About This Report

The Black & Veatch 2019 Strategic Directions: Water Report examines the issues and trends impacting the water industry today. From the troublesome scenario of Day Zero in South Africa’s Cape Town to heartbreaking images of Midwestern towns dealing with extreme flooding, water remains a challenge for far too many communities around the globe.

The situation will only get more complicated as the impacts of climate change continue to add to the challenges. The latest Intergovernmental Panel on Climate Change estimates the planet will warm by an estimated 0.3 to 4.8 degrees Celsius (0.5 to 8.6 Fahrenheit) by the end of this century, increasing the number and frequency of extreme weather events.

This prediction, paired with an expanding global population and increased urbanization, is reason enough for the industry to evolve its collective approach to water.

New strides in technology offer the promise of transformation, as advanced digital systems inject a much-needed merge of data into water operations across the industry. Big Data and the Internet of Things continue to disrupt legacy processes, introducing new efficiencies and opportunities. Encouraged by this success, more and more water leaders are looking to data to optimize systems and breathe new life into aging assets, changing perspective on asset maintenance, budgets and financial viability, sustainability, planning and resilience.

This year’s report dives into these issues and many more and provides 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.

Sincerely,

CINDY WALLIS-LAGE | President, Black & Veatch’s water business
JOHN CHEVRETTE | President, Black & Veatch Management Consulting, Inc.
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Executive Summary

FROM INTERNET OF THINGS TO INTERNET OF WATER: HOW INTEGRATED DATA CAN HELP STOP ‘DAY ZERO’

By Cindy Wallis-Lage
The taps are flowing more freely in Cape Town, one of the world’s premier tourist destinations and a cultural center of South Africa. In 2018, Cape Town residents stared down “Day Zero,” the moment when the water system — jeopardized by the combination of population growth, drought cycles, aging infrastructure and deferred system improvements — was predicted to literally run dry.

Fortunately, citizens rallied by heeding the conservation calls, and the skies opened. A historic crisis was averted for its more than 3 million residents. But the lesson lingers on: Government and water industry leaders the world over are reconsidering how climate impacts and deferred maintenance threaten the resilience of our supply.

From scarcity in South Africa to flood control in the United States, many believe that a smarter infrastructure, with data at its core, will be key to overcoming the many threats to our water supply. In its various forms and monikers — from “Digital Water” to “Smart Water” to the “Internet of Water” — data has woven itself into the central fabric of our water economy, increasingly driving sustainability, resilience, asset management (AM) and planning. Just as industries have embraced the Internet of Things to connect technologies and add value to our daily lives, the Internet of Water promises a similar transformation for our water systems.

Cape Town briefly flirted with running out of water. But the rains came and citizens conserved. What can we do to avoid future challenges?

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. Wallis-Lage joined the company in 1986 and has provided leadership and project expertise to more than 100 municipal and industrial facilities throughout North America, South America, the UK, India and Asia Pacific. Wallis-Lage joined the Black & Veatch Board of Directors in 2012. A licensed professional engineer, she earned a Bachelor of Science in Civil Engineering from Kansas State University in 1985 and her Master of Science in Environmental Health Engineering from the University of Kansas in 1990.
From precise reads of consumption and customer engagement to leak detection and climate change, a culture of data science is lighting new paths to enriching our supply. Responses to Black & Veatch’s 2019 Strategic Directions: Water Report survey about data use clearly reflect its role in utility operation (Figure 1).

Another statistic from the 2019 Strategic Directions: Water Report illustrates an unfortunate symptom of this new era’s emphasis on data creation: What to do with it all?

In many ways, we’ve put data in a kind of information lockup. Just 5 percent of respondents to our annual

### What types of data does your utility have, and which data types are adding value?

<table>
<thead>
<tr>
<th>Data Type</th>
<th>We have it and we need to keep it</th>
<th>We don’t have it but we need it</th>
<th>We neither have nor need this data</th>
<th>We have it but we don’t need it</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter and billing data</td>
<td>97.6%</td>
<td>2.4%</td>
<td>0.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Customer information</td>
<td>96.2%</td>
<td>0.0%</td>
<td>1.3%</td>
<td>2.5%</td>
</tr>
<tr>
<td>SCADA (Supervisory Control and Data Acquisition) Systems</td>
<td>92.9%</td>
<td>3.6%</td>
<td>1.2%</td>
<td>2.4%</td>
</tr>
<tr>
<td>Operations data (sewer maintenance, hydrant flushing)</td>
<td>92.2%</td>
<td>2.6%</td>
<td>3.9%</td>
<td>1.3%</td>
</tr>
<tr>
<td>GIS (Geographic Information System)</td>
<td>89.4%</td>
<td>3.5%</td>
<td>2.4%</td>
<td>4.7%</td>
</tr>
<tr>
<td>Laboratory Information Management System</td>
<td>81.8%</td>
<td>6.5%</td>
<td>9.1%</td>
<td>2.6%</td>
</tr>
<tr>
<td>CMMMS (Computerized Maintenance Management System)</td>
<td>80.2%</td>
<td>11.1%</td>
<td>3.7%</td>
<td>4.9%</td>
</tr>
<tr>
<td>Weather data (rainfall, temperature etc.)</td>
<td>75.9%</td>
<td>7.6%</td>
<td>10.1%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Static datasets (in-house Excel models)</td>
<td>72.6%</td>
<td>8.1%</td>
<td>11.3%</td>
<td>8.1%</td>
</tr>
<tr>
<td>Mobile workforce solutions</td>
<td>71.1%</td>
<td>22.4%</td>
<td>3.9%</td>
<td>2.6%</td>
</tr>
<tr>
<td>Leakage data (surveys, leakage locations etc.)</td>
<td>69.7%</td>
<td>18.2%</td>
<td>7.6%</td>
<td>4.5%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
survey of water industry leaders in North America said their organizations had implemented a robust, fully integrated approach to data management. Nearly 60 percent said their data efforts were getting stronger but weren’t fully integrated (Figure 2). Another third of respondents said their organization’s data remained siloed, while more than 4 percent of respondents said they collect little to no data, and whatever digital information they were capturing wasn’t being leveraged for actionable information.

Silos of data in computer systems don’t always talk to each other, and they miss a key opportunity to present more holistic views of the health of our systems. Digital water — through next-generation collection devices and predictive analytics — has ushered in the ability to funnel disparate data into a single, meaningful snapshot of the entire water ecosystem. This “single version of the truth” allows a user to gain insight on the connectivity and synergies within a system to drive operational efficiency, performance predictability, maintenance planning and optimize workforce needs. Data has the power to understand, manage and guide us to reliability and optimization.

Without a strategic and integrated plan, fragmented data streams feed what essentially are data “islands” that don’t communicate, thus inhibiting a beneficial, broad system snapshot. For forward-looking organizations, the move to become “insights driven” puts a premium on data collection and analytics to drive integrated decision-making. Some organizations have even appointed “chief data officers” to enable inclusive, data-driven planning.

That kind of approach is at work in the UK, where leaders of Yorkshire Water sought an asset management program to satisfy the often-competing demands of customer satisfaction and regulatory compliance. Under a comprehensive strategy that capitalizes on technology and predictive data analytics, professionals carrying tablets with sophisticated documentation software are enabling live asset survey findings, and piping and instrumentation diagram updates, to be uploaded to a dynamic asset database.

The Yorkshire project, spotlighted on page 17 in this report, features operations and maintenance teams in the field that are empowered to access a condition-based maintenance program which guides their activities, and to record and upload condition reports, in real time. The utility’s work with Black & Veatch is central to enabling the implementation of an effective predictive maintenance regime covering 695 water and wastewater treatment facilities and 83,000 kilometers (about 51,570 miles) of water and sewerage pipes. In the first three months of the program alone, they saw a 31 percent decrease in reactive O&M activities and saved more than £47,000 through a single failure mitigation at the site.

**Figure 2**

Which of the following statements best describe the data management strategy at your organization? *(Select one)*

- 5.3% Robust, fully integrated approach
- 54.7% Strong, and getting stronger, but not fully integrated
- 33.0% Data largely still in silos and not integrated
- 4.3% Collecting little data and not leveraging

Source: Black & Veatch
Data to Validate Investments: Once declared “the world’s most valuable resource” by *The Economist*, data continues to flex increasing muscle in helping many utilities boost operational efficiency and cut costs. In the water sector, our survey finds that data remains underused in helping those utilities forge risk-based strategies for asset-replacement investments. Instead, operators and “tribal knowledge” are largely making decisions where data can provide key insights, support, and justification.

Water Meets “New Energy”: While water and energy are frequently assigned to their own silos, improving only one of those resources while neglecting the other in what’s an interdependent system can be counterproductive when pursuing sustainability and security. Opportunities to boost energy efficiency, cut greenhouse gas emissions and capitalize on new revenue streams differ among wastewater utilities, but there is a commonality: the ability to contain or cut energy and operational costs by embracing modern technology. While data can unlock greater system efficiency and asset management, on-site generation of new energy sources — options such as biogas, hydroelectric and renewables — are maturing and gaining sway, with solar generation a natural option for utilities that largely have access to large spaces and rooftops of public buildings.

Resilience in the Face of Limits: Arid conditions and frequent drought cycles continue to challenge water supplies across the United States, causing concerns about water security to reverberate throughout the industry. Survey data finds water providers are squarely focused on hardening their systems to withstand both natural events and man-made threats, with 86 percent saying resilience is a crucial priority.

