
We have little to no cash reserves set aside for major adverse events

13.4%
Other (specify)

Financial Resilience

Commissioned by two leading trade groups — the American Water Works Association (AWWA) and the Association of Metropolitan Water Agencies — *an assessment released in April 2020* indicated an aggregate financial impact of COVID-19 on drinking water utilities of approximately $13.9 billion, representing an overall 16.9 percent financial toll. Wastewater utilities were expected to lose an estimated $16.8 billion in lost revenues, along with the costs of maintaining sewer access.

The National Association of Clean Water Agencies (NACWA) warned that without taxpayer help to the industry, the revenue loss from forgiving customer debts and providing services without payment during the pandemic ultimately would be passed on to water customers in subsequent years and lead to future rate increases.

Often saddled with the costly need to upgrade their chronically aging infrastructure but constrained in doing so by the rates they manage to collect, utilities generally aren't considered to be flush with cash. But a majority of respondents to Black & Veatch's survey suggest they've got enough on hand to weather a setback.

When asked to gauge their utility's financial resilience, slightly more than half — 51 percent — report they have "substantial" cash reserves to withstand an adverse, isolated event. Thirty percent of respondents said they have cash reserves, though a major event would be "detrimental" *(Figure 49)*.

Left to question is what they perceive to be a "substantial" amount in the bank, and whether those who say they have it have false confidence. Is it considered enough to get them through a catastrophic event like a flood that puts them out of operation for a few months? Or are they viewing their reserves as simply the amount to get past a service-disrupting infrastructure or equipment failure? How much money on hand is the right amount?

COVID-19 and its financial fallout may answer much of that, showing just how fiscally ready water and wastewater providers are in dealing with something that suddenly sinks their revenues through delinquent accounts and lost customers. Utilities would be well-served using this pandemic as a learning moment by strengthening their cash reserves — at least enough to cover four to six months of costs, with perhaps a line of credit on standby. Moreover, the need for innovative approaches to address the affordability and develop strategies and programs assisting those in need will continue to be an ongoing concern — pandemic or not.

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Overseas Perspectives

Ensuring All Customers Have an Equal Opportunity to Receive Leading-Edge Service

By Mark Kaney

The more you can spend to achieve successful outcomes, the greater the likelihood of success. Since the 2013 Australian Grand Prix, no Formula 1 team other than Red Bull, Ferrari or Mercedes has won a Grand Prix. The "Big Three's" spending power consistently outstrips the rest of the pack. During the 2019 season, won by Mercedes — with Ferrari second and Red Bull third — the Big Three spent more money than the other seven teams combined.

During the 2018/19 British Premier League season, Liverpool paid £43m to football agents — more than any other club — followed by Chelsea (£26m) and Manchester City (£24m). City beat Liverpool to the title by one point, Chelsea finished third. During the same season, Championship clubs' combined pay-outs to agents totaled £50m.

Could we see something similar apply to the water industry in England and Wales? It's an exciting time with digital transformation gaining pace, a renewed appetite for innovation, and the opening up of the sector to tech start-ups. Against this backdrop, is there a chance that customers of bigger water companies — with more to invest in innovation — enjoy better outcomes, better customer experience, than customers of smaller, less affluent water companies? This matters when you are dealing with natural monopolies like water companies, because few customers can choose their supplier, creating the potential for a postal code lottery in digital water services.

Innovation is a prime mover for better services and customer experience. It follows that the more a water company can spend on innovation, the greater the likelihood that the company's customers will enjoy a better experience. It also follows that the converse is true. If the chance to invest in innovation is limited, customer experience is less likely to improve.

While smaller companies may have the advantage of being nimbler and better-suited to adopting new technologies from start-up companies — with less proof of scalability — they are taking on greater risk than those able to afford proven heritage brands.

The bigger the innovation investment, the greater the pool of partners and suppliers water companies can draw from. Access to technologies and approaches not traditionally associated with the water sector is enhanced, so is the ability to create multi-company top-tier alliances.

It's definitely the case that the bigger water companies are making significant investments in initiatives intended to foster innovation.

Anglian Water's "Future Water Company" initiative uses the Newmarket region of its operating area as a proving ground for innovators and technologies promising the greatest benefits. At Newmarket, the utility is working with more than 100 partners on 62 different projects to achieve zero leakage and bursts; 100 percent customer satisfaction; water consumption of 80 liters per person per day; zero pollution and flooding; 100 percent compliant and chemical-free drinking water; carbon neutrality; and building a circular economy that eliminates the concept of waste.

