2021 Black & Veatch
Strategic Directions

Water Report

About This Report

Cindy Wallis-Lage
President, Black & Veatch's water business

The year 2020 supplied no shortage of challenges yet provided the water industry with an opportunity to find new ways of doing business and collaborating. Black & Veatch's *2021 Strategic Directions: Water Report* examines the issues and trends impacting today's water industry based on a survey of more than 200 stakeholders in the United States sphere of water, wastewater and stormwater.

The COVID-19 pandemic, initiated in early 2020 and continuing in 2021, created financial stress on many utilities, complicating existing industry challenges such as such as the continued aging of infrastructure and workforce. Intensifying natural disasters — wildfires, floods and drought — impacted water systems, highlighting the rising effects of climate change, testing the resilience of infrastructures, and reinforcing the need for significant investment.

While water utilities responded admirably to the fallout from COVID-19, the global pandemic required all utilities to be more resilient in their services and make sorely needed investment in supply, treatment, conveyance and storage facilities. In forcing federal, state and local governments to halt businesses and industries, the pandemic left tens of millions of Americans jobless and unable to pay utility bills, further straining the bottom lines of many water utilities.

Still, that crisis amplified the opportunity and need to accelerate innovation in strategy, operations and funding, with utilities compelled more than ever to unleash the value of data in their operations. Without question, analytics and other technologies drive better decision-making, optimize and prioritize system investments, and drive cost efficiencies that propel sustainable and resilient systems.

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

CONTENTS

4
Executive Summary: From COVID-19 to Climate Change, Challenges Press Water Industry to Grow Resilience, Embrace Technology

9
As Climate Change Concerns Rise, Utilities Must Elevate Thoughts of Resilience

13
Decarbonizing the Water Industry

17
Sustainable Solutions, Data Use and Integrated Solutions Plugged into a Circular Economy Will Drive Tomorrow's Water Infrastructure

20
Weathering COVID-19: A Water Utility Success Story, With Lessons Learned

24
Water as a Business: Data, Innovation and Planning Drives Value

27
The Politics of Water

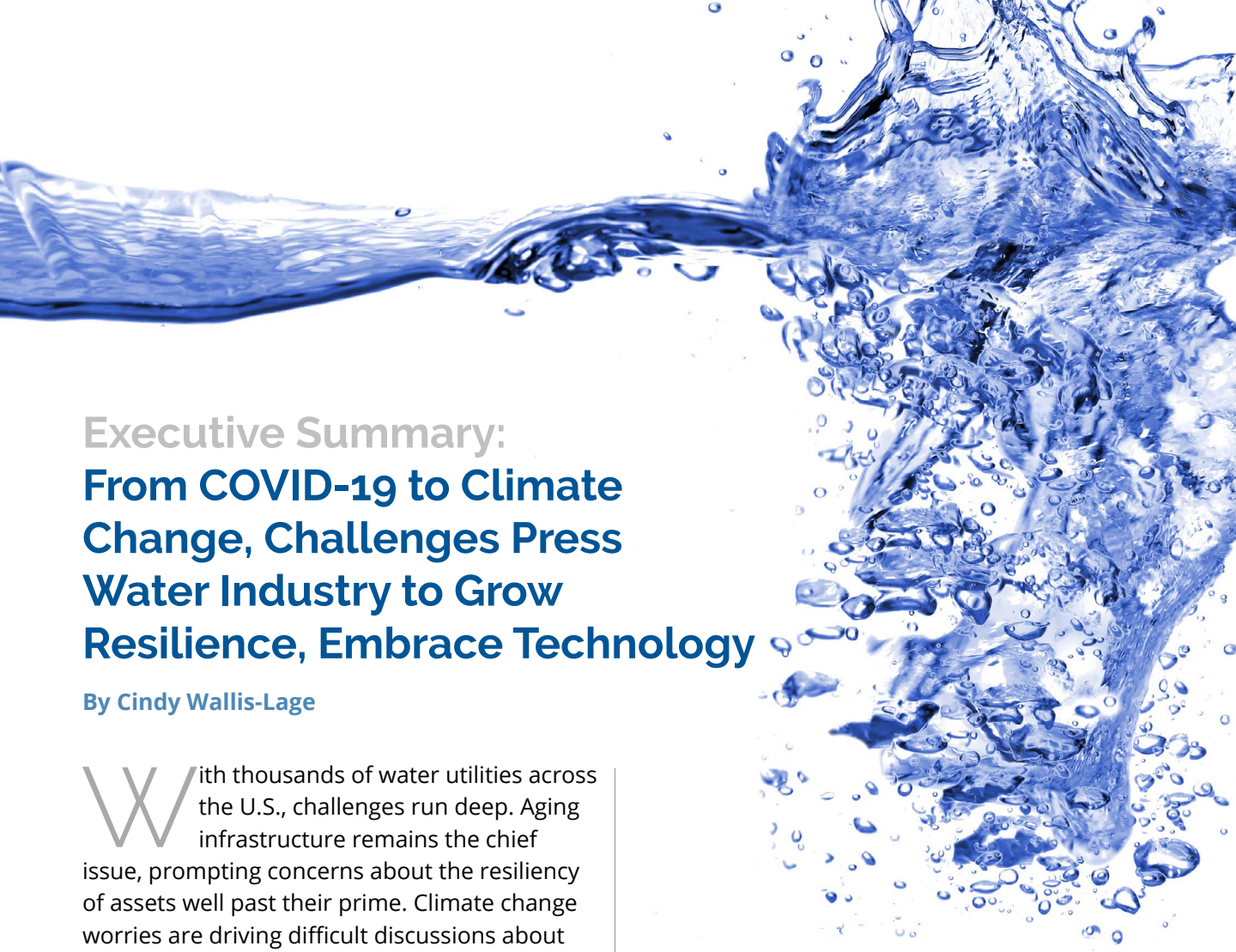
31
Attention to Data-Driven Digital Twins Rising, Though Jury Still Out on Return on Investment

35
Unsettled Regulatory Landscape Deters Decontamination Upgrades

39
Despite Barriers During a Pandemic, Growth in Reuse Drives Participation in the Circular Economy

43
From the Catskills to the Gulf, Projects Prove Promise of Green, Sustainable Infrastructure

47
Food for Thought: NextGen Agriculture May Help Satisfy World's Growing Appetite



Executive Summary: From COVID-19 to Climate Change, Challenges Press Water Industry to Grow Resilience, Embrace Technology

By Cindy Wallis-Lage

With thousands of water utilities across the U.S., challenges run deep. Aging infrastructure remains the chief issue, prompting concerns about the resiliency of assets well past their prime. Climate change worries are driving difficult discussions about hardening the infrastructure — and how to pay for it — to withstand droughts, floods, wildfires or extreme shocks, such as February's deep freeze in Texas that disrupted water services to millions.

The need for greater, more reliable cybersecurity is more pronounced, after hackers in February exploited a security vulnerability in a Florida water treatment plant's operating system and tried to taint the local water supply. Thankfully, a plant supervisor, through his computer interface, noticed the hack in progress and intervened before any real damage was done.

Technology advances from process intensification to data analytics and artificial intelligence continue to light a way forward, helping utilities and industry optimize asset performance, reduce costs, save energy, achieve regulatory compliance and bolster security.

Such challenges and opportunities are at least familiar territory. The COVID-19 pandemic hit the industry in 2020 seemingly out of nowhere, creating uncertainty about safety and further straining the bottom lines of many water utilities. Yet, the sector as a whole rose to the challenge, demonstrating remarkable agility and adaptability through its front-line professionals in keeping the water flowing, true to its mission of delivering a clean, reliable and safe supply.

This *2021 Strategic Directions: Water Report* details that backdrop and the complexities of the transforming U.S. water, wastewater and stormwater industries. Backed by expert analyses of responses to a survey of more than 200 U.S. stakeholders, the report brings into focus a sector challenged as always on multiple fronts while advancing "One Water," the premise that integrated and holistic water resource management — the value of all water regardless of history — must be considered when drafting plans and making investment decisions.

'Digital Water' Holds the Key as Infrastructure Continues Aging

To little surprise, the aging of the U.S. water industry's infrastructure continues to be a core issue. Three-quarters of survey respondents listed aging infrastructure as their foremost challenge, far outdistancing issues such as making the case for capital improvement programs (34 percent), system resilience (30 percent) and managing capital costs (26 percent) *(Figure 1).*

Taken together, the issues magnify the case for digital water solutions as utilities need to "do more with less." Leveraging digital technology provides the opportunity to harness data precisely, which leads to enhanced capabilities in tracking consumption, driving customer engagement, optimizing performance, driving efficiencies and prioritizing investment dollars. Greater sustainability and resilience through informed asset management and planning are the rewards, along with an invaluable, holistic view of the water system.

Leveraging digital technology provides the opportunity to harness data precisely, which leads to enhanced capabilities in tracking consumption, drives customer engagement, optimizes performance and prioritizes investment dollars.

Figure 1

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

Source: Black & Veatch

	2020	2021
Aging water and wastewater infrastructure	**79.4%**	**74.8%**
Justifying CIPs and/or rate requirements	26.0%	33.6%
System resilience	24.9%	30.3%
Managing capital costs	25.3%	25.6%
Managing operational costs	19.9%	21.8%
Data collection and management	22.7%	20.6%
Water conservation	17.7%	17.2%
Treatment technology	19.1%	15.1%
Condition assessment capabilities	17.0%	14.3%
Integrated water planning	17.0%	11.8%
Information technology	9.7%	10.9%

It's undeniable that data can guide utilities to higher operational efficiency, greater performance predictability and better maintenance planning, along the way boosting insight about when, where and how much to invest in the systems. The opportunity to gather and integrate information using current data collection systems — combined with evolving next-generation, cost-effective sensors and smart devices — enables predictive analytics to detect leaks, forecast usage, reduce costs and everything in between.

But Black & Veatch's survey finds that many utilities are missing out, conceding that they're harvesting more data but lack insights about what to do with it all. Roughly two-thirds of respondents categorize their data management practice as robust and strengthening but not fully integrated, up slightly from a year earlier. An additional three in 10 respondents say their data is unintegrated and siloed, consistent with the 2020 survey. Just 5 percent called their data management robust and fully integrated.

In a separate question, half of respondents say they're collecting lots of data but not effectively leveraging it to actionable information, down from 60 percent in 2020 *(Figure 2).*

The bottom line: Siloed data keeps utilities from having a complete and clear picture of their assets and operations and how best to invest in them.