Stormwater Funding: Our survey finds that while the need for a programmatic approach to stormwater management is at an all-time high, funding remains critically low, underscoring the need for education on how to develop innovative funding alternatives. Community-based partnerships can resolve many of the challenges associated with stormwater management — but understanding and adoption of P3 strategies remain low among municipal leaders.

Resilience and Too Much Water: The troubling images of a giant stretch of the Upper Midwest inundated with flooding offered a reminder of water’s destructive power and revisits the need to mediate it along inland rivers and coastal areas prone to storm surges and rising sea levels. As legacy conveyance strategies are put to the test, causing some communities to turn to transformational water infrastructure such as huge tunnels, others are arriving at short-term fixes over long-term resilience.

Alternative Delivery of Projects: New projects are seeing new approaches to project delivery. Build-outs of pipelines, sewer lines, treatment plants, pump stations, reservoirs and more are increasingly seeing non-traditional delivery methods gaining ground. One such option is the progressive design-build method, in which utilities use contractor qualifications or some pre-defined attributes of best value as their...
selection criteria and then move through the construction processes in a collaborative way. Our survey found more than half of respondents had employed the strategy.

**Asset Management and Predictive Maintenance**: As water utilities work to improve customer service and meet quality and environmental regulatory targets, there is an emerging emphasis on asset management, particularly predictive maintenance. The rate of change is accelerating as artificial intelligence (AI), data analytics tools and smart sensors become less expensive and more widely available, offering water utilities options for addressing aging infrastructure.

**Nutrient Removal**: Nutrient runoff from industrial farming, wastewater treatment plants and other sources threaten aquatic life and public health. Aided by new advances in nutrient management technology and a growing interest in nutrient trading, efforts to reduce nutrient levels are evolving as water and wastewater utilities work to improve effluent quality and meet regulatory requirements.

**Energy Planning and Management**: Energy is the highest operational cost for a water and wastewater utility. Water is extremely heavy to move through pipes and many treatment processes are energy intensive thus conveyance and treatment requires an enormous amount of power — and money. According to our survey, two-thirds of respondents say energy management is “extremely or very important,” while one-quarter prioritized it as “moderately important.” How plant operators strategize their approach to power management can have significant effects on revenue and operations.

From inside the fence to behind the meter, the digitization of water is pushing data’s potential deeper into our organizations, influencing planning, asset management, customer interaction and operations. Our survey results show more organizations are incorporating digital strategies into their offerings, and the result promises a water ecosystem that is responsive, secure, resilient and abundant. We don’t have to settle for merely putting off “Day Zero” for another day. We have the tools to help end the threat altogether.
Data, Renewables Drive Water Forward
Water Utilities Urged to Exploit Data, Use Less Guesswork

By Phil Crossland, Paul McRoberts and Joe Zhou

In the water industry, data is driving the discussion. To understand what this means requires a story about motor oil.

For decades, car manufacturers recommended that vehicles have their engine oil changed at least every 3,000 miles without fail. This was never proven practical, given that such decisions should be based on individual driving style, the conditions and climate — even the type of oil used. But these real-world conditions don’t tend to factor into the carmaker’s original guidelines.

Similarly, data is changing the game in the infrastructure space, giving operators better oversight of their assets without needing to religiously follow the manufacturer’s maintenance bible. Digital information, exchanged at staggering rates, often is actionable and predictive, foretelling when to replace or rehab equipment even well before the manual suggested.

In the water industry, data is taking on an ever more muscular role as what The Economist has called “the world’s most valuable resource.” This resource, among so many other things, helps utilities validate investments and demonstrate return on investment.

This also raises the question: Is data being prized as it should, as something abundant and valuable, but all too often relegated to silos? The industry, for the most part, believes it is. Wireless sensors continue to
Budgets have grown tighter, squeezing operators to get the most out of equipment and systems that often have surpassed or are nearing their life expectancies.

Figure 3

How would you assess the quality of asset data at your agency/facility? (Select one)

- **3.3%** Excellent
  we can trust that 100% of the data is correct

- **32.6%** Very good
  almost all of the data is correct

- **54.3%** Good
  most of the data is correct

- **9.8%** Poor
  about half of the data is correct

Source: Black & Veatch

There’s still more work to be done on optimizing digitization. And that begins with the need for an asset management blueprint.

**Asset Management Programs Grab Attention**

More than half the respondents to Black & Veatch’s annual survey of water industry leaders say they have adopted an asset management program (AMP), while a little more than one-third say they’re in the process of doing so. But the devil is in those details. Are utilities that report having an AMP saying they have a document that lists how assets are viewed from a financial standpoint? Or is it duly comprehensive, collecting all available information about the history, longevity and the value of each asset? More about data, less about process and procedure?

Fifty-seven percent of respondents said their data management strategy is strong and getting better, though it’s still not fully integrated, making it difficult to understand what’s occurring collectively across systems. One-third said their data still is siloed and unintegrated.

At the same time, the quality of data collected remains largely favorable. More than half of respondents cast their asset data as good, meaning most of what’s collected is correct. One-third declares its data very good, almost always spot on. Only 3 percent trust that all its data is right (Figure 3).

**More Data, Less Guesswork or “Tribal Knowledge”**

When it comes to helping decide when to replace assets, nine of every 10 respondents say they employ a risk-based approach at different levels. More than 40 percent say they use factors such as the likelihood or consequence of failure to plan investments in new equipment. Twenty-eight percent said they defer to the skill and experiences of operators and technicians, suggesting more of a “tribal knowledge” approach rather than a decision that is based on technology.
On the maintenance front, the oil-change analogy and the owner’s manuals come back into play. Roughly one-third of respondents scheduled preventive maintenance according to the original manufacturer’s recommendations, or “doing it by the book.” One of every five respondents lean on reliability or condition-based maintenance. Thirty percent follow the status quo, reactively fixing equipment when it breaks or repairing it based on usage (Figure 4).

Suggested upkeep of assets is based on how they were designed, built and tested, often in perfect conditions: 70 degrees, 50 percent relative humidity and a spotless, dust-free environment. Contrast that with pumps, boilers and other assets operating in real-world conditions, with data spitting out instantaneous details about how each is behaving. If the performance changes, sensors alert the operator, helping predict failure or over-extension.

Helping the cause is Asset360®, a cloud-based analytics platform by Black & Veatch subsidiary Atonix Digital. The tool gives clients a one-stop solution that employs analytics to help manage risk, plan capital and monitor system heath. As the adage goes, you can’t manage what you don’t measure.

ABOUT THE AUTHORS

Phil Crossland is Director of Asset Management for Black & Veatch management consulting. A skilled enterprise asset management and supply chain professional, he has more than 25 years of operations and consulting experience across numerous industries including energy, utilities, mining, aerospace and defense, automotive and telecommunications with experience in the United States, Canada and Europe.

Paul McRoberts is President of Atonix Digital, a Black & Veatch software subsidiary. He oversees the development and deployment of the company’s suite of software products powered by the ASSET360® analytics platform. McRoberts brings both rich software development experience and an in-depth understanding of how deep data exploration is helping transform businesses through greater insight and intelligence.

Joe Zhou is Managing Director at Black & Veatch management consulting, where he leads the asset management and analytics practice to provide innovative and insightful consulting services to asset-intensive industries, such as power, oil and gas, and water. Zhou has more than 20 years’ experience enabling business transformations through the use of digital technologies and leading business practices.
Predictive Maintenance Offers Promise in Asset Management

By Andrew Chastain-Howley, Jeff Stillman and Chris Steele

Water utilities the world over are faced with challenges, including of increasing demand, falling revenues and climate change. While building new assets remains part of the solution, enhancing the performance of existing assets is more important than ever before.

The growing focus on asset management as a route to providing a high-quality service for utilities’ customers — and meeting quality and environmental regulatory targets — has been driven to a large extent by the falling cost of and increased access to smart sensors and data analytics tools. The rate of change is accelerating as artificial intelligence (AI) and machine learning software similarly becomes less expensive and more widely available.

Spurred by these drivers, adoption is growing. According to Black & Veatch’s 2019 Strategic Directions: Water Report survey, which polls North American water utilities, 88 percent of respondents either have implemented or are in the process of implementing an asset management program (Figure 5).

Figure 5
Which of the following statements best describes the asset management (AM) program at your agency? (Select one)

52.7% Implemented an AM program
35.5% In the process of implementing an AM program
10.8% Considering an AM program
1.1% No AM program

Source: Black & Veatch

ABOUT THE AUTHORS

Andrew Chastain-Howley is a Director of Water Solutions for Atonix Digital, a Black & Veatch software subsidiary. He specializes in reducing water loss and managing water demand. He is based in Fort Worth, Texas, and has 26 years of experience in the fields of water loss control and water conservation.

Jeff Stillman is the Practice Leader for Asset Management in Black & Veatch’s Americas water business. A major theme of his work has been enhancing the use of information systems to improve both CAPEX and OPEX decision-making in water utilities. He is based in Boston and has 24 years of experience in infrastructure planning and asset management.

Chris Steele is Head of Information Management and Analytics for Black & Veatch’s Europe business. Experienced in practical implementations of analytical solutions and technologies, he has more than 15 years of experience in asset management across regulated and nonregulated water, energy and waste sectors.
However, technology alone, however, is insufficient. The most successful smart asset management and maintenance programs blend human and technological excellence. Dynamic maintenance needs to be grounded in the deep institutional knowledge of an asset base that can only come from the people who design, build and operate it.