For the second consecutive year in 2019, United Utilities ran its award-winning Innovation Lab program. The 2019 focus was on how innovative companies can help the utility develop systems thinking and improve service using various connected customers; empowered, knowledgeable colleagues; right information, right place, right time; and the future of water.

During the summer of 2019, more than 3,000 people from nearly 700 leading organizations around the globe attended Northumbrian Water's Innovation Festival. The aim of the five-day event was to come up with innovative solutions to some of the biggest challenges faced by society and the environment.

For the smaller water companies and new entrants, initiatives on this scale likely are to be too expensive, and difficult to resource effectively, to undertake alone. By partnering with Anglian, however, the much smaller Essex & Suffolk Water was able to participate in September 2019's three-day Innovate East event. Customers of those companies unable to take part in major innovation initiatives may not enjoy the benefits of any successful innovations that arise.

While justly rewarding good performance, the comparative competition model which underpins economic regulation of the water industry in England and Wales reinforces this disparity in the ability to invest in innovation. The companies best placed to achieve their outcome delivery incentives typically will be those most able to invest in innovation. With performance measured relative to self year-on-year, the companies with the most to invest in successful outcomes will accrue even more funding for further innovation, with their customers seeing better, cheaper service and greater speed-to-value.

While smaller companies may have the advantage of being nimbler and better-suited to adopting new technologies from start-up companies — with less proof of scalability — they are taking on greater risk than those able to afford proven heritage brands.

With no incentive to share innovation across the sector, this propensity to variable speed innovation will grow. This risk of a postal code lottery in customer experience is likely to be exacerbated by the cost of investing in leading-edge, data and artificial intelligence-driven technologies.

While smaller companies may have the advantage of being nimbler, and better suited to adopting new technologies from start-up companies — with less proof of scalability — they are taking on greater risk than those able to afford proven heritage brands.

Seemingly cognizant of this and recognizing that part of the solution lies in some form of sector-wide mechanism to foster and share innovation, Ofwat — the water industry's economic regulator for England and Wales — ran a consultation in 2019 on its own proposals to drive "transformational innovation" in the sector. The proposals centered upon:

- A collectively funded innovation competition during AMP7*
- Rewarding the successful roll-out of innovative solutions at the end of AMP7 as part of PR24**
- Creating a company-led innovation in water center of excellence
- Proposals on ways to make better use of data

Ofwat opted for the innovation competition, collectively-funded by the water companies, to provide up to £200m of additional funding for innovation during AMP7 (2020-25). When designing the competition, the regulator will try to address the concerns of smaller water companies that a lack of resources, compared to their larger counterparts, may hamper access.

Entrance to the competition is restricted solely to the water companies. Although Ofwat hopes for collaborative bids — with water companies, the supply chain and other stakeholders working together — there remains the challenge of how to access quickly and fairly the innovation capabilities of the supply community. The competition's structure, in effect, means innovation coming from the supply chain will be largely dictated by the procurement choices of each water company.

As the innovation initiatives described previously show, water companies typically look to the supply chain to develop innovative technologies and ways of working. The utilities have shown a willingness to trial and adopt innovation borne of the supply chain; but not to expose customers, owners and shareholders to the financial risks inherent in undertaking large-scale research and development of their own.

Consequently, to succeed, any initiative to create "transformational innovation" needs to facilitate supply chain involvement at a sector-wide level. As Ofwat's consultation document noted, "Supply chain companies report facing slow commercial deployment, and often having to trial their new technologies independently on each incumbent water company." Finding a viable alternative is vital to speed-up the nurturing of innovation from good idea to something with the potential to offer tangible value for customers, shareholders and owners.

Data will be at the core of genuinely transformational innovation.

Adjunct to this is the tendency from many water companies to want to own the intellectual property rights (IPR) for all supply-chain derived innovations they adopt. This acts as a disincentive to suppliers because they do not get a sustainable return on their investment in innovations. This serves as a barrier to the supply chain making a sector-wide contribution to transformational innovation as there is a propensity for the wealthiest companies to monopolize the best ideas, which risks contributing to the development of a postal code lottery for the best water services. The journey from a great idea to the ultimate cost and service benefit to the customer has many barriers; and the chances of that idea becoming real and making it to a customer, let alone all customers, reduces at each hurdle.

Data will be at the core of genuinely transformational innovation. To mitigate against the risk of a two-tier provision of water services data needs to be fully accessible to all, with the returns on investment mainly residing with the ability to turn data into information. Currently, the trend is toward seeing how data can be monetized. We need to move to a position where the wisdom and insights which data informs are valued, rather than the data itself.