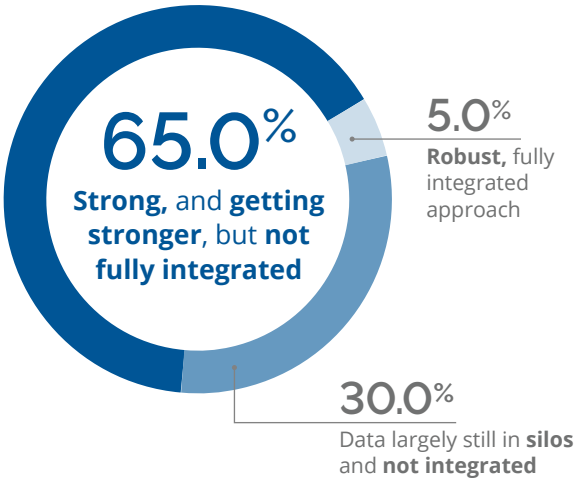
In addition to digital water's influences on the water industry, our report examines:

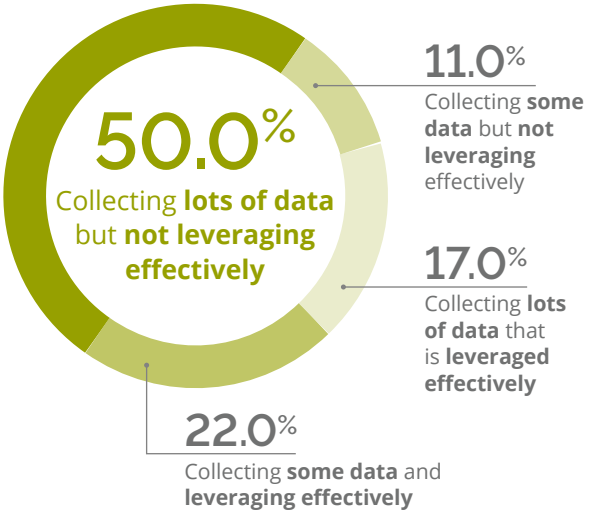
- **Climate Change:** Utilities and communities face an evolving challenge to harden their water, wastewater and stormwater infrastructure and assets against drought, flooding, wildfires and other weather-related disasters that appear to be gaining in terms of frequency

Figure 2

Which of the following statements best describe the current data management practice at your organization? *(Select one for each set)*

Source: Black & Veatch





and intensity as a result of climate changes. Impacts from climate change ranked fifth among respondents' most significant perceived resilience concerns. By beginning or advancing the planning process for operational resilience in the near term, utilities can help to provide water security in the future.

- **Contaminant Removal:** Many water utilities will have to upgrade their systems to meet new maximum contaminant levels (MCLs). The MCLs — namely per- and polyfluoroalkyl substances (PFAS), or so-called "forever chemicals" that don't easily biodegrade. Momentum looks to be building at the state and federal levels (e.g., H.R. 2467, the PFAS Action Act of 2021) to study treatment technologies and establish limits for PFAS in water sources.
- **Tomorrow's Infrastructure:** More utilities are deploying digital capabilities, including digital mapping to catalog utility systems and assets, evidence that digital technology is taking a firmer hold across the water and wastewater industry. Work is happening that pushes past data analytics to introduce new opportunities in digital water, from treatment innovations to advances in Internet of Things (IoT) integration.
- **Politics of Water:** The water and wastewater industry is chronically underfunded, and the value of water often is misunderstood and underappreciated. Hope is springing anew in the sector that significant, instrumental investments in water infrastructure may be on the horizon, given the new presidential administration's proposal of a robust funding package.

COVID-19 and the Water Sector

Across the spectrum of water utilities, the COVID-19 pandemic's impact was profound from the moment it began its sweep through the U.S. in early 2020.

Industries and businesses shuttered, forcing tens of millions of layoffs that, in turn, produced delinquencies in water bills, cutting into the revenues and cash flows of utilities big and small. By and large, they suspended water and wastewater shutoffs to past-due accounts, both as a humane gesture and as an acknowledgement of the importance of water and sanitation during a health crisis, regardless of one's ability to pay. Some utilities forgave the unpaid amounts; others deferred them through extended payment plans.

Figure 3

Would you say that your organization is giving more consideration to technology because of COVID? *(Select all that apply)*

Source: Black & Veatch

67.8%
Yes, remote work for professionals

31.5%
Yes, more consideration to customer engagement

29.4%
Yes, more remote operation/automation

18.9%
Yes, more remote monitoring/diagnostics

20.3% No

Closures of big commercial and industrial (C&I) water customers adversely impacted utility revenues and cash flows as water demand shifted to residential areas, where displaced workers suddenly found themselves working remotely.

Two-thirds of respondents to Black & Veatch's survey reported that the outbreak had at least a moderate impact on their day-to-day operations. But the sector weathered the storm and learned from it.

More than two-thirds of respondents credited COVID-19 for their organization's increased consideration of technology, pointing to the pandemic-forced remote working practices of their employees. Thirty-two percent report giving more thought to customer engagement, with 29 percent saying they're supporting increased remote operations and automation *(Figure 3).*

As the survey shows, utilities appear to be moving beyond their historical business activities and increasing their engagement with digital and electronic management approaches. Water, wastewater and stormwater utilities found that perhaps their data management wasn't as robust as they thought during the operational challenges of COVID-19, inspiring them to ramp up efforts to harness and optimize use of information.

Despite its impacts, the pandemic amplified the opportunity and need to accelerate innovation in strategy, operations and funding to protect human health and the environment, along the way greasing the economic engine that comes from infrastructure investment.

More than ever, the industry is at a crossroads to invest in its systems, leverage new funding sources, collaborate with partners, plan its systems holistically and prioritize water as a way to revitalize, rejuvenate and equitably build our communities of the future.

Now is the time for the water industry to make change.

ABOUT THE AUTHOR

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

As Climate Change Concerns Rise, Utilities Must Elevate Thoughts of Resilience

By Ed Rectenwald, Jim Schlaman and Andrew Smith

Providers of drinking water, treated water and stormwater solutions have tended to give thoughts of climate change a relatively cold shoulder, given their other demands ranging from chronically aging infrastructure and workforces to shifting regulations. A new iceberg should give them pause.

In May 2021, a slab of ice bigger than Rhode Island — at roughly 105 miles long and 15 miles wide, covering more than 1,600 square miles — sheared off an Antarctic ice shelf, making it the world's biggest iceberg. Such calving events aren't uncommon, but scientists who have seen Antarctic ice shelves rapidly disintegrate in recent years suspect climate change. The suspicion of climate change induces concerns about rising sea levels and related questions about the resiliency of water utilities, particularly along low-lying coastal areas.

As impacts of climate change manifest themselves elsewhere in the form of expansive, seemingly more common droughts, flooding, hurricanes and wildfires, questions arise. Are utilities and communities doing enough to harden their water, wastewater and stormwater infrastructures and assets against such threats? Or are they at least starting to plan for such upgrades in the interest of dependable water security and supply?

The short answer is that there's much more the industry needs to be doing to become resilient, according to a survey of more than 200 U.S. water industry stakeholders surveyed for Black & Veatch's *Strategic Directions: Water Report.*

Impacts from climate change ranked fifth among respondents' most significant perceived resilience concerns, which was outdistanced handily by potential catastrophic infrastructure failure — the top choice, at roughly two-thirds of respondents. Those results may have been influenced by the powerful mid-February winter storm that blanketed much of Texas with snow, ice and record low temperatures, knocking out power and heat to millions of homes and businesses for days and disrupting water service.

Natural or human-made disasters — some associated with climate change — came in second at nearly six in 10 respondents (57 percent), down dramatically from last year's 84 percent. Extended drought and water supply restrictions followed at 44 percent, with climate change impacts next at 29 percent, relatively unchanged from the previous year *(Figure 4)*.

The Texas deep freeze highlighted in dramatic fashion an often-overlooked fact — our energy, electricity, water, transportation and communications infrastructure systems are intertwined. When one system fails, it can create cascading catastrophes.

Increasingly extreme weather events should compel water utilities — many underfunded and starved for capital — to proactively and thoughtfully plan for ways to harden their assets as a backstop. Last year alone, a historically busy Atlantic hurricane season produced 30 named storms, including a half dozen major hurricanes. Severe wildfires burned millions of acres of land in California, Colorado and Oregon — and elsewhere around the globe — while flooding inundated portions of Louisiana, Michigan and Tennessee. Midway through 2021, much of the western U.S. remained gripped by drought and wildfires.

Three-quarters of larger systems surveyed said water conservation and/or drought management was part of their blueprint, compared to 63 percent of smaller systems.

Resiliency Remains a Lesser Priority

To little surprise, projects meant to ensure or enhance water quality — the chief mandate of water providers — held the most sway among the survey's respondents, with roughly four in 10 casting that as the highest prioritization. Efforts to bolster the conditions of assets or to replace them altogether was the principle priority of one-quarter of respondents, followed by

Figure 4

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

Source: Black & Veatch

	2020	2021
Infrastructure catastrophic failure	**55.7%**	**67.4%**
Natural or man-made disaster	83.5%	57.3%
Cyberattack	34.0%	56.2%
Extended drought/supply restrictions	38.1%	43.8%
Impacts from climate change	30.9%	29.2%
Terrorist attack	12.4%	5.6%

addressing capacity and growth (17 percent) and operations and efficiency (12 percent). Projects meant to bolster resiliency drew just 5 percent, with nearly three in 10 labelling resilience as their lowest priority *(Figure 5).*

The takeaway: Many system managers direct their energy and focus on meeting state and federal water quality standards and simply keeping the system running. For managers, any issues beyond the job's operational requirements tend to get kicked down the road as "tomorrow's crisis" — something to address only after today's crises are managed.

Bigger water utilities — those serving at least 500,000 people — listed resiliency as their third-highest priority, behind water quality and matters involving asset condition or replacement. For utilities with fewer than 500,000 customers, resilience languished at the bottom of five priority choices, underscoring that resilience planning is a luxury for those smaller water systems.

A similar split between larger and smaller water utilities surfaced when respondents were asked about elements of their water plan. Three-quarters of larger systems surveyed said water conservation and/or drought management was part of their blueprint, compared to 63 percent of smaller systems. Officials at systems of various sizes had roughly the same responses about scenario planning and new reservoir storage.

But a large gap emerged when it came to climate change or variability, with half of respondents at larger utilities saying such factors were part of their water roadmap — compared to 17 percent of smaller water systems *(Figure 6)*.

The Value of Water and Climate Change's Impact

The U.S. built a lot of water and wastewater infrastructure in the 1950s and 1960s, but capital spending since has dropped off sharply. Until systems break, water and wastewater functions remain an "out of sight, out of mind" business. But breakdowns are becoming more frequent, given the prevalence of aging infrastructure stressed by population growth and migration.

Figure 5

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

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

Source: Black & Veatch

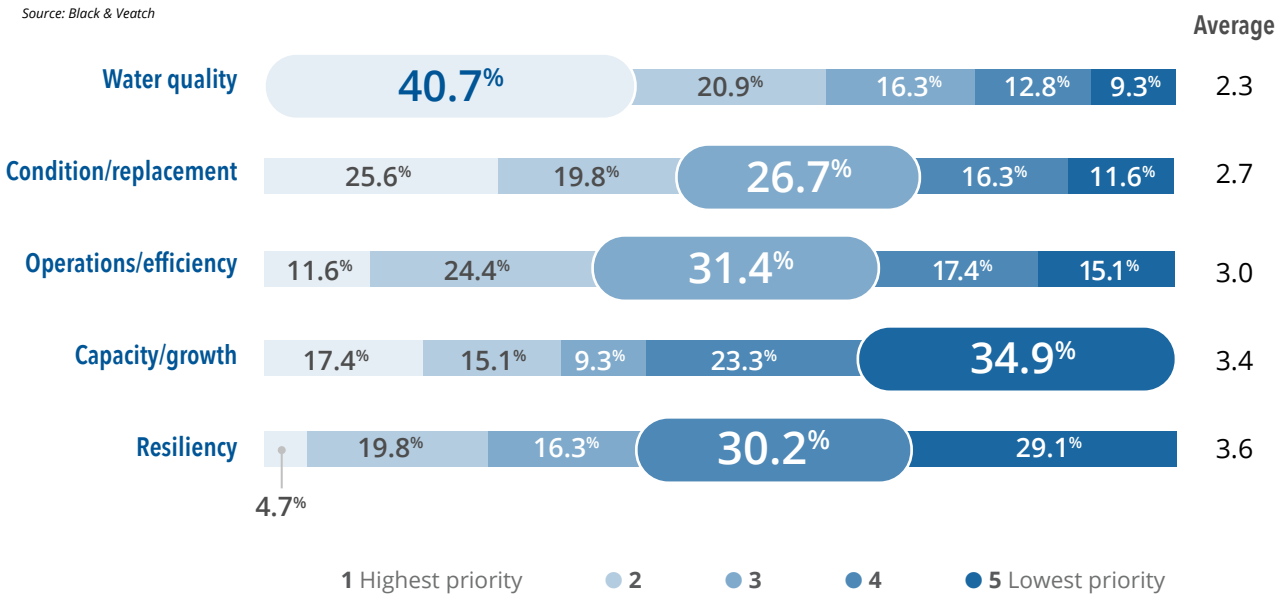


Figure 6

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

Source: Black & Veatch

By Population Served	Less than 500,000	500,000 or more
Water conservation and/or drought management	**62.9%**	**75.0%**
Scenario planning	57.1%	60.7%
New reservoir storage	37.1%	32.1%
Climate change/ variability	17.1%	50.0%
New surface water supplies	14.3%	32.1%
We do not have a water supply plan	14.3%	3.6%

As worries about climate change escalate — and citizens, regulators and other stakeholders demand greater resiliency in such critical infrastructure — utilities big and small would be well-served to strategize thoughtfully now about upgrades, knowing that such projects are years in the making.