**The Rise of the Machines**

AI and machine learning technologies allow water utilities to move beyond the descriptive analytics many currently use to understand past incidents and trends — and shift to predictive analytics, which establish what is likely to happen, and prescriptive analytics, which suggest actions based on predictions.

When it comes to understanding how utilities approach asset maintenance, survey data shows that, on average, they tend to weight their efforts more heavily toward preventive maintenance, which accounts for 43 percent of respondents, followed by reactive (40 percent) and predictive (17 percent). These results show an opportunity for utilities to eventually shift from reactive strategies and toward a more predictive approach (Figure 6).

The Internet of Things (IoT) will be an important enabler for these approaches. The IoT is made up of connected devices, from simple sensors to smartphones. The internet’s ubiquity and the availability of cheap sensors make possible ever-increasing, cost-efficient gathering of condition and performance data.

Sensors connected via the internet for the purposes of analytics make the visibility of performance cheaper. This gives the flexibility to extend lower-cost performance monitoring into areas where the level of criticality traditionally would not justify more expensive control and protection systems, but where the asset failure would not be without cost implications.

These technological advances are helping facilitate new approaches to how assets are managed and operated:

- **Dynamic Preventive Maintenance (DPM)**, which prevents failures before they occur by using intelligent predictions and dynamic maintenance planning.

- **Prognostic Maintenance Interventions (PMI)**, which use machine learning, pattern recognition and advanced analytics to optimize, manage and deliver interventions.
Data Comes at a Price

The volume of data these technologies make accessible to a water utility is potentially overwhelming. In addition, there is a cost to capturing, storing and accessing each data point. So when developing DPM and PMI strategies, it is vital that utilities define the assets and related data that best support their goals — and focus only on them.

Failure to achieve this has resulted in data gathering initiatives that cost more than the savings they were expected to yield. Capturing and storing data and — most importantly — maintaining accurate, up-to-date information can be costly.

Like physical assets, asset data has a life cycle. About 20 percent of the cost of gathering asset data comes in the capital phase of the asset’s life cycle. The remaining four-fifths of data costs are generated during the operations and maintenance (O&M) phase. This is due in part to the length of the capital phase compared to the O&M phase, but mostly because the O&M data is live, evolving and in need of ongoing monitoring, storage and updating.

Understanding the costs associated with the different phases of the asset data life cycle — and planning data acquisition accordingly — is the cornerstone of dynamic preventive maintenance. Harvesting unneeded data combined with the risk of using bad data comes, literally, at a price.

After the most significant assets and associated data have been identified, their criticality can be understood. This means focusing on what an asset or process is intended to do and identifying factors that stop it from performing as required. This information is used to inform measures to mitigate the factors degrading asset performance, creating a condition or output-based maintenance regime at the optimum balance between cost, risk and performance.

That root cause analysis and failure mitigation will allow water utilities to better understand planned and unplanned costs across comparable processes and, if they differ, understand why. This will provide vital insights into the true cost-to-serve.

Toward Maintenance 4.0

DPM and PMI programs mark a significant step toward Maintenance 4.0 — the fourth industrial revolution and the shift toward cyber-physical systems. Water utilities need to embrace this change, knowing that technology is only part of the solution.

To deliver the smartest possible maintenance solutions, O&M teams will need to trust in AI-driven programs. For this to work, the AI platform needs to be founded on the deep institutional knowledge of water utility design, construction and O&M experts.
Yorkshire Water’s Dynamic Maintenance Planning Program (DMPP) is one of the first, and largest, programs of its kind undertaken by a UK water utility. Yorkshire Water serves 5 million customers in northern England. The DMPP created an effective predictive maintenance program covering the utility's entire asset base, encompassing 695 water and wastewater treatment facilities and 83,000 kilometers (about 51,570 miles) of water and sewerage pipes.

Central to the program’s success was the blending of human and technological capabilities. The Asset Information Standards, which dictate how the assets are recorded and the asset information held, were created with full participation of Yorkshire Water’s O&M teams.

This enabled a collaborative DPM study, producing a condition-based maintenance program based on failure modes, with O&M buy-in. This approach meant time and money are focused on ensuring process and asset outputs are maintained.

Innovative use of mobile technology also yielded benefits. iPads with Bluebeam enabled live asset survey findings, and piping and instrumentation diagram updates, to be uploaded to a dynamic asset database. O&M teams in the field are using mobile devices to access the condition-based maintenance program that guides their activities, and to record and upload condition reports, in real-time. Initial indications are an approximately 30 percent decrease in reactive O&M work.

In Reality: Yorkshire Water’s Dynamic Maintenance Planning Program
Water and energy systems long have been intrinsically intertwined, given electricity’s entrenchment as one of a water or wastewater utility’s biggest expenditures. But as water suppliers and wastewater service providers grapple with ways to reduce power costs, advance toward “green” energy and participate in the electric industry evolution, there’s talk of “new energy.”

Consider Orlando, where the Iron Bridge plant treats tens of millions of gallons of sewage, making it far and away the central Florida city’s biggest electricity user. As Orlando works to wean itself from power derived from burning coal or natural gas, it’s considering working with the regional electric utility to turn some of Iron Bridge’s property into a microgrid armed with thousands of solar panels that can churn out cheaper, greener power.

As the nexus of water and “new energy” becomes more common in the water sector’s lexicon, Black & Veatch’s 2019 Strategic Directions: Water Report survey shows that water and wastewater plant operators are embracing “master plans” meant to optimize their energy use, which unlike labor and chemical costs is something they can influence. Making the most of their data and bringing on more efficient equipment is helping, although water-related utilities also are exploring renewable energy — notably solar — as options in deferring operating costs.

The energy shift is not coming as vigorously as one might expect, perhaps partially because operators are focused on keeping their aging infrastructure functioning rather than thinking about tomorrow’s energy scene.
A First Step: Developing an Energy Master Plan

Black & Veatch’s annual survey of water industry leaders in North America shows that while two-thirds of respondents see energy management as very or extremely important, just less than half reported having an energy master plan. A little more than one-quarter of respondents said they’re not working on such a blueprint in any form — perhaps because they feel they may not need one, given that they may be small utilities serving a small territory, or because their lagoon treatment of wastewater requires scant energy.

Low electricity rates also may be undercutting wider acceptance of new energy in the water industry, considering that nearly three-quarters of respondents to the Black & Veatch survey report paying just a 10 cents or less per kilowatt hour. Regions where those rates are higher — traditionally along the nation’s coasts — offer a greater value proposition and incentive to take the upfront financial plunge into renewables.

Even so, according to the survey, renewables clearly are on the table, with three-quarters of respondents considering them. This shows that utilities are essentially scoping out whether there’s a business case for solar — or if there is another driver, such as a local population pushing for cleaner, greener energy.

The solar alternative was far and away the popular energy choice among respondents to the poll, not surprisingly, given the shrinking cost of solar equipment and advances in the efficiency and lifespan of the panels. Solar is a logical, credible option because it’s a passive, sunshine-collecting system without a lot of operations and maintenance (O&M) demands, which can be handled by outside contractors as needed.

Looking at other options for generation, one-third said they were pondering gas generation from biosolids, while one-fifth are weighing hydroelectric options, increasingly on a small-scale basis.

In Solar, Shining Examples of Water Utilities Taking Action

Some water utilities are taking the dive into new energy, turning shovels in the interest of resilience. And they’re finding different ways to pay for it, with everything from federal and local funds to Public-Private Partnerships (P3s).

In northern California’s Redding, the local Bella Vista Water District enlisted CalCom Energy — a solar developer and energy services company — to install what’s now a 693-kilowatt solar farm that, along with the district’s earlier solar array, helps the utility offset three-quarters of its annual electricity usage tied to pumping water. Paid for by a federal grant and district funds, the project is expected to produce $3 million in cost savings over the next quarter century and churn out more than 1 million kilowatt-hours of clean energy per year for the 20,000-customer district with 53 square miles of service territory.

“By leveraging district funds, we managed to maximize our overall investment in locally produced clean energy, which is central to the district’s energy strategy to reduce dependence upon retail power purchases and exposure to greatly increasing energy costs,” David Coxey, the water district’s general manager, said upon announcing the latest project’s completion in March 2019.

In Puerto Rico, which struggled to restore power in remote areas after Hurricane Maria ravaged the island’s electrical system in 2017, new water and wastewater systems in the form of a half dozen microgrid-powered pumping systems are up and running. They’re courtesy of a partnership between South Carolina-based nonprofit Water Mission and Blue Planet Energy, an energy storage company out of Hawaii. All six pumping systems run independently of the island’s public water utility.

In Las Cruces, New Mexico, local dignitaries convened in March 2019 to celebrate the startup of two new co-generators that convert methane — a byproduct of wastewater processing — and natural gas into efficient energy, saving the city about $220,000 a year.

In western Australia, that region’s chief water supplier — Water Corporation, with 2.6 million square kilometers (or, just over 1 million square miles) of surface territory — announced in early 2019 that...
it plans to spend $325,000 to install rooftop solar systems on its offices, pump stations, treatment plants and borefields. There are also plans to build an energy generator powered by biogas, a byproduct of wastewater treatment. With expectations that the panels will generate half of the total power to run each site and cut the corporation’s yearly emissions by 450 tons, the state’s water minister, Dave Kelly calls it leading by example “and doing what they can to reduce greenhouse gases that accelerate climate change.”

And then there’s Orlando, which is weighing partnering with the regional electric utility to set up the microgrid station near the city’s Iron Bridge sewage plant, the Orlando Sentinel has reported. The system, to be built and owned by the power company, would give one of the state’s biggest handlers of sewage coveted resilience in times of emergency. Initial plans for the new energy system at the 37-year-old plant, which was upgraded in 2005, call for it to produce 1 to 3 megawatts of power.