To enable this change, could water companies and the supply chain create and have access to a central open data resource? This will help foster a sector-wide innovative culture by making the building block of digital innovation — data — available to all. The role that open data must play in driving innovation is acknowledged in Ofwat's innovation competition plans, "There will be an 'open by default' approach to data and learning …"

In contrast to IPR, when it comes to data, water companies are starting to show a much greater willingness to share. Yorkshire Water is setting a precedent with an open data initiative partnership with the Open Data Institute, using Datamill North as a data repository. The company is considering giving independent data scientists access to data streams including water consumption, water resources, leakage and bio resources.

A two-tier, postal code lottery, for water services is in no ones' interest; especially at a time when our industry is facing more intense scrutiny than ever before. There is no silver bullet, but the fact the regulator has put forward concrete proposals to foster innovation is a welcome step. As we move toward Industry 4.0 — and the role of data, artificial intelligence, and machine learning underpin everything we do — embracing open data now and creating an industry that encourages and enables innovation from all, will help us future-proof world-class quality and consistency of service for all.

* *AMP7 is the seventh five-year asset management period (AMP) to be delivered by water companies in England and Wales since privatization in 1989; AMP7 runs from 2020 to 2025.*

** *PR24 is the regulatory price review (PR) of water company funding, due in 2024, which will set revenues and requirements for AMP8 (2025-2030).*

ABOUT THE AUTHOR

Mark Kaney *is Black & Veatch's asset management director for Europe. He has more than 20 years of experience in the utilities industry. Prior to joining Black & Veatch, Kaney held senior asset management positions in both asset-owning and consultancy organizations, and served as head of digital development. He is actively involved with the Institute of Asset Management, where he is as an endorsed assessor and with a seat on the IAM Council and British Water, serves as the International Business Mentor for Europe.*

Asia Pacific's Water Industry Focuses on Sustainability, Resource Recovery

By James Currie, Andy Kwok, William Yong

Amid climate change and growing urbanization, Asia Pacific's water networks are getting more complex and extensive. Increasing incidences of extreme weather that changes rainfall patterns, affecting rainfall availability and distribution, are one aspect of climate change that regional water leaders are addressing.

In April 2020, Australia's Bureau of Meteorology reported that the top end was experiencing two wet seasons of low rainfall. In the same month, Indonesia reported that floods damaged homes in Banten, Bengkulu and East Kalimantan, and at least 2,000 people were affected.

Other challenges the region is facing arise from rapid urbanization and aging water infrastructure.

As of April 2020, the United Nations estimates that the population of Southeast Asia is more than 667 million, with half of the population urban. On the one hand, the growing urban population increases the demand for water, which puts a strain on water resources and infrastructure. Conversely, cities are well-positioned to provide more integrated and sustainable water use and waste management.

Recognizing the value of that integration and sustainability, Asia Pacific water leaders are identifying possibilities for resource recovery in urban water infrastructure to continue building resilient, livable cities. Digital transformation is one tool that the region is investing in to support better infrastructure lifecycle management decisions and strategies.

Digital Transformation Reframes Water Sector

Digital transformation allows water utilities to explore new ways to enhance productivity and achieve planning and operations efficiency in stormwater, water and wastewater management.

Asia Pacific water leaders are progressively incorporating water infrastructure with sensors and communications infrastructures to relay data from the sensors to control centers. Data is analyzed at treatment works and central control facilities. In some cases, artificial intelligence is incorporated into the analytics and control system.

For water and wastewater assets, technologies such as data analytics, robotics and asset management tools are alerting water utilities of potential operations issues in advance and identifying productivity opportunities.

Robotics are used, for example, in automated lab analysis to test more samples in the same amount of time. Data-driven asset management offers the opportunity to take preventive actions before equipment failure, minimizing infrastructure lifecycle costs while ensuring network reliability. Smart meters are encouraging conservation efforts as they provide users with data that may influence their water consumption.

Asia Pacific water leaders are progressively incorporating water infrastructure with sensors and communications infrastructures to relay data from the sensors to control centers.

Regional Progress:

Australia Invests in Integrated Water Systems

Fishermans Bend Sustainability Hub in Melbourne, Australia, is an integrated water system that will optimize locally available water, minimize water and sewerage loads, reduce flooding and transform urban amenities.

Fishermans Bend is the largest inner-city high-density redevelopment in Australia and one of the world's largest urban renewal projects, with a high focus on sustainability.