Water and wastewater utilities should begin by having earnest, honest conversations about the value of water with their boards, critical stakeholders and customers, pressing the salient point that the environment is not static. Whether on the coast or in America's breadbasket, it's not about the infrastructure's performance over past decades but what challenges the assets will have to handle sooner or later.

It's far cheaper to repair or replace assets now, before systems weaken and fail, than playing catchup — and pointing fingers — when trouble strikes.

ABOUT THE AUTHORS

Ed Rectenwald *is a hydrogeology national practice lead for Black & Veatch's water business. With 26 years of technical and management experience, he successfully has managed projects and teams across the globe related to design, permitting, construction, expansion and operation for wellfields, Class V aquifer storage and recovery (ASR), aquifer recharge and Class I injection well systems.*

Jim Schlaman *is the director of planning and water resources for Black & Veatch's water business and serves on the One Water Council for the U.S. Water Alliance. During the past 19 years, he has worked across the country on all types of planning and water resources projects. including water supply and reuse/alternative water supply evaluations, integrated planning and water quality studies, and stormwater/flood control planning and design projects.*

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

Decarbonizing the Water Industry

By Jay Kemp and Jason Rowell

As the water and wastewater industry replaces its aging infrastructure and continues to seek ways to reduce energy consumption, is there a greener, more sustainable way to approach water and wastewater systems in the future?

Black & Veatch's *2021 Strategic Directions: Water Report* survey shows progress being made when it comes to sustainability. Opportunity for this is high, given that the industry can address the physical construction of its assets by considering more sustainable alternatives to traditional concrete and steel. Additionally, the industry can confront its own energy-intensive nature by investing in renewable energy and energy recovery programs to help keep water and wastewater plants humming.

Top Drivers, Strategies Toward Sustainability

Survey data shows that financial drivers (56 percent) and strong consumer demand (42 percent) outrank political pressure (36 percent) when driving the water industry to set sustainability goals. These motivations illustrate how sustainability awareness has evolved. Only a decade ago, political pressure was the primary driver as the government

Renewable natural gas derived from biogas — a byproduct of wastewater treatment — offers the immediate potential to decarbonize the natural gas grid, because the infrastructure is in place.

Figure 7

Does your organization have a strategy to become more sustainable? If so, what's included in that sustainability strategy? *(Select all that apply)*

Source: Black & Veatch

48.9%
Renewable energy

43.8%
Water loss mitigation

32.1%
New/alternative water supplies

24.1%
Decarbonization goals

7.3%
Low-carbon building materials

21.2%
None of the above

wielded the U.S. Environmental Protection Agency (EPA) to enact change through both regulation and funding by supporting state revolving loan funds.

Cost continually is a consideration, but utilities can stretch their funding by investing in existing assets. In the wastewater industry, this approach is called "intensifying the process," to get more performance out of existing process units. A lot of concrete water and wastewater infrastructure already exists, and improving the efficiency and effectiveness of these assets allows the industry to avoid costly new construction and lower its carbon footprint.

The survey also found that renewable energy, water loss mitigation and new/alternative water supplies are key components in many sustainability strategies, as utilities reconsider how they manage their product to reduce energy needs and losses *(Figure 7).*

The sustainability strategies seek more efficient use of water and energy resources with subsequent decreases in carbon emissions. Decarbonization is a unifying principle of sustainability.

Renewable natural gas (RNG) derived from biogas — a byproduct of wastewater treatment — offers the immediate potential to aid in decarbonizing the natural gas grid, because the infrastructure is in place. RNG directed to vehicle fuel is incentivized by the EPA Renewable Fuel Standard and California Low-Carbon Fuel Standard. Renewable portfolio standards for natural gas are on the horizon. These opportunities can help the industry decarbonize while leveraging incentives to help make it cost-neutral or even profitable.

Improved leak detection with no-dig technology is driving improvements in addressing water loss. Identifying and fixing leaks saves energy and the resource itself. Water reuse also is

gaining momentum because of pre-existing technologies. Water reuse has great potential for commercial and industrial users as well.

Although only 7 percent of respondents said they plan to integrate low-carbon building materials into their overall sustainability strategy, a separate question in the survey found that a combined 61 percent would be willing to consider the use of sustainable building construction materials even if they cost more. Low-carbon material may be produced by emerging technologies that have historically carried a higher price tag. These solutions include removing carbon dioxide from — or permanently store it in — concrete, or by using legacy materials such as ductile iron pipe, which is made from recycled iron and is more sustainable than plastic. The industry can recoup the added cost through incentives or pass them on to ratepayers, opening the door for future adoption.

Proposed Funding in the Infrastructure Bill

When polled on the Biden Administration's proposed American Jobs Plan, 59 percent of respondents showed support for including decarbonization incentives in the federal bill, while 41 percent did not. This suggests that water and wastewater utilities may have other priorities, such as upgrading aging infrastructure and implementing new systems rather than decarbonizing. It also could mean that respondents may not see themselves as significant emissions contributors when compared to carbon-heavy industries such as power, transportation, and the commercial and industrial sector.

But when asked which components of the American Jobs Plan are expected to pass Congress, respondents anticipate all of Biden's water infrastructure measures to advance, albeit at a lower budget amount than proposed *(Figure 8).*

Figure 8

Which water components of Biden's infrastructure plan do you think will eventually pass in Congress? *(Select one per row)*

Source: Black & Veatch

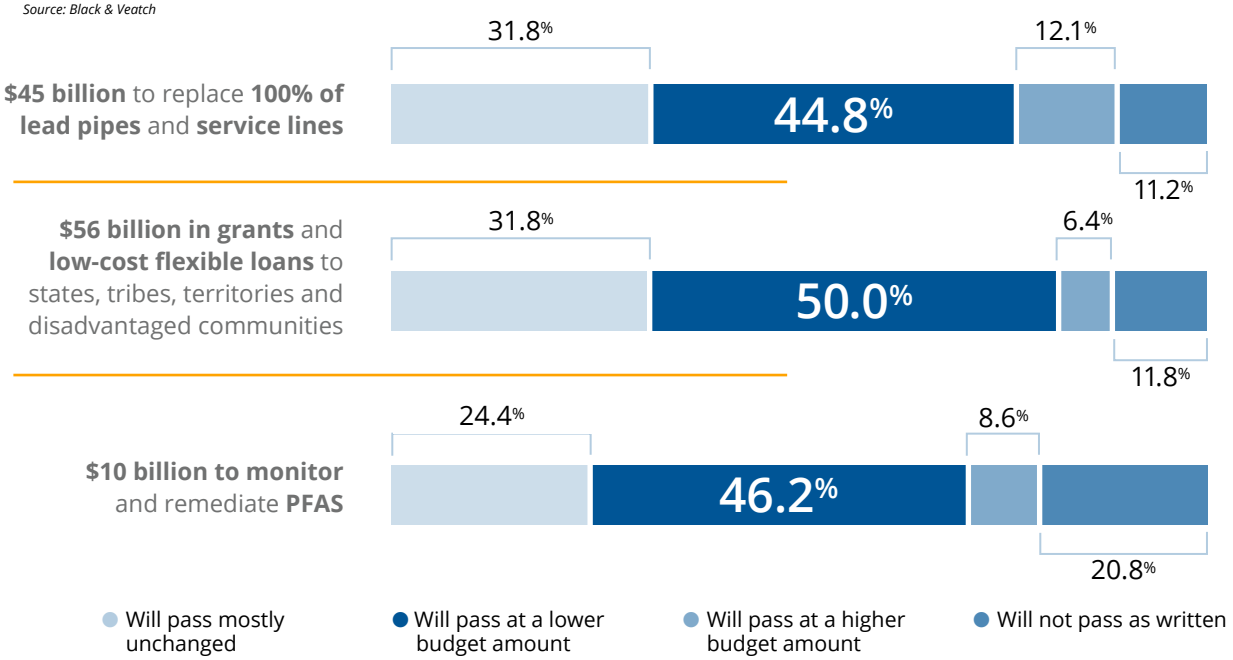
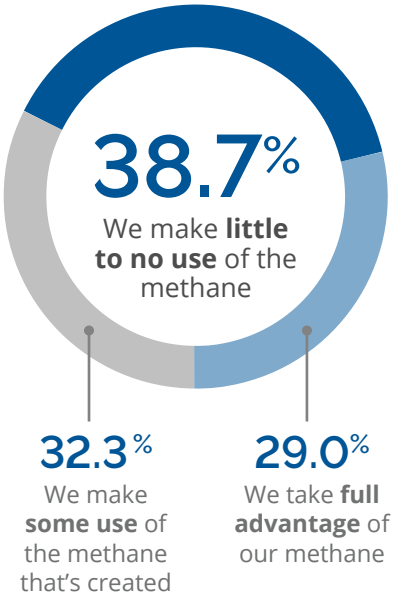


Figure 9

To what degree is your utility taking advantage of the biogas (e.g. methane) produced during treatment from an energy and revenue standpoint? *(Select one)*

Source: Black & Veatch



Nearly nine out of 10 respondents expect to see some money allocated to replace lead pipes and lines in the U.S., although 45 percent expect to see a lower number than the proposed $45 billion. Responses were similar when it came to the proposed $56 billion in grants and loans, with 88 percent expecting some amount of funding to be provided.

There was less confidence in funding to mitigate per- and polyfluoroalkyl substances (PFAS) in drinking water.

Looking to Biogas for Energy, Revenue

Methane in biogas is an energy source that can offset purchased energy or produce a revenue stream when sold with incentives. According to Black & Veatch's survey, some 61 percent of wastewater utilities are leveraging methane in some way *(Figure 9)*. The 32 percent only using some of their methane likely burn it to produce the heat required to support the anaerobic digestion process that generates the biogas. The 29 percent that makes full use includes those that have invested in RNG production or combined heat and power (CHP) systems, closing the loop on their energy cycle.

Overall, the water industry is investing in forward-thinking strategies around sustainability, with efforts that support decarbonization playing a heavy role. Although carbon-intensive industries may have a larger impact when it comes to lowering emissions, the water and wastewater industry continues to adopt technologies and trends that support sustainability, particularly when it comes to better managing existing assets and considering renewable energy opportunities.