**Getting Off the Sidelines and into the Game**

While water and energy often are deemed to be different silos, improving only one of those resources while neglecting the other in what’s an interdependent system is counterproductive when pursuing sustainability and security.

Opportunities to boost energy efficiency, cut greenhouse gas emissions and capitalize on new revenue streams differ among wastewater utilities. Yet beyond being decades-old and traditionally in need of upgrades, a clear commonality exists: the ability to contain or cut energy and operational costs by embracing modern technology.

Utilities can exploit the benefits of the large volumes of available data for greater system efficiency and asset management. And they should know on-site generation of new energy sources — options such as biogas, hydroelectric and renewables — are maturing and gaining sway, with solar generation a natural option for utilities that largely have access to large spaces and rooftops of public buildings.

Funding doesn’t need to be an obstacle. Public-private partnerships or power purchase deals can help pave the way toward sizable, long-term cost savings via traditional solar providers or power purchase agreement (PPA) ventures fashioned to implement energy efficiency work and provide renewable resources with private funding. That financing then receives the “savings” experienced by the water/sewer agency, thereby resulting in no capital spend or increase in operations and maintenance costs.

There is significant conversation, too, about financing and the increased risk. An additional topic of conversation is the impact the shift to renewables will have on water power generation and what role water will play in power generation.

With such climate variability, Australia’s water chief Kelly presses, “what’s important is that we don’t wait but (that we) take every opportunity now to reduce energy use and greenhouse gases,” and “adopting new technology and applying it in the field allows us to learn what works best.”
The Future Rests on Resilience
It’s been said that Texas suffers perennial drought, broken up by severe floods from time to time. These days, however, Texas isn’t alone in its misery. Researchers from Climate Central analyzed 65 years of rainfall records in the United States and found that 40 of the lower 48 states have seen an increase in heavy downpours since 1950. We’re talking about the kind of flood-making torrential events that exceed the top 1 percent of all rain and snow days. And droughts are frequent, too. During the second half of 2012, more than half of the land area in the United States suffered from a drought ranked moderate or worse.

Both floods and drought impact water systems, and water providers are squarely focused on hardening their systems to withstand these natural events, as well as manmade threats. Are water utilities doing the right things to drive toward resilience? Results from Black & Veatch’s 2019 Strategic Directions: Water Report survey indicate that most are on the right track, although there is room for improvement. Overall, water utilities would benefit from taking more proactive action toward resilience and being more ambitious in chasing funds to pay for projects.

“Weather” or Not
Resilience refers to a water system’s ability to rebound after an event. Extreme drought is part of it, but so is flooding, contamination, cybersecurity and more. Among the 430 respondents who participated in the survey, 86 percent rate resilience a crucial priority for their community. Unfortunately, only half of them say their organization has developed an approach to address this issue. More than a third (36 percent) say resilience is crucial, but their team has yet to make formal plans for achieving it. Another 12 percent see resilience becoming important in the future (Figure 7).

**Figure 7**

How would you characterize your community’s or your organization’s prioritization of resilience? (Select one)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>49.7%</td>
<td>This is critical, and we have developed an approach</td>
</tr>
<tr>
<td>35.9%</td>
<td>This is critical, but we have yet to develop an approach</td>
</tr>
<tr>
<td>12.4%</td>
<td>This isn’t a priority for us at this time, but it will be in the future</td>
</tr>
<tr>
<td>2.1%</td>
<td>I don’t see this being a priority for us</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
Multiple threats keep water providers up at night, and catastrophic infrastructure failure tops the list. Fifty-nine percent named it as a significant concern, and 58 percent said the same about natural or manmade disasters. Weather-related threats also were high on the list, as 44 percent named drought as a worry, and 34 percent have climate-change impacts in their sights (Figure 8).

Such awareness prompts new approaches to system operation. One utility on Florida’s eastern coast is anticipating sea-level rise. The organization’s leaders are incorporating 100-year storm surge events into plans for wastewater treatment plant upgrades, and they’re engineering all the electrical components to sit 25 feet above land surface.

Even without storm surges, seawater intrusion is negatively impacting groundwater in Florida as aquifers are pumped more than they’re recharged. Some utilities are looking at injecting reuse water into aquifers to form saline barriers.

Across the United States, states are seeing more intense flood events and droughts. There’s enough water today, but climate variability brings the potential for increased scarcity and reduced reliability. What’s more, new development is likely to be costly, time-consuming, or both, regardless of whether it’s desalination, reuse technology, new reservoirs or well field development. The low-hanging fruit is gone.

Ahead, utilities may look to increasingly recharge efforts to secure safe yield in aquifers, adding water storage and adding water supply to boost climate change resilience and mitigate vulnerability.

**Best-Laid Plans**

A bright spot in survey results is that 71 percent of respondents work for organizations that conduct infrastructure risk assessments. Four out of five wisely perform these exercises at least every few years (Figures 9a and 9b).

Fifteen percent conduct no risk assessments at all. Master plans formerly focused on simple hydraulic monitoring and forecasting. Today, utilities can use these exercises to evaluate the big picture.

This means looking at every step in the water delivery process. If the organization runs an integrated model — water, wastewater, stormwater, reclaimed water — staff should be examining the whole water journey: how they get the water to the plant, to the customers, to the wastewater plant, back into the reclaim and, eventually, back into the environment or, if appropriate, back into the water system itself.

Organizational staff should look for risks to their infrastructure and balance those risks against the criticality of the assets. Is it a crucial piece

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**Figure 8**

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

58.8% Infrastructure catastrophic failure

58.1% Natural or manmade disaster

Extended drought/supply restrictions 43.8%

33.8% Impacts from climate change

Cyber attack 30.6%

8.1% Terrorist attack

6.3% Other

Source: Black & Veatch
of infrastructure — such as a water main that is the only source of water for an area — or is it something that can be quickly replaced, such as a pump with a backup device in a warehouse? What is the likelihood and consequence of failure? How can redundancy be built into the system? These are the kinds of questions water providers should be answering at least once every five years.

When it comes to the hazards for which survey respondents plan, 90 percent look for ways to mitigate infrastructure failure, and 68 percent evaluate risks associated with physical security, such as terrorism or wildfires. Nearly 60 percent chart cybersecurity threats, with one-third of respondents planning for recovery after an attack on infrastructure.

More than four of every 10 respondents (42 percent) budget more toward maintenance, and 25 percent split their dollars between maintenance and new infrastructure. Only 17 percent are slanting budgets toward new infrastructure investments, and 16 percent invest with little or no pattern.

Securing the Future
Water providers do try to be proactive with their investment. Unexpected events and — at times — political pressure can sidetrack such foresight. Still, most utilities could likely benefit from an investment strategy that is more proactive than reactive.

In its “Report Card for America’s Infrastructure,” the American Society for Civil Engineers (ASCE) gives the nation’s drinking water infrastructure a disturbing grade of “D,” and has for some time. The nation’s wastewater grade recently went up – now it earns a “D+.”

According to ASCE, the nation’s drinking water travels to customer premises via approximately 1 million miles of pipes, many of which have a lifespan of only 100 years but were installed in the early to mid-20th century. ASCE also notes that, utilities have an average replacement rate of 0.5 percent of their pipes each year, which means it will take some 200 years to turn over the whole system.

While Black & Veatch’s 2019 Strategic Directions: Water Report survey results show that most utilities are planning for maintenance of their systems, being more proactive with their systems would be more cost-efficient. Yes, it will cost more upfront, but investments in new infrastructure will pay off.

Utilities may be foregoing this type of investment because they don’t have the funds. Nearly two-thirds said their organization doesn’t have a steady funding source for resilience from the state or federal level.
There are, in fact, multiple funding resources available through state and federal agencies, and more funding is coming through the America’s Water Infrastructure Act of 2018 (AWIA 2018). It reauthorized the Water Infrastructure Finance and Innovation Act, legislation that establishes a water infrastructure bank under the U.S. Environmental Protection Agency to support water systems through low-interest, long-term loans and loan guarantees for a variety of water projects.

Money also is available through the Drinking Water State Revolving Fund program, a 1996 amendment to the 1974 Safe Drinking Water Act, which so far has provided $35.38 billion in assistance to water systems for 14,090 projects.

Given that AWIA 2018 also calls for utilities to have emergency response plans and risk assessments, now would be a good time for utilities to start writing those grant requests. After all, restoring aging infrastructure, accommodating weather variability and expanding water systems to keep up with population growth is going to take plenty of work.

How much might that work cost? The American Water Works Association puts the price tag at $1 trillion through 2035.

Clearly, resilience will continue to be a pressing need faced by U.S. water utilities for years to come. Rain or shine, it’s time to meet the challenge.

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. Rectenwald has successfully 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.

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Will Williams is Associate Vice President of Asset Management for Black & Veatch’s water business. He has spent nearly three decades working in Australia, Europe, the Middle East and the United States implementing asset management solutions for multi-sector utility clients. Williams has extensive experience in asset management planning, including asset failure analysis, risk assessment, performance benchmarking, maintenance optimization, business planning, serviceability assessment, whole life costing, operational efficiency, business change management and infrastructure rehabilitation.
In an era when climate change, organizational capacity constraints, funding challenges and limited public support continue to test the resilience of a community’s stormwater system, images of flooded neighborhoods and arterial streets turned into rivers highlight the urgency for a strategic vision and alternative approaches to stormwater management service delivery. The critical question is whether leaders and managers are exploring holistic alternative approaches that address program planning, organizational capacity, service delivery mechanisms and financing.