South East Water's objective for this project is to create a water-sensitive community that secures Melbourne's livability and set a new benchmark in sustainable urban design. Potential outcomes anticipated for the integrated water system include: flood reduction with 400ML rainwater reuse, 45 percent reduction in mains water consumption; a drought-resilient urban forest; and 50 percent reduction in treated wastewater discharge.

South East Water will design, construct and operate the robust integrated water system to deliver a reliable recycled water supply. The system will tap on "Smart Grid" technology to maximize the capture of rainwater for reuse in buildings. That technology also will enhance flood mitigation in the area.

Future developments include a precinct scale treatment plant that will mine the city's sewage and treat it to a high recycled water standard at a significantly lower cost than smaller building-scale systems. Reticulated recycled water will be supplied through the precincts to create drought-resilient green spaces that enhance livability.

For a water utility, a digital twin offers the prospect of helping enhance customer experience ...

By creating digital twins of water facilities, regional water utilities have an opportunity to take insights to a more advanced level. A digital twin is an integrated digital representation of physical assets that provides historical, current and predictive analysis in near real-time. What separates the digital twin from a traditional model is that the twin is in constant dialogue with its physical counterpart through combining information technology (IT) and operations technology (OT) enabling its users to simulate scenario options before actioning them in the real world.

For a water utility, a digital twin offers the prospect of helping enhance customer experience, without increasing bills to fund improvements, by optimizing performance of existing assets and increasing the efficiency with which they are operated and maintained. A digital twin supports this by facilitating systems thinking — combining multiple internal and external data sources across the asset base with predictive analytical techniques served through multiple functional views. This enables improved insights that support better decisions, leading to better outcomes in the physical world.

With foresight, many Asia Pacific utilities are identifying the components of a digital transformation program to address their social and economic development requirements.

Regional Progress:

Hong Kong Increases Resource Recovery Capacity

The Drainage Services Department (DSD) of the Government of the Hong Kong Special Administrative Region is investigating the upgrade of the Tai Po Sewage Treatment Works (STW).

Tai Po STW, built inside Tai Po Industrial Estate (TPIE), is the second-largest secondary sewage treatment works in Hong Kong. Tai Po STW serves the TPIE, Tai Po, Lam Tsuen and Ting Kok areas.

One objective of the Tai Po STW upgrade is to increase the capacity of sewage treatment, biosolids management, energy recovery and sewage discharge disposal to support the housing and economic needs of the Tai Po District. Another objective is to provide facilities to receive and digest sludge from the sewage treatment works in eastern New Territories for co-digestion with pre-treated food waste. Featuring a compact design, the upgraded STW is anticipated to accommodate the new regional sludge treatment facilities and future expansion.

Core innovations that will be assessed for the Tai Po STW upgrade include:

- Uncertainty-based dynamic process modelling, which enables the use of statistical techniques in combination with process models to evaluate solutions. It provides the ability to right-size process systems and equipment.
- Low-energy solutions, including biological nutrient removal incorporating sustainable nitrogen removal strategies.
- High solids digestion, a compact solution that offers more effective management of high strength feedstocks.

In Australia, the Intelligent Water Networks (IWN) Program is a partnership between Victoria's peak industry association, VicWater, various water utilities and Victoria's Department of Environment, Land, Water and Planning.

The objective of IWN programs is to assess new technologies and innovations that meet common challenges such as population growth, aging infrastructure and climate variability in a more efficient manner. Its Big Data and Analytics Program helps Victorian water utilities, like Lower Murray Water and East Gippsland Water, transition into "digital utilities" by exploring new and emerging technologies designed to manage better and integrate data.

Lower Murray Water and East Gippsland Water piloted a solution to demonstrate aggregation and analysis of data from distributed assets, including smart meters and sensors, with web-based visualization of this data. Key business outcomes include saving time and reducing human errors as the digital platform was able to incorporate data from different sources, perform calculations on the data and use the data in reports and dashboards. The utilities benefitted from faster and better decision making on issues and assets as the platform provided a single point for data access to real-time data, organized it and provided self-service visualization tools.

The objective of Intelligent Water Networks programs is to assess new technologies and innovations that meet common challenges such as population growth, aging infrastructure and climate variability in a more efficient manner.

Regional Progress:

Singapore Harnesses Water-Energy-Waste Nexus

Singapore's Tuas Nexus is the world's first fully energy self-sufficient greenfield facility in a compact footprint that will integrate used water treatment and waste management in a single facility. It was named the "Most Innovative Water-Energy Nexus Project" at the International Desalination Association (IDA) World Congress 2019 in Dubai, United Arab Emirates.