ABOUT THE AUTHORS

Jay Kemp *is a project manager and senior process engineer with Black & Veatch's water business. Kemp is experienced in energy-saving wastewater technologies and biogas-to-energy service offerings, including biogas upgrades for vehicle fueling systems. He supports utility and industry clients by providing a range of energy solutions that help reduce operating costs, generate revenue and gain additional capacity of fixed assets.*

Jason Rowell *is an associate vice president and global decarbonization solutions manager with Black & Veatch's power business. With more than two decades of experience — including 13 years with Black & Veatch — Rowell directs the development and implementation of industry-leading sustainable decarbonization solutions across multiple industry sectors. He is a renowned expert in deploying and promoting the adoption of hydrogen technologies at scale and sits on the board of directors with the California Hydrogen Business Council.*

Sustainable Solutions, Data Use and Integrated Solutions Plugged into a Circular Economy Will Drive Tomorrow's Water Infrastructure

By Sandeep Sathyamoorthy

Technology is taking a firmer grip across the water and wastewater industry, pushing past data analytics to introduce new opportunities from improvements in treatment technology to advances in Internet of Things (IoT) integration. Early adopters are seeing returns while others are just starting to embrace digitization, with the Ohio Rural Water Association's turning to digital mapping to catalog its utility system and assets as a case in point.

Amid estimates that the world will invest tens of trillions of dollars in infrastructure in the next two decades, utilities are weighing their options around data and sustainability as they look to design tomorrow's water infrastructure.

Strategically Developing Sustainable Solutions

Sustainability continues to play a starring role as utilities prepare and plan for their future infrastructure. This is particularly true when it comes to efforts that support decarbonization — renewable energy, decarbonization goals and low-carbon building materials. When asked, in a survey of more than 200 U.S. water industry stakeholders for Black & Veatch's *2021 Strategic Directions: Water Report,* which components they plan to include in their sustainability strategies, respondents pointed to renewable energy, water loss mitigation and new/alternative water supplies as their top three focus areas *(Figure 10).*

With one-third of utilities planning to include new or alternative water supplies in their sustainability strategies, the survey also asked whether respondents plan to consider potable reuse. A combined 56 percent said potable reuse will likely increase in their region; 36 percent said probably not, and 8 percent said definitely

Figure 10

Does your organization have a strategy to become more sustainable? If so, what's included in that sustainability strategy?
(Select all that apply, by organization type)

Source: Black & Veatch

Organization Type	Utilities	*Non-Utilities
Renewable energy	56.5%	36.5%
Water loss mitigation	55.3%	25.0%
New/alternative water supplies	37.6%	23.1%
Decarbonization goals	20.0%	30.8%
Low carbon building materials	3.5%	13.5%
None of the above	11.8%	36.5%

*Non-utilities include consulting firms, educational institutions, OEMs, research or analytical laboratories, and other stakeholders

not. Potable reuse increasingly is a primary or secondary driver, particularly in arid regions of the U.S. where sustainable water supplies are at a premium, such as Arizona, California, Nevada and Texas.

Figure 11

How confident are you in the accuracy of your data captured from sensors?

Source: Black & Veatch

A Growing Embrace of Data

Water and wastewater utilities are becoming more comfortable utilizing data derived from online sensors, according to Black & Veatch's survey. A combined 89 percent of respondents reported they are "somewhat" or "very" confident in the accuracy of their data *(Figure 11).* Ninety-five percent said separately that their confidence is increasing.

In the *2020 Strategic Directions: Water Report*, most respondents indicated they were collecting a high volume of data but not leveraging value. This illustrates increased awareness that data — both digital and analog — can inform decision-making, from process management to large asset maintenance and rehabilitation.

The increasing adoption of sensors and real-time data in the water industry is linked to continued improvement of sensor technologies and reduction in sensor costs. Seeing this return on investment continues to reinforce their decision to collect, manage and analyze this critical information.

Organizations continue to build knowledge capital and skillsets around managing smart technologies, maximizing data utility through analytics and data-driven decision making. Utilities with teams that specialize in these areas will continue to improve operations and maintenance going forward, allowing them to increase trust and reliance on data. This validation will continue to build additional confidence, resulting in a growing willingness to invest in advanced IoT technology, a critical consideration as industry begins to address replacing its aging assets and embrace a fully connected, integrated system in the future.

Building Tomorrow's Infrastructure

With this data in hand, what does the future of water infrastructure look like in America? The Biden Administration has laid out significant funding in its proposed American Jobs Plan. As written, the legislation would allocate $111 billion to ensure clean, safe drinking water, including $56 billion to modernize drinking water, wastewater and stormwater systems.

Utility organizations are enthusiastic about the opportunity to develop and implement a broad range of integrated solutions targeting clean energy, resilient water supply and delivery and sustainable solutions to support achievement of U.N. sustainable development goals. Equally exciting is the potential to use

The water industry has to remain mindful of ensuring innovation equity, where utilities of all sizes have access to these advanced IoT technologies as they chart this exciting course forward.

this funding to enhance the workforce. This infrastructure bill is an opportunity to re-energize and revitalize the water industry similar to the boom in spending following the Clean Water Act.

Wastewater utilities, for example, historically have been stewards of the environment, and this remains an important guiding principle. Today, some utilities are exploring sustainable solutions to help achieve this goal. This requires a multi-faceted approach to reduce the number, environmental footprint and cost of inputs (e.g., air, energy, chemicals) and incorporates opportunities to upcycle system inputs into resources that can be used elsewhere (e.g., soil amendments, biomaterials, renewable energy). This paradigm shift undoubtedly will result in some exciting and novel innovations in the industry.

When planning tomorrow's infrastructure, strategists should focus on opportunities to integrate every component of the water life cycle into a broader circular economy system. Water and wastewater utilities could invest in renewable energy, either by purchasing it from a provider or generating their own electricity on-site. Some utilities have sizeable land parcels that could support the development of on-site renewable energy generation.

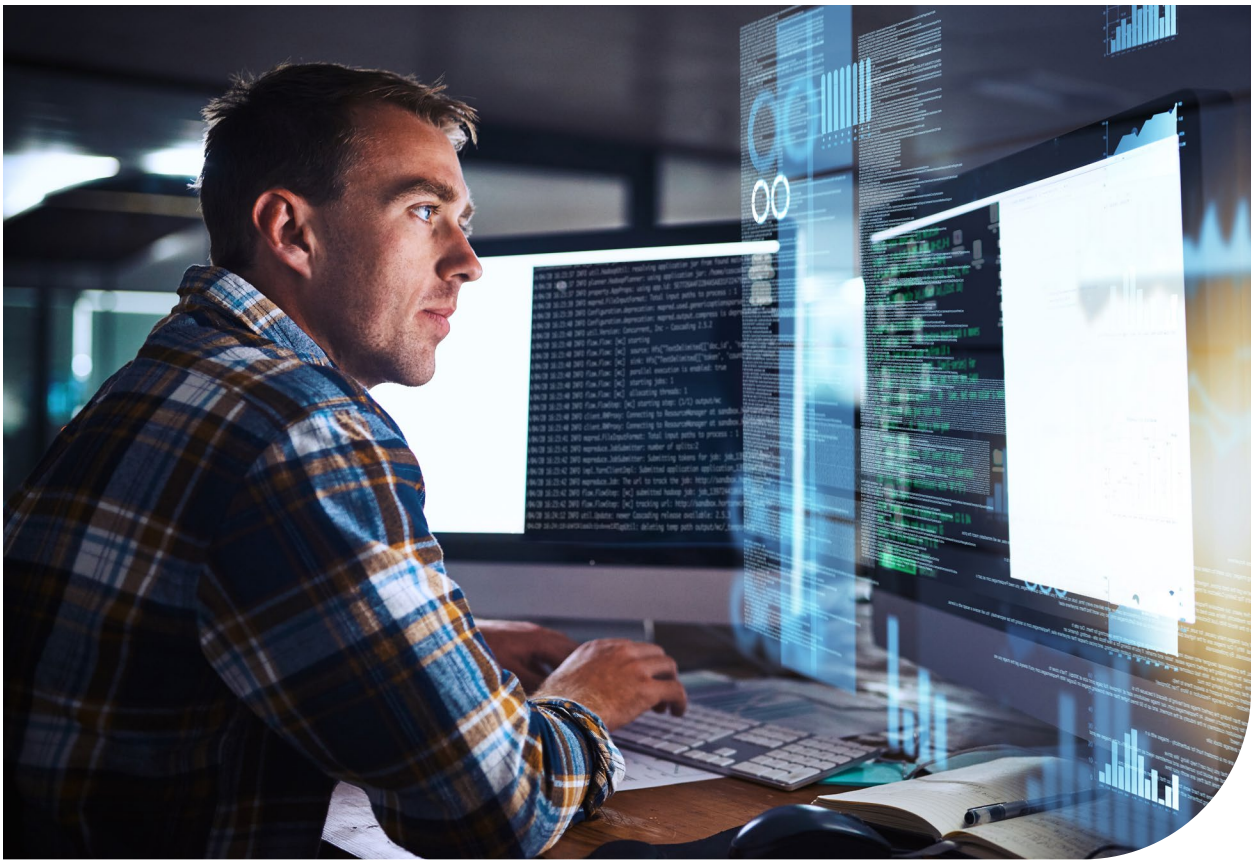
As the low-carbon fuel standard market continues to drive up the price of natural gas, many utilities are considering renewable natural gas (RNG). This gas could be used to produce materials that can be employed in higher-value industries. One example: the production of packing chips that go into Amazon boxes. A utility could co-locate a wastewater plant next to a factory that produces those chips and use the outputs from the plant to help produce those materials. The waste then would go to an adjacent recycling facility.

Data centers, as another example, require large amounts of high-quality water for cooling and could be co-located next to a wastewater plant, with the treated water used to cool the plant. The heated water then would be pushed back into the wastewater plant in a closed loop. Conceptually speaking, let's assume the plant is using 20 percent of the flow in the closed loop. Each time it cycles through, it raises the temperature of the wastewater by one or two degrees. This could benefit the biology, offering a better way to integrate the treatment facility into a true circular economy system.

The possibilities for reimagining tomorrow's water infrastructure are boundless if utilities continue to prioritize integrated solutions, sustainability and data management in planning and implementation. However, the water industry has to remain mindful of ensuring innovation equity, where utilities of all sizes have access to these advanced IoT technologies as they chart this exciting course forward. Doing so will help drive these integrated, smart, connected and sustainable engineered ecosystems.

ABOUT THE AUTHOR

Sandeep Sathyamoorthy *serves as global practice and technology leader for innovation and applied research with Black & Veatch's water business. An industry expert with a track record of successfully leading applied research in wastewater treatment and reuse, Sathyamoorthy is responsible for driving innovation and research across the areas of water and wastewater treatment, sustainability, energy efficiency, solids and organics management, and digital water, analytics and artificial intelligence.*



Weathering COVID-19: A Water Utility Success Story, With Lessons Learned

By Ann Bui, Zeynep Erdal and Gary Hunter

The challenges facing utilities that supply water and those that rid it of pollutants are well-known, well-documented and enduring. Aging infrastructure and an aging workforce remain chronic issues. Evolving regulations, tight budgets and the rising demand for greater resilience against climate change — and the increasingly extreme weather events it brings — have challenged utilities to adequately prioritize resilience and infrastructure renewal needs.

The continued impacts of COVID-19 on communities have made the challenges more pronounced. But what has emerged is a sector — long notorious for being slow to innovate or transform — that rose to the challenge and continued to deliver its essential services by being remarkably agile and adaptable.