In Black & Veatch’s 2018 Strategic Directions: Water Report, we discussed the role of community-based partnerships (CBP) as an efficient, integrated approach to helping overcome the challenges municipalities face when it comes to delivery and funding for stormwater initiatives. In this report, we highlight the tangible value of integrating delivery frameworks and user fee-funding mechanisms as a practical path to long-term resilience.

The Paradigm Shift: A Call for Integrated Frameworks and Collaborative Management

While water and sewer systems are infrastructure-heavy, capital intensive and require a skilled workforce, two key factors distinguish them from stormwater systems. First, municipal water and sewer system management involves predominantly publicly-owned land; whereas, effective stormwater management requires management of both publicly-owned point sources and privately-owned, non-point sources.

Consequently, with respect to planning, operations and capital program management, water and sewer systems are more conducive to centralized management and governance. Stormwater management, on the other hand, lends itself more to alternative approaches such as distributed management and more collaborative partnerships.

As new trends in urban stormwater management emerge, Krishna P. Dhakal and Lizzette R. Chevalier explain in their research article, “Urban Stormwater Governance: The Need for a Paradigm Shift,” that since “stormwater management has become a highly integrated, multi-objective undertaking that includes flood control, water quality control, visual amenity,” effective management of stormwater also requires an alternative form of governance. They opine that management must expand from a centralized governance to a multiple stakeholder management paradigm that includes private land owners, community organizations, residents, landscape designers and other business organizations.
In evaluating five U.S. cities that are heavily incentivizing green infrastructure, the authors conclude that while these locales encourage public participation through education and outreach, they still do not have any formal “community-level governance mechanism to involve individual land owners and other local stakeholders.”

A structured path to a paradigm shift in stormwater management can be developed by integrating an alternative program planning and execution framework, and by enhancing financial resilience through effective funding mechanisms, as both involve multiple stakeholders beyond just a municipal entity.

**Alternative Planning and Execution Framework — Understanding Possible Solutions**

Municipal entities are generally adept at meeting all their permit and regulatory compliance requirements despite an ever-evolving environment. However, utility managers still face four critical challenges:

1. Developing a more holistic, multi-objective planning framework that integrates stormwater management and broader community development.
2. Building their internal organizational capacity to accelerate program execution.
3. Leveraging available funding for greater cost efficiencies.
4. Achieving performance driven outcomes that the community can readily support.

In Black & Veatch’s 2019 Strategic Directions: Water Report survey, we asked municipal leaders about organizational capacity. Nearly two-thirds (64 percent) of respondents stated that their organization does not have adequate capacity to plan, design, deliver and maintain quality stormwater management services in their community (Figure 10).

It is important to note that organizational capacity with respect to operations and maintenance (O&M) will come under increasing stress especially if the municipal entity continues to invest in and deploy distributed best management practices throughout the municipal jurisdiction. Those will require ongoing inspections and maintenance.

For municipal entities that recognize their lack of capacity in delivering stormwater services, what is the level of awareness about other potential delivery frameworks, partnering with the private sector to augment capacity, manage risk and meet the municipality’s service obligation?

The first step to considering an integrated framework approach is assessing the current level of understanding regarding alternative delivery...
methods. Of the survey respondents, more than half said they were not familiar and one-quarter only slightly familiar with mechanisms such as CBP3s (Figure 11). The results definitively point to a greater need among the public and private stakeholder groups and industry organizations to disseminate information on potential integrated frameworks.

It’s vital that utility leaders invest in an active evaluation of integrated delivery approaches that are performance and outcome-driven. This evaluation should not only assess the most efficient way to deliver the capital and O&M program through an aggregated delivery and risk management approach but should also consider ancillary community benefits that can be driven by stormwater investment into the community. Some of the benefits include workforce engagement, mentor-protégé programs, environmental equity, school education programs and economic development goals that best leverage the benefits of stormwater investment in the community.

For example, the Clean Water Partnership between Prince George’s County in Maryland and private-sector company Corvias is one delivery model the municipal entity found viable when looking at how best to deliver its stormwater program. This project is further detailed below.

**Clean Water Partnership (CWP) performance-based results for the first phase of the partnership include the following:**

- **$100 million** program investment.
- **94 projects** delivered in only 36 months.
- **2,000 acres** retrofitted for municipal separate storm sewer system (MS4)/total maximum daily load (TMDL) permit compliance.
- **Over 5,000-acre foot (AF)/year** in stormwater capture and filtration.
- **Diversified projects** on public, quasi-public and private property.
- **$183 million** initial local county economic impact.

*Based on an actual economic development study conducted by Towson University on the CWP. CWP is a 30-year stormwater program partnership between Corvias and Prince George’s County.*
Enhancing Funding Capacity and Customer Equity

In addition to building organizational and service delivery capacity, a continuing saga for municipal entities is a lack of funding. In Black & Veatch’s 2018 Stormwater Utility Survey, utility leaders with user fee-funding mechanisms in place revealed that funding availability and public support for their stormwater management program were the two issues of highest importance.

The fact that there are well over 1,800 user fee-funded programs nationwide points to the multiple benefits they provide, such as a dedicated funding source, a more equitable approach to cost recovery, and a reasonable nexus between fees and costs incurred in providing services.

A significant ancillary benefit to a user fee funding approach is that it directly involves all public and private property owners who must contribute fairly to cost recovery. In addition, all owners gain recognition in the form of partial fee reductions and other incentives based on private on-site stormwater management stewardship. From emerging funding programs such as the Water Infrastructure Finance and Innovation Act, to established programs such as bond financing and the State Revolving Fund, user fee-funding offers additional assurance of debt repayment, thereby providing significant leverage in establishing a balanced portfolio of funding sources.

Currently, most municipal jurisdictions in the United States strive to fund stormwater management through a tax-based revenue mechanism as opposed to establishing a dedicated stormwater user fee-funding mechanism. The lack of public acceptance and lack of political support, however, will continue to be major barriers to integrating user fee-funding into the overall stormwater management planning framework unless the public can see the economic and community benefit such a fee provides. Only six of 10 of this year’s municipal respondents indicated having user fee-based funding as one of the approaches to funding stormwater management.

Stormwater management requirements, organizational capacity constraints and the need for resilience to extreme weather conditions continue to increase. To address this combination of challenges, municipal entities should consider development of a “resilience roadmap” that incorporates two key components: an integrated capital and O&M delivery framework that can synthesize both broader community benefits and specific stormwater management objectives, and an equitable and dedicated user fee-based funding mechanism to effectively support both existing and integrated delivery frameworks while providing long-term financial resilience.

ABOUT THE AUTHORS

Bruce Allender is Chief Operating Officer of infraManagement Group LLC (iMG), a wholly-owned subsidiary of Black & Veatch. He has more than 25 years of experience in the water and wastewater sector and has been part of teams that have proposed and implemented public-private partnerships in North America, Australia and Asia Pacific for the water and wastewater municipal and industrial marketplace.

Prabha Kumar is a Director for Black & Veatch management consulting. She leads the water, wastewater and stormwater utilities offering within the Advisory and Planning group. Kumar specializes in stormwater utility feasibility studies, utility development and implementation. She also helps utilities with both internal stakeholder education and engagement and external public education and outreach.

Francesca McCann is a leader in the U.S. water industry with expertise in investments, public-private partnerships and project development. Before joining iMG, McCann served as CEO for Abengoa Water, where she successfully led the $3.4 billion Vista Ridge Project in San Antonio, Texas. McCann also founded a consulting company, Global Water Strategies, and started her water career in 2003, covering the water sector for Wall Street.
If ever communities and regions needed to rethink their defenses against too much water, the footage of an inundated Upper Midwest offered the latest reminder in early 2019.

Not yet two years since Hurricane Harvey inflicted more than $100 billion of damage from catastrophic flooding in Houston and southeast Texas, record snowfall followed by a quick melt-off in America’s midsection proved ruinous. Unprecedented floodwaters submerged farmlands, wastewater plants and federal Superfund cleanup sites, and more than a million private wells from the Canadian border south to Kentucky were threatened with chemicals, sewage and pathogens.

Water, water everywhere. And with the troubling prospect of more of it in coming years, concerns over climate change and its effects are deepening, from more frequent extreme events in the Midwest to rising sea levels affecting low-lying areas vulnerable to coastal flooding.

Some communities are taking action, making the needed holistic investments, with Charleston, Fort Wayne and Dallas as high-profile examples of cities turning to massive, deep large-diameter tunnels that divert and contain excess stormwater. It’s a matter of resilience, and hundreds of water industry representatives surveyed for Black & Veatch’s 2019 Strategic Directions: Water Report say they’re paying heed.

Aging infrastructure still dominates the discussion, yet a pressing question lingers: How can water utilities and those entrusted to oversee them do more, sometimes with less, to mitigate against mega-storms already proven to outmatch legacy conveyance and storage strategies?

The short answer is that it’s a mixed bag. Consistent with past years, concerns over aging assets continue to command the conversation, with three-quarters of respondents naming aging water and wastewater infrastructure as the most challenging issue facing the industry today (Figure 12).
Diving deeper, two-thirds report preparing for physical security threats — everything from vandalism, and theft, to wildfires, storms, flooding and landslides. When asked separately to identify their most significant resilience concern, roughly six of every 10 respondents cited natural or manmade disaster — virtually tied atop the list with catastrophic failure of infrastructure. One-third chose impacts from climate change, in fourth just behind extended drought and supply restrictions (44 percent).