Tuas Nexus integrates and co-locates Singapore's National Water Agency Public Utilities Board's (PUB) Tuas Water Reclamation Plant (Tuas WRP) with the National Environment Agency's (NEA) Integrated Waste Management Facility (IWMF). This new way of treating used water and municipal solid waste will allow Singapore to effectively harness process synergies from the water-energy-waste nexus.

Tuas WRP will be the first of its kind in Singapore to co-digest used water sludge and food waste in the same plant to enhance biogas production. The biogas produced will be used to further enhance the overall thermal efficiency of the waste-to-energy process and electricity production at the IWMF. Electricity generated at IWMF will be supplied to Tuas WRP for its operations. Excess electricity will be exported back to the grid.

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Asia Pacific water leaders recognize that success requires proven expertise in the design, construction and management of critical infrastructure; underpinned by leading-edge capabilities in data analytics, artificial intelligence and machine learning. They see the value in augmenting utility infrastructure with sensors, wireless connectivity and data analytics to create cyber-physical systems that enhance the planning, operation and management of utility assets.

To tap on the opportunities, regional water leaders are collaborating with partners who can add value at every point along the infrastructure lifecycle. In turn, these partners are systematically fostering new ways of work by sharing deep institutional knowledge to keep Asia Pacific water leaders ahead of rapid changes.

ABOUT THE AUTHORS

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Andy Kwok *is the managing director of Black & Veatch's North Asia Pacific water business. In this role, he is responsible for the management and sales of the company's water business in Hong Kong, mainland China and Vietnam. Kwok has 27 years of experience in water and integrated infrastructure projects.*

William Yong *is managing director of Black & Veatch's Southeast Asia water business. With more than 39 years of experience in project management, design, construction supervision and commissioning, Yong has worked in Australia, Hong Kong and Singapore.*

Regional Progress:

Singapore Harnesses Water-Energy-Waste Nexus Continued

Several other innovative synergies between the two facilities significantly enhance energy and resource efficiency, reduce emissions, minimize land take and improve reliability, resilience and sustainability.

Tuas WRP is a core component of the Deep Tunnel Sewerage System (DTSS) Phase 2 project. The DTSS is a superhighway for Singapore's used water management, using deep tunnels to convey used water by gravity to three centralized treatment plants strategically located in coastal areas.

The IWMF is a world-class integrated facility that receives and treats municipal solid wastes, recyclable wastes collected under the National Recycling Programme, food wastes separately collected across Singapore, and dewatered used water sludge from the TWRP.

2020 Report Background

The Black & Veatch 2020 *Strategic Directions: Water Report* is a compilation of data and analysis from an industry-wide survey. This year's online survey was conducted from 3 March through 30 March 2020 and reflects the input of 279 qualified utility, municipal, commercial and community stakeholders in North America. Because the survey was administered online, the amount of self-selection bias is unknown; therefore, no estimates of sampling error have been calculated. The following figures provide additional details on the participants in this year's survey.

INDUSTRY TYPE

Which of the following BEST describes your organization?
(Select one)

Source: Black & Veatch

40.9% Water, wastewater or stormwater plant

17.6% Consulting firm that offers water or wastewater management solutions

13.3% Local government or municipality with knowledge of local water/wastewater/ stormwater issues

12.5% Combined utility that provides water or wastewater services and other utility services (such as electric or natural gas utility services)

15.7% Other

SERVICE TYPE

Please identify all of the services provided by your utility. *(Select all that apply)*

Source: Black & Veatch

82.7% Drinking water

67.9% Wastewater

28.2% Stormwater

12.2% Electricity

9.0% Solid waste

2.6% Natural gas

POPULATION

What is the estimated population served by your organization? *(Select one choice)*

Source: Black & Veatch

31.1% Less than 100,000

27.4% 100,000-499,999

14.7% 500,000-999,999

8.9% 1,000,000-1,999,999

17.9% 2,000,000 or more

PRIMARY BUSINESS REGION

In which regions of the United States is your organization located and/or provide services? *(Select all that apply).*

Source: Black & Veatch

New England	10.7%
Mid-Atlantic	12.8%
North Central	31.0%
Great Plains	13.2%
Southeast	33.5%
South Central	16.9%
Southwest	28.1%
Rocky Mountain	14.0%
Northwest	22.3%
Other U.S. locations	11.2%

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