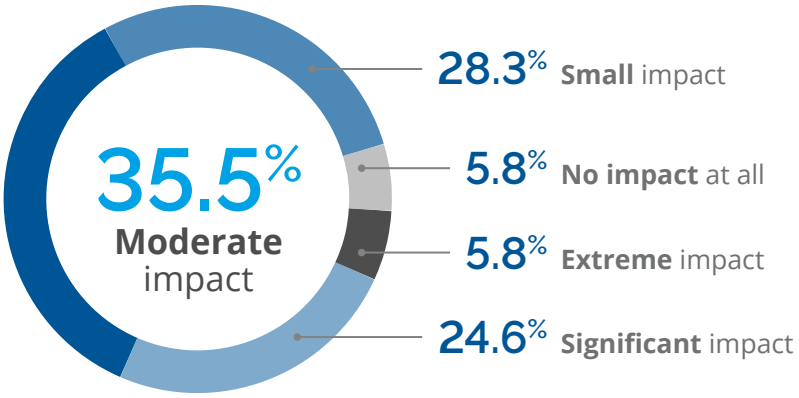
Amid the pandemic's sweep, water, wastewater and stormwater interests kept the water flowing and the pumps running despite considerable challenges, including staffing issues due to quarantines and lower revenues resulting from payment delinquencies by ratepayers suddenly jobless because of pandemic-related shutdowns.

One-quarter of respondents to a Black & Veatch surey of more than 200 U.S. water industry stakeholders said the pandemic significantly impacted their day-to-day operations, with more than one-third — 36 percent — saying it affected

Figure 12

What impact has COVID had in your day-to-day operations?
(Select one)

Source: Black & Veatch



Utilities adapted nimbly to the day-to-day impacts of the virus by implementing social distancing guidelines or factoring the loss of infected, quarantined workers into their scheduling plans.

them moderately. An additional 28 percent said it only had a small impact, indicating that utilities could adapt and continue to provide excellent service to their customer base. Utilities serving smaller populations (fewer than 500,000 people) perceived COVID-19 as having less of an impact operationally, with 22 percent labeling the effect extreme or significant, compared to 31 percent of utilities with customer bases above that threshold *(Figure 12)*.

Such results were promising — if not surprisingly low — in terms of disruption, perhaps reflecting that automation among utilities mitigated the leaner shifts forced by the pandemic. Or it might illustrate that utilities adapted nimbly to the day-to-day impacts of the virus by implementing social distancing guidelines or factoring the loss of infected, quarantined workers into their scheduling plans.

- By and large, the survey found that utilities managed to avoid large-scale, COVID-19-related staffing cuts. Eighteen percent of respondents said they trimmed their workforces in some capacity. The upside: such downsizing, however nominal and always as a last resort, could and should incentivize cross-training of employees — a proven way to ensure that workers efficiently gain resilience in the workforce. This effort also provides additional opportunities for staff resiliency due to changes in the utility's workforce.

Remote Working: The New Normal?

The merits of remote work in the water utility space during the pandemic proved to be an awakening for many utilities, given

that more than two-thirds of respondents (68 percent) cited the outbreak for fanning their use of technology to transition to remote work for continued service. An additional three in 10 credited the pandemic with feeding their consideration of technology for better customer engagement or more remote operations and automation *(Figure 13).*

To what extent remote working continues may depend on each utility's structure. However, those who continue offering the flexibility to do the job off-site may find worker recruitment and retention easier.

Figure 13

Would you say that your organization is giving more consideration to technology because of COVID? *(Select all that apply)*

Source: Black & Veatch

67.8%
Yes, remote work for professionals

31.5%
Yes, more consideration to customer engagement

29.4%
Yes, more remote operation/ automation

18.9%
Yes, more remote monitoring/ diagnostics

20.3% **No**

The Big Picture Post-COVID-19: A Holistic Evaluation of Cybersecurity

Even as water utilities deftly pivoted to remote working to weather the COVID-19 storm, taxing their information technology crews in the process, it also highlighted the imminent need to strengthen the cybersecurity of their digital systems and data networks.

As the pandemic lingers, utilities should seize the moment to think holistically and examine their robustness against cyber threats. When considering cybersecurity, it is important to account for the ever-increasing array of operating systems that remote workers use and the prospect that their technology tools may be vulnerable.

Fresh evidence that cyber threats are real surfaced in February when an older version of Windows and a vulnerable cybersecurity network allowed a hacker to access a Florida water treatment plant's computer system, ABC News reported, citing a memo by federal investigators.

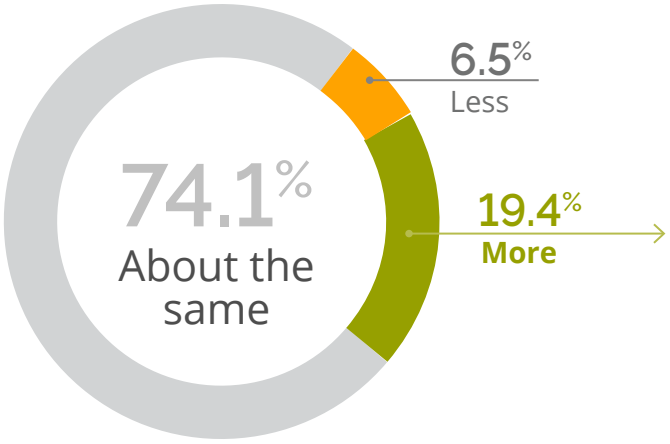
Authorities said the hacker used a remote access program shared by workers at the plant in Oldsmar, Florida, just northwest of Tampa, and tried to taint the water supply of the city with a caustic chemical. The hacker was thwarted by a plant manager who spotted the chemical being tampered with and immediately returned the system to normal before any major damage occurred.

Oldsmar officials disabled the remote-access system since the attack, according to reports from The Associated Press. However, officials warned other city leaders in the region about the incident and suggested they check their systems. Experts say municipal water and other systems can be easy prey for hackers because the computer infrastructure of local governments tends to be underfunded.

Figure 14

Would you say your organization is outsourcing more or less compared to previous years? *(Select one)*

Source: Black & Veatch



Which functions are you **outsourcing more?** *(Select all that apply)*

Engineering/technical staff	**63.0%**
Information technology (IT) staff	33.3%
Operations staff	22.2%
Finance/accounting staff	14.8%
Administrative staff	11.1%
Human resources (HR) staff	11.1%
Marketing/sales staff	11.1%
Other functions	14.8%

COVID-19 and the Utility Workforce

In an industry dealing with the chronic issue of an aging workforce, roughly three-quarters of respondents (74 percent) report they're holding the line on outsourcing work. Nineteen percent say they're outsourcing more, predominantly in their engineering and technical staffing ranks and, to a lesser degree, IT and operations functions. Such outsourcing could be in response to retirements in the sector that has grappled with an aging workforce or to the exodus of younger workers chasing other opportunities *(Figure 14).*

In the interest of cost savings, more outsourcing may gain momentum in an industry striving to jettison its reputation as slow-footed and become more known for being agile. The sector already leaped in that direction by staring down COVID-19's challenges.

Now comes the time to think about proactive steps for new or recurring crises. Taking stock of and folding in positives and lessons learned during the pandemic can be an opportunity to enhance operations blueprints for the next challenge.

ABOUT THE AUTHORS

Ann Bui *is a managing director and co-leads Black & Veatch Management Consulting Group's strategy advisory water market business. Besides providing clients with strategic financial management strategies, her responsibilities include driving growth and innovation to water utilities in the areas of financial and advisory planning, advanced metering, customer experience, asset integrity and enterprise risk management services. Bui has more than 30 years of experience with clients in North and South America, Europe, and Asia.*

Zeynep Erdal *leads integrated solutions for Black & Veatch, where she specializes in water infrastructure solutions that integrate resource recovery and resilience. She has 25 years of experience in water reclamation projects around the world and is a recognized expert in treatment technologies and innovation, focusing on the water-nutrient-energy nexus as well as integration of water system solutions.*

Gary Hunter *is a principal wastewater process specialist who focuses on disinfection and public health issues throughout the world. He has more than 36 years of experience focusing on providing innovative treatment solutions that protect the public and environment while being sustainable and resilient.*

Water as a Business: Data, Innovation and Planning Drives Value

By Chris deBarbadillo, Kent Lackey, Bo Poats, Jeffrey Stillman and James Strayer

A Virginia wastewater district serving hundreds of thousands of homes and businesses is thinking big and looking ahead. The Hampton Roads Sanitation District is striving to demonstrate what is doable and investing mightily to show it.

The district's billion-dollar "Sustainable Water Infrastructure for Tomorrow" program, or SWIFT, looks to eventually inject 120 million gallons a day of treated wastewater into a shrinking aquifer to replenish it, lessening the amount that's released into rivers. According to the *Daily Press of Norfolk, Virginia*, the district hopes to have five plants running by 2030.

The project more than underscores the notion that bold ideas can and do take root in a sector that has been slow to change. It reflects that it doesn't always have to be business as usual, as Black & Veatch's *2021 Strategic Directions: Water Report* bears out.

Based on expert analyses of a survey of more than 200 U.S. water industry stakeholders, the report shows that water utilities are fostering innovation in an evolving sector. And more than anything, they're increasingly leveraging data to drive better decision-making, optimize and prioritize system investments and drive cost efficiencies that propel sustainable, resilient systems and results.

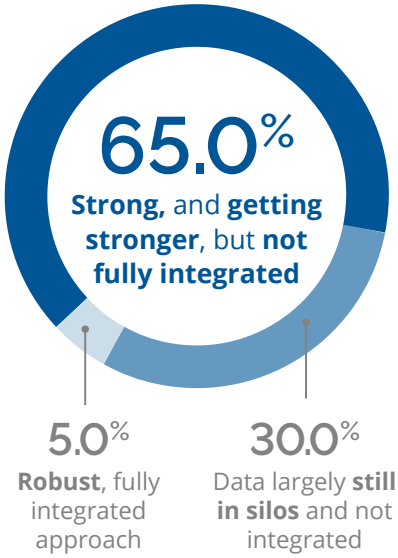
Data, Data Everywhere, But Where's the Intelligence?

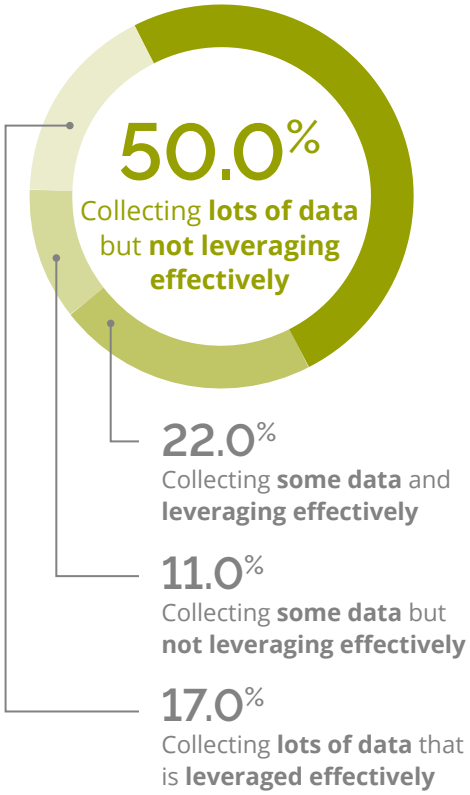
Rapid advances in business intelligence software and computing and data analytics are providing the opportunity to gather and integrate existing data with evolving next-generation, cost-effective sensors and smart devices. Such

Figure 15

Which of the following statements best describe the current data management practice at your organization? *(Select one for each set)*

Source: Black & Veatch





rich data sources can be overwhelming, but they also allow for predictive analytics to detect leaks, identify overflows, forecast usage, predict failures, inform investments, reduce lifecycle costs and much more.