Getting to the core of resilience requires serious evaluation, and that appears to be happening. A little more than seven of every 10 respondents say they do infrastructure risk assessments, the lion’s share annually or every few years. Yet 15 percent said they don’t do such analyses. Separately, half of respondents deem their organization’s resilience as critical enough to already having developed an approach.

Unsurprisingly, funding — or relative lack thereof — remains troublesome. More than six of every 10 respondents say they get no outside sourcing for resilience-related efforts. Just 29 percent report that their resilience pursuits are covered by general funds and some matching state and federal funds. Even then, as a reflection of concern over aging assets, 42 percent responded separately that they typically budget more toward maintenance of existing infrastructure instead of building new.

Simply put, it’s a balancing act of pressures between when to simply repair existing infrastructure or take the plunge and modernize — and, of course, where to find the money for it. Resolving that may require something paramount: viewing and resolving this dilemma more as a regional one than that of a single community, understanding that the broader approach brings economy of scale, enhanced influence with federal decision-makers about funding mechanisms and simply the societal value of having wider peace of mind.

On the funding front, the federal government has opened some of its purse strings, lately through the bipartisan America’s Water Infrastructure Act of 2018. That law authorizes billions of dollars to the U.S. Army Corps of Engineers to build, expedite, modify or study several megaprojects in coastal communities and more than 100 water resource projects around the nation. There also are significant measures that will increase water conveyance and storage in the West, replenish shorelines in the East, build new dams in the Front Range and manage flood risk across the country.

Figure 12

From your perspective, what are the most challenging issues facing the water, wastewater, and stormwater industry today? (Select the TOP THREE most challenging issues)

<table>
<thead>
<tr>
<th>Issue</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aging water and wastewater infrastructure</td>
<td>75.8%</td>
</tr>
<tr>
<td>Managing capital costs</td>
<td>27.2%</td>
</tr>
<tr>
<td>Justifying capital improvement programs</td>
<td>23.0%</td>
</tr>
<tr>
<td>and/or rate requirements</td>
<td></td>
</tr>
<tr>
<td>Data collection and management</td>
<td>22.6%</td>
</tr>
<tr>
<td>Managing operational costs</td>
<td>21.6%</td>
</tr>
<tr>
<td>Water conservation</td>
<td>20.9%</td>
</tr>
<tr>
<td>System resilience</td>
<td>20.7%</td>
</tr>
<tr>
<td>Integrated water planning</td>
<td>18.4%</td>
</tr>
<tr>
<td>Condition assessment capabilities</td>
<td>18.4%</td>
</tr>
<tr>
<td>Treatment technology</td>
<td>12.6%</td>
</tr>
<tr>
<td>Information technology</td>
<td>11.2%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
But many flood-prone communities still face the prospect of going it alone, often turning to increasingly popular tunneling-based solutions that, after the significant up-front costs, generally require the least maintenance. Tunneling-based solutions — described by Black & Veatch as a $6-billion-a-year business in North America and at “critical mass” — also don’t require significant land or urban disruptions to build. Tunneling is environment and ecosystem friendly and adds significant community economic and social benefits, especially when coupled with green infrastructure projects.

Near Houston, which before Hurricane Harvey had what had widely been considered an already robust regional flood-management system, Harris County’s flood-control district is getting an approximately $400,000 federal grant for a four-month study of the feasibility of tunnels to whisk stormwater to Houston’s shipping channel. That’s in addition to the district’s work on projects underwritten by a $2.5 billion flood bond approved by voters last summer.

In Charleston, crews are in the homestretch of a nearly $200 million quest to finish work on massive drainage tunnels capable of moving hundreds of thousands of gallons of water a minute off a swath of the city’s peninsula, where other such projects are planned. That’s part of a regional discussion about transformative infrastructure — and the virtues of being proactive.

Tunneling projects also are forging ahead from Fort Wayne in Indiana — at a price tag of $188 million — to Dallas, where that flood risk mitigation and management effort is expected to cost $207 million.

Solving it all will take a holistic view of how budgets for operations and maintenance and for capital improvements like “future-ready systems” are prioritized, viewing everything through a prism of risk. Wisdom also shows in building to meet the hydrologic needs of tomorrow — not the historical record — while appreciative that climate change means the next half century isn’t likely to look like the past century.

“This is something that has to be done,” South Carolina Gov. Henry McMaster declared to reporters and members of the state’s Floodwater Commission during their tour of the Charleston tunnel system in February 2019. “The cost of not doing it is astronomical.”

Therein lies the quandary for water utilities grappling with resiliency amid expectations of brutal, repetitive weather and coastal catastrophes tied to climate change on the horizon.

ABOUT THE AUTHORS

Andrew Smith is the national Watershed, Stormwater and Flood Management Practice Lead for Black & Veatch’s water business in 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.

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Faruk Oksuz is Vice President and Infrastructure Systems Director for Black & Veatch. With more than 30 years’ experience, Oksuz leads and manages the growth and delivery of infrastructure projects and services for tunnels, dams, reservoirs, levees, canals; water/wastewater distribution and collection systems; and infrastructure resilience and risk analysis and rehabilitation.
Adapting to Change to Move Ahead
There are an estimated 240,000 water main breaks every year in the United States, and those ruptures waste between 14 percent and 18 percent of the nation’s drinking water. Aging infrastructure is primarily to blame, as an estimated 40 percent of U.S. water and wastewater pipes are beyond their life expectancy, notes a recent article in WaterWorld. The article goes on to say that half of forecasted capital expenditures by water providers will cover new installation and rehabilitation of underground infrastructure.

In other words, utilities have plenty of large projects ahead: new pipelines, sewer lines, water and wastewater treatment plants, pump stations, reservoirs and more. In commissioning these initiatives, non-traditional delivery methods are gaining ground. Results from Black & Veatch’s 2019 Strategic Directions: Water Report survey show that water providers are looking at new ways to get big jobs done.

Signed, Sealed, Delivered
This year’s survey asked water utility staff to share their views on four methods of project delivery. Design-bid-build (DBB) is the most common approach to getting projects done. This delivery mechanism gives the utility a guaranteed maximum price based on the plans and specifications presented by the utility when it solicits bids. A newer approach is the progressive design-build methodology, in which utilities use design-builder qualifications or pre-defined attributes of best value...
as their selection criteria, and then move through both the design and construction processes in a collaborative way.

Also evaluated by survey respondents was the construction-manager-at-risk (CMAR) approach. Although CMAR delivery involves two separate contracts — one for design and one for construction, the CMAR firm — often referred to as construction manager/general contractor (CM/GC) — provides value with input into the engineer’s design while also providing early cost estimates that can assist the owner in better understanding the project’s anticipated cost and process features.

Respondents also evaluated lump-sum or fixed price design-build, in which the design-builder presents a price that includes all elements of the design and construction based upon the owner’s description of the project requirements or a conceptual design provided in the procurement documents.

Choosing a delivery method is a case-by-case activity. We’ll probably never see all projects go with one of the options noted above, but there seems to be increasing interest and usage of the newer, progressive design-build approach.

Survey results show that 70 percent of water providers have used the DBB delivery method, which comes as no surprise. However, more than half — 52 percent — have also tried the progressive design-build methodology (Figure 13).

In DBB, the utility bids the project out to contractors using design plans and specifications, and the company that wins the contract handles all construction management details for a set price. The construction-manager-at-risk approach is like DBB, except the contractor delivers the project without exceeding a guaranteed maximum price (GMP). The GMP is based on the design specifications, plus reasonably inferred tasks or additional items, and the contractor is generally selected on qualifications and not on the lowest price.

Since most water utilities are public entities, they’re generally subject to low-bid laws, which means they must take the lowest bidder for those DBB contracts. Project owners are relying on the initial drawings and specifications and trusting that they continue to reflect the actual needs once the construction begins. That may, or more likely may not, be the case. What often happens is that once the facility is up and running, if there are problems, the utility has little leverage to hold the contractor accountable for fixing issues.

This problem arises with CMAR contracts, too. In all these approaches, the designer is always incentivized to come in with the lowest price.
Often, the hiring authorities think they’re still getting a value-based deal. They’re not. Even worse, there are many times when something goes out to bid when the design isn’t entirely done. Because contractors are incentivized to offer low bids, they’ll often assume the least, not the most expensive approaches. Project owners frequently are disappointed because they went into the contract thinking they had the documentation necessary to get what they wanted and then find out they didn’t.

In the newer delivery model — the progressive design-build approach — utilities have a single entity designing and constructing the new facility, and they’re not subject to low-bid laws. Instead, utilities can do a best-value selection, and they pick the design-builder largely based on qualifications, not price. Then the design-build entity — a team of a designer and a contractor or an integrated design-builder — and the utility work on developing the project specifications, plans, budget and timeline collaboratively.

Both DBB and progressive design-build approaches earn generally good evaluations from those water providers who’ve used them. Two-thirds of survey respondents rated DBB projects very successful, and 61 percent said the same for progressive design-build projects. The construction-management-at-risk approach earned a “very successful” thumbs up from 53 percent of respondents (Figure 14).

Of these approaches, the progressive design-build delivery method often gives utilities more innovative designs because it’s not based on the lowest bidder, which tends to prompt engineers to be conservative for two reasons: First, the engineers are targeting lowest-cost, tried-and-true solutions; and, second, if some new approach doesn’t work, it will likely wind up with fingers being pointed in the engineers’ direction.