But even though Black & Veatch's survey shows a growing appreciation for the value of data, it's typically not harnessed for maximum potential. Half of respondents said they're collecting large amounts of data but not leveraging it effectively, while slightly more than one-fifth (22 percent) say they're gathering just some data and putting to good use *(Figure 15)*.

Nearly two-thirds of respondents described their data management practice as strong and strengthening, yet not fully integrated. That's up 9 percentage points from 2020. At first blush, that appears to be an improvement, but it actually reflects a reduction of utilities reporting a robust, fully integrated approach (from 15 percent in 2020 to just 5 percent in 2021). This suggests that during the COVID-19 pandemic, utilities awakened to additional data utilization options and the fact that their use of data wasn't as robust as they previously believed. An additional 30 percent said their data is siloed and unintegrated, unchanged from the previous year.

The survey's findings appear to reflect that water utilities are discovering that their old way of doing business was fine when they had limited amounts of data coming in, but the tsunami of data being collected requires a more robust approach to capture its full potential.

The Need for Innovation

It's not easy fostering innovation in organizations that have, in many cases, operated for more than a century based on legacy systems, given organizational inertia and the mindset that "we've always done it that way." But the old business model — build essential infrastructure and charge the public for their share of the asset — no longer is viable.

Black & Veatch's survey found that water and wastewater leaders are trying to foster innovation in various ways, typically in relation to organizational culture. Six in 10 respondents say their organization is promoting innovation through open lines of internal communication and by empowering employees to make decisions. However, it's important to note that these are minimum conditions

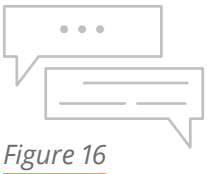


Figure 16

How does your organization promote and foster innovation?
(Select all that apply)

Source: Black & Veatch

59.3%
By having an open line of communication

58.6%
By **empowering employees** to make decisions

52.1%
By including **innovation in our strategic plan**

47.1%
Through **our culture**

44.3%
By being **open-minded**

32.9%
On a **case-by-case basis**

28.6%
By having a **department or cross-functional team** for innovation

15.7%
By trying to **prevent overwork** and **employee burnout**

for innovation, as opposed to voicing proactive encouragement. More than half said they're also doing so by folding innovation into their strategic plans *(Figure 16).*

Innovation is a process blending leadership and management much like implementing a safety program — you can neglect it, allow it or encourage it with culture and appropriate programs. The survey results suggest that companies in the water industry remain in an early stage of maturity when it comes to innovation. The development of innovation metrics will be helpful in signaling the management commitment to data analytics to drive innovation.

Innovation won't change the laws of physics or enable water to be teleported from one location to another. But a disciplined inquiry into other ways an organization could envision, fulfill or expand its mission often shines a light on managerial practices or processes that are limiting thinking or action.

As the Hampton Roads project shows, water and wastewater utilities looking to survive and thrive as their business environment evolves need to approach innovation as they would any other managerial task: taking tangible steps, breaking down silos and committing to leveraging data to its fullest potential. Pick a desired end state, create specific measurable goals and metrics to guide progress, set up processes to nurture innovation and measure progress, and ultimately require accountability.

ABOUT THE AUTHORS

Chris deBarbadillo *is plant optimization practice leader and a client director in Black & Veatch's water business. She has 33 years of experience in wastewater process engineering, design, operations and research, including nine years of utility experience.*

Kent Lackey *is the East Region managing director for Black & Veatch's water business. He has 26 years of experience supporting all facets of the water industry, from utility and infrastructure planning to design and construction of water, wastewater and reclaimed water systems facilities and infrastructure.*

Bo Poats *is an asset lifecycle risk management practice leader in the infrastructure modernization offering group of Black & Veatch's Management Consulting. He brings 40 years of enterprise in risk management, strategic planning and implementation to multiple public and investor-owned utilities.*

Jeffrey Stillman *is Black & Veatch's asset management practice leader for North America. He has 25 years of experience in system planning, program development, modeling, information system integration and business intelligence.*

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

The Politics of Water

By Ann Bui, Pamela Lemoine, Francesca McCann, Jim Schlaman and Anna White

With the water and wastewater industry chronically underfunded, questions around the value of water constantly are in play. The economic impacts of COVID-19 exacerbated this situation. However, the industry is optimistic that it could see game-changing improvements to water infrastructure with the new presidential administration proposing a robust infrastructure funding package.

COVID-19 Impacts on Budgets

At the start of the COVID-19 pandemic, utilities were concerned that their budgets would be seriously damaged by the financial havoc that was sure to come from the outbreak shutting down the world's economy. But data from Black & Veatch's *2021 Strategic Directions: Water Report* survey of more than 200 stakeholders in the U.S. water industry shows that while some budgets were impacted, the damage was not nearly as significant as originally feared.

A few factors helped soften the blow. As businesses shuttered, there were shortfalls on the commercial and non-residential side, but as schools closed and working professionals shifted their work into their homes, residential usage increased, helping mitigate the drop in commercial revenue. The influx of cash from three rounds of federal stimulus money also helped reduce the impact of increasing delinquencies.

The pandemic also caused city leaders around the nation to hesitate when it came to enacting revenue increases, either foregoing them entirely or drastically reducing them, forcing utilities to reduce budgets.

It would be foolish, however, to minimize the economic damage caused by the pandemic. The tourism, leisure, hospitality and restaurant industries were sent reeling by the global lockdown. According to the Brookings Institute, cities and regions reliant on tourism and hospitality — e.g., Kahului, Hawaii; Atlantic City and Ocean City, New Jersey; Las Vegas, Nevada; Orlando, Florida; Myrtle Beach, South Carolina; and the Gulf Coasts of Mississippi and Alabama, places that employ one-third of their workforce in these industries — continue to face economic hardship.

As a result, a combined 20 percent of survey respondents reported reducing their capital program budgets, while 31 percent adjusted their operations and maintenance (O&M) budgets *(Figure 17).* The impacts were significant for those utilities who did experience economic fallout.

The pandemic also caused city leaders around the nation to hesitate when it came to enacting revenue increases, either foregoing them entirely or drastically reducing them, forcing utilities to reduce budgets. This hesitancy will continue as leaders make decisions about upcoming budgets, giving the pandemic's impacts a "long tail" that is uncertain at this time. Delaying necessary rate adjustments generally will result in more O&M and capital costs as aging assets continue to deteriorate, so the short-term relief from no rate increases may give way to potentially much larger future adjustments.

Investigating Funding Options

Utilities have several options when it comes to capital project funding. Survey data shows that utilities prioritize state revolving funds (SRFs), federal grant programs, Water Infrastructure Finance and Innovation Act (WIFIA) funding, Federal Emergency Management Agency (FEMA) programs, and public-private partnerships (PPPs) as they consider various funding sources.

Nearly two-thirds of respondents (62 percent) consider SRFs as an alternative funding source. Run by the U.S. Environmental Protection Agency (EPA) and administered at the state level, the Clean Water and Drinking Water SRF programs are a federal-state partnership. The

Figure 17

Has COVID-19 led to a shortage in your budgets? *(Select one for each row)*

Source: Black & Veatch

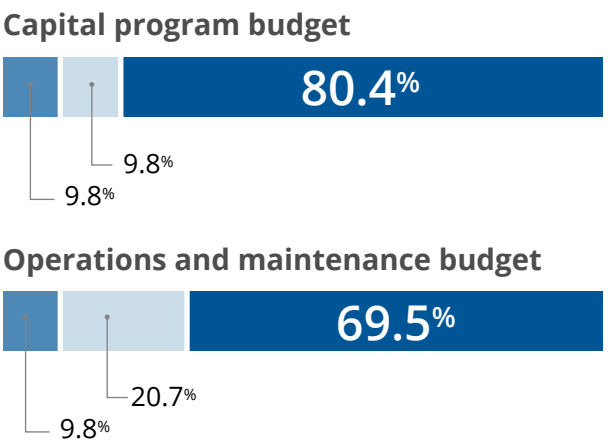


Figure 18

Which of the following sources has your utility looked into for capital project funding? *(Select all that apply)*

Source: Black & Veatch

62.4%
State revolving funds (SRF)

56.5%
Other federal grant programs

31.8%
Water Infrastructure Finance and Innovation Act (WIFIA)

27.1%
FEMA programs

25.9%
Public-private partnerships (PPPs)

17.6%
Community development block grants

10.6%
Building Resilient Infrastructure and **Communities** (BRIC)

9.4%
Community-based partnerships

programs and partnership provide communities with flexible, low-cost financing to address their highest priority water quality infrastructure projects.

In addition, nearly one-third of utilities are considering WIFIA, the federal credit program administered by the EPA to accelerate investment in water and wastewater infrastructure by providing long-term, low-cost supplemental loans *(Figure 18).*

PPPs ranked relatively high, at 26 percent. Building Resilient Infrastructure and Communities (BRIC), a FEMA disaster mitigation program rather than a disaster response, ranked seventh at 11 percent. The community-based partnership (CBP), a relatively new delivery model, showed 9 percent consideration, and utilities appear increasingly interested in CBPs.

But not every utility takes advantage of these programs. When asked why not, 43 percent of respondents said they were "administratively too burdensome," while 23 percent said the programs "are too restrictive." This has been a common refrain since the inception of these programs, though most states have made concerted efforts to decrease the administrative burden and make programs easily accessible.

The question now: Are utilities banking on the pending American Jobs Plan legislation, the large-scale infrastructure funding package proposed by the Biden Administration?

Infrastructure Funding Isn't a Cure-All

As originally written, the proposed infrastructure funding package of the American Jobs Plan could allocate $111 billion in funding to improve the water and wastewater industry, including $10 billion to monitor and remediate PFAS; $45 billion to replace lead pipes and service lines; and $56 billion to modernize drinking water, wastewater and stormwater systems (a drop in the bucket compared to the $1.3 trillion that is estimated to be needed).

In late July, a bipartisan group of U.S. senators reached a deal meant to address sticking points that had stalled the infrastructure package, calling for more than $550 billion in new federal investments in infrastructure over five years. The release of the bill's full text was pending.

The Biden Administration's proposed package is robust, but the chances that it will pass as drafted are slim. Although the additional funding would be significant for the industry, it should not be at the expense of using existing funding options. Utilities still should apply for the many existing low-interest

loan and grant programs and explore P3s and community-based partnerships. The possibility of this extra funding would be meaningful in helping move infrastructure renewal forward, but it does not remove the duty from utilities to have their own solvent revenue streams in place.

While the funding could allow utilities to accelerate certain critical initiatives — such as addressing unforeseen issues that include PFAS and lead service line replacement — it is not a panacea. Let this be a call to action that investing in water, wastewater and stormwater infrastructure must remain a high priority even if this additional federal funding comes to fruition. The industry still is woefully underfunded, and utilities must continue to manage spending, look at capital prioritization and advocate for financial support while pursuing traditional and alternative funding sources.

And if this once-in-a-lifetime funding package allocates money for critical priorities, it will not solve all the industry's problems. The uphill battle for infrastructure investment will remain, and utility customers still will have to contribute to the cost of reliable water infrastructure. It's up to the industry to not use this potential new funding as a crutch, but rather to leverage it to the fullest to maximize long-term investments in water, wastewater and stormwater.

The industry still is woefully underfunded, and utilities must continue to manage spending, look at capital prioritization and advocate for financial support while pursuing traditional and alternative funding sources.

ABOUT THE AUTHORS

Ann Bui *is a managing director with Black & Veatch Management Consulting, where she leads the water market business. Besides providing clients with strategic financial management strategies, her responsibilities include driving growth and innovation to water utilities in the areas of financial and advisory planning, advanced metering, customer experience, asset integrity and enterprise risk management. Bui has more than 30 years of global experience with clients in North and South America, Europe and Asia.*

Pamela Lemoine *is a principal consultant with Black & Veatch Management Consulting. She has more than 30 years of experience providing water, wastewater and stormwater utilities with strategic financial planning, cost of service and rate design studies, affordability analyses, cost/benefit analyses and a broad range of strategic financial and management consulting services. She is a member of the American Water Works Association and the Water Environment Federation and regularly participates in National Association of Clean Water Agencies conferences and committees. She also serves on the EPA's Environmental Financial Advisory Board.*

Francesca McCann *is a business development director with the InfraManagement Group at Black & Veatch. McCann leads the company's alternative funding and financing practice. A leader in the U.S. water industry with expertise in investments, public-private partnerships and project development, McCann served as CEO for Abengoa Water USA, where she successfully led the $3.4-billion Vista Ridge Project in San Antonio, Texas. She also founded a consulting company, Global Water Strategies, and started her water career in 2003, covering the water sector for Wall Street.*

Jim Schlaman *is the director of planning and water resources for Black & Veatch's water business and serves on the One Water Council for the U.S. Water Alliance. Over the past 19 years, he has worked across the country on all types of planning and water resources projects, including water supply and reuse/alternative water supply evaluations, integrated planning and water quality studies and stormwater/flood control planning and design projects.*

Anna White *is a principal consultant with Black & Veatch Management Consulting, where she leads stormwater user fee development and implementation and stormwater rate study projects. White specializes in projects involving cost of service and rate determination, revenue bond determination and financial reviews of operations for water, wastewater and stormwater utilities in the public sector. Her economics background and experience with computer modeling and software applications have been utilized in developing financial analyses of municipal water and wastewater utilities.*

Attention to Data-Driven Digital Twins Rising, Though Jury Still Out on Return on Investment

By Jeff Buxton, Brian Melton, Chris Murphy and Doug Preece

Aging infrastructure has remained water utilities' biggest pain point throughout the nine years of Black & Veatch's annual *Strategic Directions: Water Report.* Relief is now available in the form of advanced simulation technologies, such as digital twins, that give utilities greater situational awareness of asset performance as it happens, allowing them to do more with less and operate more efficiently.

Digital twins provide a real-time digital counterpart of a physical object or process, using historical and current data to help predict and maximize performance. They work by integrating system performance data, connecting source systems and aggregating asset information to provide a digital simulation of operating assets and systems.

The technology can be built on design criteria, calibrated based on historical data, refreshed with current real-time sensor-driven data and used to test and predict future performance.

Black & Veatch created one of the world's first water utility digital twins for Anglian Water in the United Kingdom. The company was tasked with "creating a digital representation of the [Newmarket] region's water treatment and distribution infrastructure and embedding Hybrid Adaptive Real-time Virtual Intelligence (HARVI), an artificial intelligence (AI) provided by its strategic partner EMAGIN, into the digital twin. This enables predictive capabilities and intuitive decision support and intervention," according to WaterWorld.

A differentiator from a traditional model is that the twin can have constant dialogue with its physical counterpart by combining information technology and operations technology.

Anglian Water is hoping to use the digital twin technology to help it achieve its seven goals for the region:

- Zero leakage and bursts
- 100-percent customer satisfaction
- Water consumption of 80 liters per person per day
- Zero pollution and flooding
- 100-percent compliant and chemical-free drinking water
- Carbon neutrality
- Building a circular economy that eliminates the concept of waste from the processes.

The Digital Twin Difference

A differentiator from a traditional model is that the twin can have constant dialogue with its physical counterpart by combining information technology and operations technology. This enables users to simulate scenario options before applying them in the real world. The technology supports this by constantly comparing what is expected from the model to what is being experienced in actual operations.

The work is done by combining multiple internal and external data sources across the asset base and comparing this with the digital twin model using machine learning and predictive analytical techniques. This provides improved insights that support better decisions, leading to better outcomes in the physical world.

For example, a digital twin can:

- Support quality and supply teams by integrating weather and raw water quality data with asset availability from supervisory control and data acquisition (SCADA) systems across the network. This creates a predictive view of operating scenarios and performance deterioration as well as root cause identification, allowing users to intervene before an event occurs.
- Take near-real-time condition performance data from critical assets to predictively determine maintenance activities.
- Help with maintenance activities, supporting better pre-planning of the work and overlaying work orders within spatial models, leading to accurate identification of asset location. Providing, in addition, a more connected experience for accessing documentation needed to perform the work.

Figure 19

Where do you see the most value for simulation modeling? *(Select all that apply)*

Source: Black & Veatch

62.8% Asset management: moving from schedule-based maintenance to preventative and predictive

52.6% Distribution system efficiencies: adjust operations based on simulated versus actual performance

52.6% Training environment for new operators and other staff

46.2% Simulations for plant expansion or site upgrades

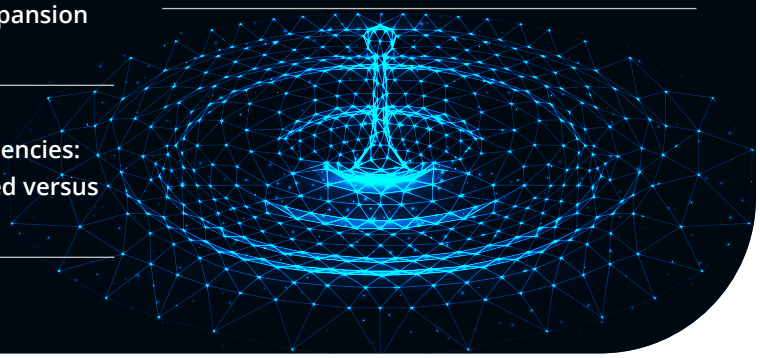
39.7% Production system efficiencies: adjust operations based on simulated versus actual performance

35.9% Testing of new processes or solutions in a digital setting

21.8% Community outreach opportunities

11.5% Improving customer engagement: modeling behind the meter to create precise customer profiles

10.3% Ability to offer new services to customers



Putting Data to Work

According to the *2021 Strategic Directions: Water Report* survey of more than 200 U.S. water industry stakeholders, water utilities see value in simulation modeling, particularly when it comes to improving asset management, distribution system efficiencies, training environments, simulated plant expansions and upgrades and production system efficiencies *(Figure 19).*

From this data, it could be construed that utilities see digital twins as making a meaningful difference in the operation and asset management of aging infrastructure. The return on investment offered by the data-driven, decision-making digital twins may be more valuable than utilities' current digital strategies, helping justify the investment.

Utilities have a growing sense of urgency and motivation to put to work the data they gather. This requires a strategy that spans the breadth of data collection to data-driven decision-making. Digital twins can make a valuable contribution to that strategy, but they are of greatest value to utilities with a mature, integrated data program.

These models will only be as good as the data upon which they are based; without solid historical data to build the model and real-time performance data to re-calibrate it continuously, the technology risks becoming a stranded asset.

A crawl-walk-run approach can yield compounding value to a maturing organization, with the digital twin in the run phase. This

builds upon foundational steps such as defining the data that best supports the simulation model, ensuring that the data properly reflects the operational system's performance, and instituting the tools to leverage the model for asset and operational system analysis.

Bridging the Knowledge Gap

A digital twin relies on data. Without the insights of the people who are intimate with how assets have been designed, built and behave — and what the assets need to do and not do — the data is far less useful, and the digital twin will deliver less value. For this reason, expertise from a wide variety of disciplines across the utility sector provides essential insights during a digital twin's development.

This makes the digital twin an accessible repository of the institutional knowledge of people who know the water and wastewater assets emulated by the digital twin. The return on investment this represents is difficult to quantify. However, the benefits could be significant at a time when knowledge management is a source of concern, and an aging workforce means a great deal of real-world expertise is being lost.

The digital twin also can serve as a training resource. It is a repository of institutional knowledge, and, as a virtual resource, the digital twin is a lower-risk option than training on live assets. It's also worth noting that software vendors are beginning to enable commercial solutions more focused on digital twins' aspects, which will lead to larger adoption of specific capabilities.

The Anglian Water case study stands as a landmark project at the forefront of digital twins, helping to drive adoption of these advanced simulation technologies. There is no doubt that digital twins offer new progress towards the digital transformation of water services.

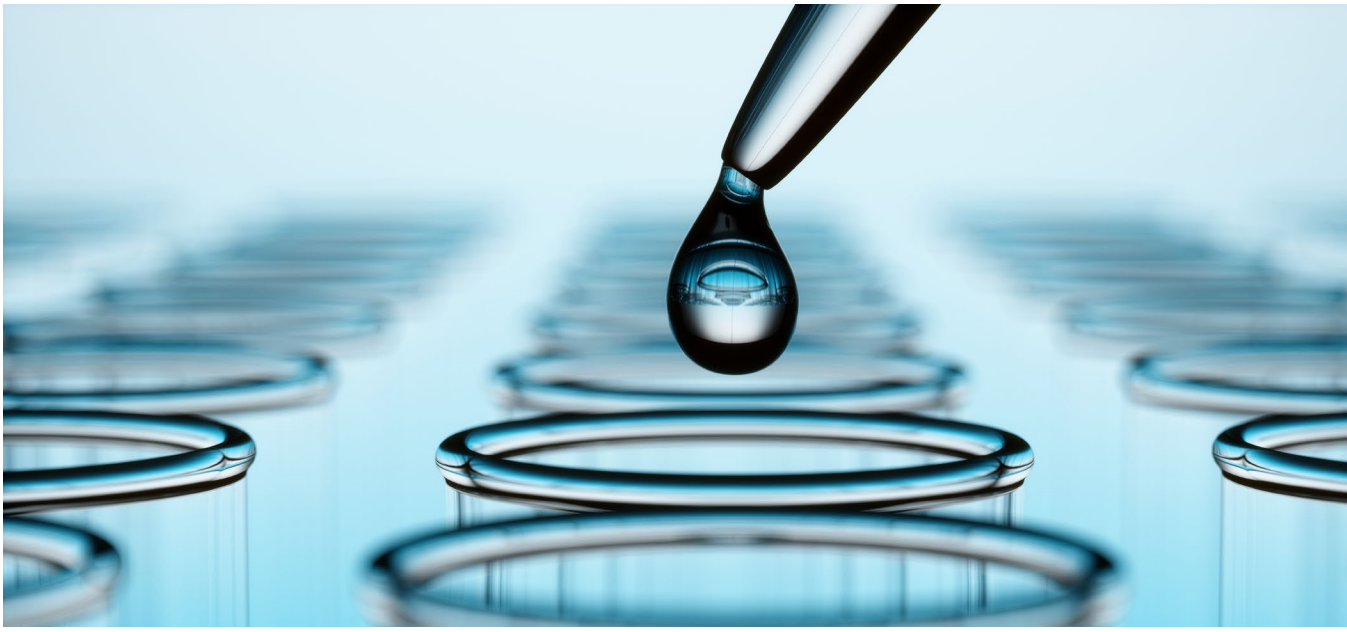
ABOUT THE AUTHORS

Brian Melton *is a chief technologist at Black & Veatch, where he helps embrace digital transformation and recognize its impact on project delivery for the company's water business. During his 21 years at Black & Veatch, Melton has had the opportunity to be a part of some of the largest infrastructure projects around the globe, including mining, hydropower, and water and wastewater treatment, conveyance and storage. He has an extensive background in building information modelling with respect to infrastructure projects.*