In contrast, the progressive design-build process tends to be more collaborative, with engineers and their water-utility clients working together as one. This, too, erodes the decades-long culture of conservative design approaches. In addition, utilities have more control over the process because they can design certain aspects of the project in parallel with construction, allowing problems to be addressed on an ongoing basis. Plus, this delivery method allows

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**Figure 14**

How would you rate the overall success for projects using each delivery type? (Select one response per row)

<table>
<thead>
<tr>
<th>Delivery Type</th>
<th>Very Successful</th>
<th>Moderately Successful</th>
<th>Slightly Successful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design-bid-build</td>
<td>66.0%</td>
<td>30.9%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Progressive design-build (paid throughout process)</td>
<td>61.4%</td>
<td>34.3%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Construction management at-risk (guaranteed maximum price)</td>
<td>53.1%</td>
<td>42.9%</td>
<td>4.1%</td>
</tr>
<tr>
<td>Lump sum design-build</td>
<td>38.5%</td>
<td>42.3%</td>
<td>19.2%</td>
</tr>
<tr>
<td>Other</td>
<td>33.3%</td>
<td>50.0%</td>
<td>16.7%</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
water providers to set a budget and have the design-builder work backward to meet the budget. Finally, the mechanism still provides for performance, scheduling and price guarantees, making it an increasingly attractive option.

Asked what delivery method they’d avoid, only 14 percent of respondents picked the progressive design-build approach. That’s twice as many as the number that would shun DBB project delivery, but it’s still notable given the newness of this approach.

Bread and Water
Finding the money is part of the construction process, so the Black & Veatch’s 2019 Strategic Directions: Water Report survey asked survey participants if they’d be open to public-private partnership (P3) arrangements. Overall, responses showed that utility staff are open-minded, with 71 percent being somewhat or very open to this funding option (Figure 15). It, like any other project delivery choice, must be determined on a project-by-project basis.

As it turns out, the predominance of aging infrastructure in use will give water providers opportunities to evaluate all the project delivery options: There’s a lot of infrastructure building ahead, and survey results show that water providers will examine all the delivery approaches to get their jobs done.

**Figure 15**
Are you open to partnerships to execute projects?

<table>
<thead>
<tr>
<th>%</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.0</td>
<td>Very open</td>
</tr>
<tr>
<td>46.7</td>
<td>Somewhat open</td>
</tr>
<tr>
<td>20.0</td>
<td>Not open</td>
</tr>
<tr>
<td>9.3</td>
<td>Don’t know what these are</td>
</tr>
</tbody>
</table>

Source: Black & Veatch

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**ABOUT THE AUTHORS**

**Blake Childress** is Managing Director of design-build services for Black & Veatch’s water business in the Americas. A management consultant with 43 years’ experience in the water and wastewater industry, Childress has been involved in the pursuit and management of both hard-dollar bid and design-build projects from concept to commissioning. His experience includes client management, project risk assessment, contract review, development of teaming agreements and leadership as well as overall project management. His work with design-build projects alone totals more than $2 billion.

**Mari Garza-Bird** is the Client Director for the Americas West region design-build services for Black & Veatch’s water business. Mari has spent the last decade of her career exclusively focusing on the development and execution of water and wastewater infrastructure design-build projects across the western portions of the United States. Her work with water and wastewater design-build projects totals more than $300 million in Texas and California.

**Justin Sobol** is the Client Director for the East region design-build services for Black & Veatch’s water business. He brings 15 years of design, project management, program management, construction management, and design-build experience across multiple industry sectors including municipal and industrial water and wastewater. He has worked for both engineering and at-risk construction companies on some of the world’s largest and most complex design-build projects equating to more than $4 billion during his career.
Nutrient pollution and the resulting excess of nutrients in waterbodies continues to plague aquatic environments around the world, threatening waterways, fish and plant life — and even public health. The runoff of phosphate and nitrogen from farming, stormwater, wastewater treatment plant discharges and other sources into waterbodies continues to unbalance ecosystems, resulting in toxic algal blooms and hypoxic dead zones.

The issue isn’t bound by state lines. Rivers and estuaries carry these nutrients across the country, impacting communities from the Great Lakes to the Mississippi River Basin and Chesapeake Bay. Although the issue is not a new one, efforts to reduce nutrient levels are shifting and becoming more widespread as water and wastewater utilities work to improve effluent quality and meet regulatory requirements.

Nutrient Management Solutions
According to Black & Veatch’s 2019 Strategic Directions: Water Report survey, a combined 57 percent of respondents either already have permitted their facilities for phosphorus, nitrogen, or both, or expect to be permitted in the near future (Figure 16). In other words, more than half of the respondents are either addressing nutrient issues or will be soon.

Figure 16
Are any of your facilities permitted for phosphorous, total nitrogen or both? If not, are there future expectations for such permits? (Select one)

43.3% Not currently and no plans for future permits
41.1% Yes, currently permitted
15.6% Not currently, but planned for

Source: Black & Veatch
Do you conduct sidestream treatment to remove ammonia or are you considering such a process? (Select one)

- **23.3%** Yes, we currently do sidestream treatment to remove ammonia
- **20.9%** Not currently but actively planning for it in the future
- **23.3%** Not currently but are starting to consider it
- **32.6%** No, not currently and not considering it

Source: Black & Veatch

Nearly four of every 10 respondents (39 percent) have facilities that include anaerobic digestion, which results in a concentrated return flow with significant nutrient loading. Sidestream treatment offers an opportunity to recover the nutrients for these facilities. Although not overly common, sidestream treatment is improving steadily, driven by the introduction of technology based on new bacteria — and new ways to harness that bacteria — that are making it more economical and cost-effective.

These various nitrogen removal technologies include bioaugmentation (BABE, InNitri), nitrification/denitrification (DigestivorePAD, SHARON) and nitrification/deammonification (ANNAMOX, DEMON, ANITA Mox). Because it uses less oxygen and does not require organic carbon, deammonification is often the most energy-efficient and carbon-efficient way to remove nitrogen. Survey results show that nearly one-quarter of respondents currently use sidestream treatment, roughly 20 percent are planning to do so, and nearly one-quarter are considering the process (Figure 17).

Black & Veatch has deep experience with deammonification technology. In 2014, the company designed the world’s largest DEMON treatment facility for DC Water’s Blue Plains Advanced Wastewater Treatment Plant (AWWTP). That facility is the largest of its kind, treating close to 300 million gallons of wastewater per day, with the ability to treat more than 1 billion gallons per day at peak flow.

The project helped DC Water meet regulatory requirements, and it will help reduce nutrient levels in Chesapeake Bay by removing ammonia-nitrogen from the filtrate sidestream generated by the final dewatering facility. The facility offers additional efficiency, saving the client approximately $500,000 per month when in full operation.

Several nutrient management technologies also exist to recover phosphorous. Among them are Ostara, which also recovers struvite, and ion exchange, which can be retrofitted on the end of an effluent stream. Newer technologies that rely on algal treatment are also being explored. Nineteen percent of survey respondents currently recover phosphorous, 17 percent are planning to do so, and 24 percent are considering it.

The Metropolitan Water Reclamation District of Greater Chicago turned to Black & Veatch — with its decades of experience in phosphorus recovery — to design and build the world’s largest nutrient recovery facility at the Stickney Water Reclamation Plant (WRP). The facility uses three Ostara Pearl 10000 reactors to recover more than 85 percent of its phosphorus and up to 15 percent of its nitrogen, converting them into market-ready fertilizers. In 2017, the Water Environment Federation (WEF) awarded a WEF Project Excellence Award to the Stickney WRP Nutrient Recovery Facility.

Revisiting Nutrient Trading

Once a fringe idea, nutrient trading is slowly gaining steam, particularly in regions such as the Chesapeake Bay and the Mississippi River Basin where point-source reduction technology has reached its limits. Nutrient trading allows facilities that reduce their discharge pollution below the legal limits to sell their
surplus reductions as “credits” to other entities. This approach makes economic sense in that it allows facilities that can reduce nutrients at a low cost to sell credits to those facing high-cost reduction upgrades, helping them meet requirements.

Although several states have put nutrient trading programs in place, actual use has been limited, according to a U.S. Government Accountability Office report issued in 2017. The report found that in 2014, 11 states had 19 nutrient credit trading programs, though most of the trading occurred in just three states – Connecticut, Pennsylvania and Virginia.

Historically, the level of effort involved in making nutrient trading a reality has been restrictive. But this appears to be changing; survey data shows that although 6 percent use nutrient trading, roughly one in five respondents expressed interest in it (Figure 18).

Perhaps more intriguing is that one-third of participants responded they do not know what nutrient trading is, which suggests a need to educate the industry on the practice to help organizations understand their options.

Organizations that manage impaired waterbodies such as the Chesapeake Bay, Mississippi River Basin, Big Bureau Creek Watershed in heavily agricultural north-central Illinois, California’s Laguna de Santa Rosa Watershed and North Carolina’s Tar-Pamlico estuary, Jordan Lake and Falls Lake are investigating nutrient trading, and we expect to see it play a larger role in the next three to five years as states dig deeper into nutrient regulation.

Data’s Role in Nutrient Removal

The introduction of Big Data, which is disrupting various sectors throughout the economy, may also offer solutions when it comes to managing nutrient flows. The fourth largest river in the world, the Mississippi River, drains all or part of 31 states into the Gulf of Mexico. This massive tributary carries nutrients into the Gulf, resulting in a giant hypoxic zone roughly the size of Connecticut.

In 2015, the U.S. Geological Survey (USGS) partnered with the Illinois Environmental Protection Agency (IEPA) to run a pilot program to assess the levels of nutrients being carried out of Illinois. The program involved installing a regional network of analyzers known as “supergauges” – advanced gauge stations that continuously monitor and analyze streamflow and nutrient data. Powered by solar energy and integrated with cellular and satellite modems, these supergauges make the data available in real-time.

Monitoring and analyzing the nutrient data from this regional network of supergauges will allow the USGS and EPA to test the viability of deploying a comprehensive nutrient monitoring network for the entire Mississippi River Valley, introducing a new way to better understand how to protect waterways.

Figure 18

Is your organization involved or interested in nutrient trading? (Select one)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5%</td>
<td>Yes, currently involved</td>
</tr>
<tr>
<td>21.3%</td>
<td>Not involved but interested</td>
</tr>
<tr>
<td>39.4%</td>
<td>No, not involved or interested</td>
</tr>
<tr>
<td>33.9%</td>
<td>Don’t know what this is</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
It is no surprise that after labor costs, energy is the next highest operational cost for water and wastewater utilities. Water is an extremely heavy resource, requiring enormous amounts of energy to move and treat it. As energy costs continue to rise and more states adopt regulatory incentives and disincentives that drive large-scale sustainability and efficiency efforts, it is expected that utilities will become more aggressive in their approach to managing energy.

Planning an Approach
According to Black & Veatch’s 2019 Strategic Directions: Water Report, energy remains a key concern for the water utilities sector. Two-thirds (67 percent) of respondents say energy management is an “extremely or very important” priority for their organization, while one-quarter prioritized it as “moderately important.”

The first step to managing energy is to put an energy master plan in place. This plan should focus on how the utility can most effectively use energy and address topics such as consumption and demand, energy production and conversion, and energy distribution. The plan should serve as a road map and offer an efficient, practical and cost-effective path forward.

Nearly half of survey respondents already have an energy master plan in place, while one-quarter are working to develop one. The remaining quarter (26 percent) do not have an energy master plan and do not plan to develop one (Figure 19).
Managing Energy to Manage Costs

Water utilities are actively working to manage rising energy costs and are prioritizing approaches that improve operations. According to survey data, six out of 10 respondents have invested in efficiency improvements over the past three years — changing out power-hungry equipment for more efficient models, exploring new, more sustainable processes, and updating treatment methodology. Forty percent say they are currently considering efficiency upgrades (Figure 20).

Asset management systems and data analytics offer utilities additional options when it comes to maximizing efficiency in power systems. For example, integrating predictive maintenance and other diagnostics into an organization’s asset management system would give operators the ability to monitor and maintain operations in real time. This topic is addressed in the article, “Predictive Maintenance Offers Promise in Asset Management,” on page 14 of this report.

Nearly half of respondents (45 percent) said they are partnering with electric utilities on demand response programs. Electric utilities historically have relied on demand response and pricing models — charging peak and off-peak rates — to modify user behavior and disincentivize users from consuming power at certain times. Water and wastewater utilities can take advantage of these programs by using energy when rates are lower, for example, running pumps at night instead of during peak hours.

If a utility offers power at X cents per kilowatt-hour (kWh) during peak demand periods, and at a fraction of X during off-peak hours, then the water utility effectively can reduce energy bills by modifying operations to take advantage of the lower rate. In fact, 37 percent already have worked to modify their operations to take advantage of off-peak charges. Renewable energy and energy storage could also help in this regard.

To keep an eye on energy costs, four of every 10 survey respondents have conducted an energy audit within the past three years. Energy audits are helpful in that they provide a granular look at power use and portfolio capabilities. When it comes to on-site power generation, more than one-third of respondents said they have invested in on-site power generation over the past three years, while slightly more than one-quarter are considering adding it, which is a relatively small number, reflecting that water-related utilities may choose to focus on their core expertise and competencies of distributing or treating water and defer to their electricity peers to do what they do best — supply power.

Finally, one-fifth of respondents are adding energy recovery technologies such as microgrids and combined heat and power (CHP) systems, while 16 percent are passing rate increases on to their consumers.

Source: Black & Veatch

**Figure 20**

What is your organization currently doing to manage electricity usage costs? *(Select all that apply)*

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.3%</td>
<td>Invested in electric efficiency improvements in the last 3 years</td>
</tr>
<tr>
<td>45.4%</td>
<td>Partnering w/electric utility on demand response programs</td>
</tr>
<tr>
<td>40.3%</td>
<td>Considering electric efficiency upgrades</td>
</tr>
<tr>
<td>38.7%</td>
<td>Energy audit conducted within the last 3 years</td>
</tr>
<tr>
<td>37.0%</td>
<td>Modifying operations for off-peak charges</td>
</tr>
<tr>
<td>35.3%</td>
<td>Invested in onsite power generation in the last 3 years</td>
</tr>
<tr>
<td>27.7%</td>
<td>Considering onsite power generation</td>
</tr>
<tr>
<td>20.2%</td>
<td>Adding energy recovery technologies</td>
</tr>
<tr>
<td>16.0%</td>
<td>Passing rate increases on to consumers in their rates</td>
</tr>
<tr>
<td>6.7%</td>
<td>None of the above</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
The Economics of Energy

Regional price considerations will play a large role in shaping energy policy going forward in that investment decisions will hinge heavily on how much a water and wastewater utility pays for power. Industrial electric rates fluctuate wildly. According to the U.S. Energy Information Administration (EIA), Washington pays the lowest rate in the country — 4.67 cents per kWh — while Hawaii pays the highest, at 26.73 cents per kWh.

Utilities in states where the regulatory environment is driving energy efficiency (coupled with high costs of energy) are more apt to invest in new approaches to energy management. For example, if a water utility in Hawaii could cut its energy bill in half, that would more than make up the original cost of the efficiency investment.

But in areas without environmental regulatory statutes — and with relatively low costs of energy — there is less of a focus on these efforts simply because the economics won’t work in their favor. If a water utility in Oklahoma is paying 4.85 cents per kWh, cutting that bill in half won’t cover the original investment. The investment to develop the infrastructure will be relatively similar, regardless of region, but the returns can be significantly different.

When looking at pay-back time, more than one-quarter of respondents (27 percent) of those surveyed said they expect to see a return on investment in less than five years, while 26 percent are prepared for a six- to 10-year window. Nearly half responded that they do not have a stated pay-back time.

Renewables

Three-quarters of respondents (76 percent) are considering renewables to help defer energy costs. According to the survey, roughly six of 10 respondents are considering solar solutions, as the technology continues to improve and costs continue to drop (Figure 21). One-third are eyeing gas generation from biosolids, which involves generating biogas from organic waste, and 22 percent are looking at hydro generation.

The numbers drop off from there. Thirteen percent said battery storage, probably because of its cost-prohibitive nature, and only 11 percent said wind, probably because the technology will not scale to the amount that water and wastewater utilities need.

Embracing a Future of Energy Management

As the intersection of energy and water becomes more deeply entwined, expect to see a shift across the industry as water utilities begin to focus more closely on how they approach energy management. Utilities in states with regulatory environments that are driving energy efficiency — and those facing high energy costs — will lead the charge when it comes to investing in resilience and sustainability. Utilities in states that are prone to natural disasters also will likely make investments in resilience irrespective of incentives or price of electricity. These efforts eventually will roll out across the rest of the country, encouraging change across the water utilities industry and municipal operations.

Figure 21
Are you considering renewables to defer your operating costs? (Select all that apply)

<table>
<thead>
<tr>
<th>Percentage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>59.1%</td>
<td>Yes, solar solutions</td>
</tr>
<tr>
<td>32.7%</td>
<td>Yes, gas generation from biosolids</td>
</tr>
<tr>
<td>21.8%</td>
<td>Yes, hydro generation</td>
</tr>
<tr>
<td>12.7%</td>
<td>Yes, battery storage</td>
</tr>
<tr>
<td>12.7%</td>
<td>Yes, diesel engines</td>
</tr>
<tr>
<td>10.9%</td>
<td>Yes, wind</td>
</tr>
<tr>
<td>8.2%</td>
<td>Yes, some other type of renewable</td>
</tr>
<tr>
<td>3.6%</td>
<td>Yes, geothermal</td>
</tr>
<tr>
<td>23.6%</td>
<td>No, not considering renewables</td>
</tr>
</tbody>
</table>

Source: Black & Veatch
2019 Report Background

The Black & Veatch 2019 Strategic Directions: Water Report is a compilation of data and analysis from an industry-wide survey. This year’s online survey was conducted from 27 February through 20 March 2019 and reflects the input of 430 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.
ORGANIZATION TYPE
Which of the following BEST describes your organization? (Select one)

39.8% Water, wastewater or stormwater plant

17.4% Consulting firm that offers water or wastewater management solutions

14.9% Combined utility that provides water or wastewater services and other utility services

14.0% Local government or municipality of local water/wastewater/stormwater issues

14.0% Other NET

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

77.6% Drinking Water

69.3% Wastewater

29.9% Stormwater

16.5% Electricity

12.6% Solid waste

6.7% Natural gas

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

New England 10.0%

Mid-Atlantic 14.2%

North Central 26.6%

Great Plains 14.5%

Southeast 34.3%

South Central 18.2%

Southwest 28.5%

Rocky Mountain 14.8%

Northwest 24.0%

Other U.S. locations 10.6%

Source: Black & Veatch
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