Doug Preece *is a managing director in the Black & Veatch Management Consulting Group. He has more than 35 years of utility experience working with utilities and energy producers to develop strategic plans and solutions to improve operational efficiencies and reduce risks. Preece's knowledge and experience spanning field operations, engineering, business, information technology and consulting enables him to assist clients with their most challenging, multi-faceted issues.*

Jeff Buxton *is managing director in the Black & Veatch Management Consulting Group. He has more than 40 years of experience within the energy, utility, information technology (IT), technology and industrial sectors, including North American and international management expertise delivering business-to-business solutions. His experience encompasses strategic business planning, technology roadmap planning, IT infrastructure management, contract development, project financing, program management, communications, change and operations management.*

Christopher Murphy *is the global chief technology officer for Black & Veatch. Over the past 38 years, he has worked in a myriad of industries, taking on roles in software engineering, customer support, sales engineering and software partner engineering. His experiences include IT strategy, technology alignment and rationalization, product and solution ideation, development and road-mapping, business capability consulting and both security and privacy advocacy.*



Unsettled Regulatory Landscape Deters Decontamination Upgrades

By Prabha Kumar, Dustin Mobley and Mark Steichen

When it comes to reducing contaminants such as per- and polyfluoroalkyl substances (PFAS) — so-called "forever chemicals" that don't easily biodegrade — many water utilities eventually will need to upgrade their systems to meet new maximum contaminant levels (MCLs). The extent of upgrades and associated capital investment for which utilities will have to plan will depend on the stringency of new regulations, the existing levels of PFAS in their water source and types of water treatment technologies in place at their treatment facilities.

The pending PFAS regulations on the horizon aren't spurring immediate action because water providers don't yet know when those MCL limits will take effect or what the required reductions will be. For now, water utilities are left waiting on greater clarity and certainty of future PFAS regulations.

That's the takeaway from responses to the survey of more than 200 water industry stakeholders for Black & Veatch's *2021 Strategic Directions: Water Report*. Significant majorities of survey respondents from water utilities big and small said the trigger for their organization to begin designing and implementing technology to limit PFAS, 1,4-dioxane and NDMA contaminants would be "regulatory action by MCL" *(Figure 20)*.

Figure 20

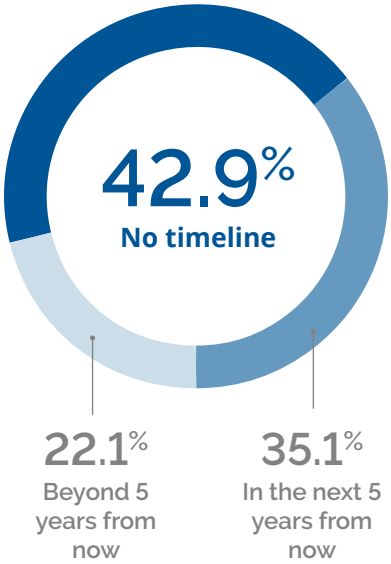
What will be the trigger for you to begin design and implementation to limit PFAS/1,4-dioxane/NDMA contaminant in drinking water, biosolids and municipal effluent? *(Select one, by population served)*

	Less than 500,000	500,000 or more
Regulatory action by MCL	**82.1%**	**61.5%**
Health advisory level	10.2%	30.8%
Public perception	7.7%	7.7%

Figure 21

When do you foresee that you may need to provide a PFAS management/treatment solution? *(Select one)*

Source: Black & Veatch



Some utilities expect proactive initiatives will be necessary soon. While 43 percent of respondents envision no timeline for regulatory activity, more than one-third expect that they'll need to provide a PFAS management or treatment solution within the next five years *(Figure 21).*

Current Regulatory Landscape

As of mid-2021, 12 states already have existing or pending PFAS MCLs for water providers to meet. Each state has established its own regulatory MCL threshold and rulemaking process. This means there are differing regulatory limits state to state and different timelines for compliance.

In addition, several states have health advisories or other guidance related to these substances. Such advisories are not enforceable but can impact public perception — one of the factors utilities balance when it comes to treating for contaminants of this type. Meanwhile, the U.S. Environmental Protection Agency (EPA) has a non-enforceable health advisory on two of the approximately 7,000 PFAS compounds. The EPA limit is seven times higher than what some states have established as their drinking water MCL. When the EPA comes up with MCL levels, all states will need to comply.

However, the EPA in March 2020 made a positive determination to begin developing an MCL for several PFAS. The regulatory process is lengthy, and it likely will be several years before proposed MCLs are issued, giving water utilities some time to develop plans to comply before the new rules are enforced.

Bolstering the EPA's seriousness about addressing PFAS, the agency's new administrator, Michael Regan, issued a memorandum in April 2021 calling for the creation of a new EPA Council on PFAS to develop strategies that optimize the use of the agency's authorities, expertise and partnerships to address PFAS. The council seeks to enhance ongoing efforts that include collection of new data on 29 PFAS compounds, soliciting data on the presence and treatment of PFAS in wastewater discharges and developing new drinking water standards for other PFAS.

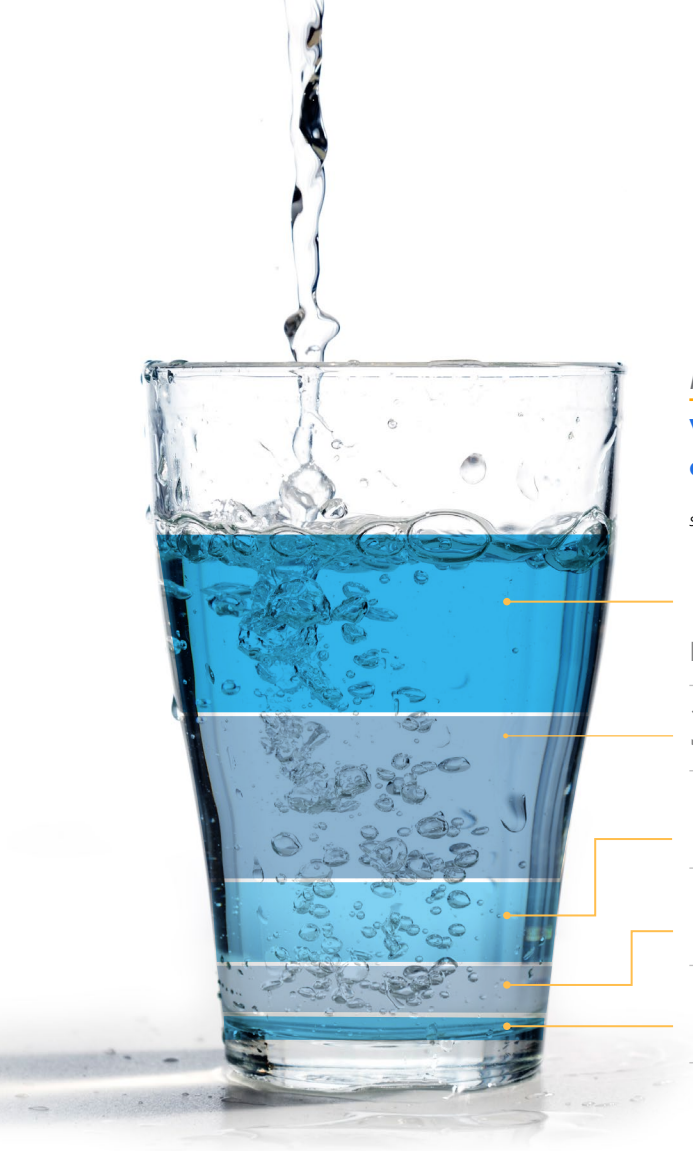


Figure 22

What is the largest barrier to lowering PFAS concentration in drinking water? *(Select one)*

Source: Black & Veatch

36.1% **Lack of regulation** to prevent PFAS in the supply

32.8% **Capital cost**

16.4% Efficacy of the **treatment** process/ management

9.8% **Footprint** to implement the treatment technology

4.9% Operating cost

If the EPA doesn't act quickly, Congress may compel action. Introduced in May 2021, H.R. 3291 requires an amendment to the Safe Drinking Water Act, aiming to provide assistance to areas and water systems affected by PFAS or lead. The resolution also seeks to mandate the EPA to implement primary drinking water regulations for PFAS, 1,4-dioxane and other toxins.

Technologies as Diverse as Utilities

Thirty-six percent of survey respondents said a lack of regulation is their foremost barrier to lowering PFAS concentration in drinking water. Such a response may be unsurprising, given that a water system can't make plans to comply with MCL levels that haven't yet been established. Regarding additional barriers, one-third of respondents cited capital costs, while 16 percent said efficacy of the treatment process was the greatest impediment. The upshot: water providers already are thinking about potential regulation *(Figure 22).*

Without question, the technology to remove something that is an exceedingly small fraction of water's makeup is a costly proposition. Depending on the MCLs that regulators identify, the technologies available for water providers to comply may have significant capital and operating expenses.

Water treatment systems vary significantly across the tens of thousands of water utilities in the U.S. All these systems meet the basic regulatory requirements for high-quality drinking water, but most technologies applied in traditional water treatment are not effective at PFAS removal. Thus, the cost incurred by utilities for PFAS removal will depend on the technologies now in use.

These technologies include granular activated carbon (GAC) absorption, ion exchange (IX) and reverse osmosis (RO). These technologies and processes are not in place at many utilities and will require a plan for implementation.

RO would require two or three times the space of those filters. Put simply, these technologies could double or triple the necessary footprint of existing facilities. Additionally, the technology selected could mean the need for more water, media regeneration and replacement, and brine removal.

Lack of regulation is the largest barrier to lowering PFAS concentration in drinking water.

Against the backdrop of the regulatory uncertainty is this fact: Three-quarters of respondents picked aging infrastructure as the top challenge facing their industry, down from 79 percent last year.

While utility managers don't yet know what MCLs they will need to meet with PFAS-reduction investments, they do know they need to prioritize their infrastructure repair, upgrade or replacement decisions.

The regulatory landscape may be filled with uncertainty today, but it's poised to have a big impact on how utilities provide safe water in the future.

ABOUT THE AUTHORS

Dustin Mobley *is the drinking water PFAS leader at Black & Veatch. He has 14 years of water process experience in the evaluation and design of water treatment processes for municipal and industrial water treatment clients. He specializes in piloting and full-scale design of GAC and ion exchange technologies for the removal of PFAS removal from drinking water.*

Mark Steichen *is the director of wastewater treatment technologies and the facilities business line at Black & Veatch. He has 31 years of experience in municipal wastewater treatment plant design and specializes in biological nutrient removal. Steichen leads a highly specialized group of wastewater treatment process engineers that deliver tailored treatment solutions for clients throughout the U.S. and globally.*

Prabha Kumar *is a managing director in Black & Veatch Management Consulting. She has more than 22 years of experience providing financial planning and cost of services studies, business transformation and utility development and implementation consulting services to water, wastewater and stormwater utilities. Kumar also is a national practice leader at Black & Veatch for stormwater utility, as well as for funding development and implementation services.*

Despite Barriers During a Pandemic, Growth in Reuse Drives Participation in the Circular Economy

By Zeynep Erdal, Jo Ann Jackson, Andrew Shaw, Ann Bui and Robert Chambers

Figure 23

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

Source: Black & Veatch

38.1%
Seeking **new groundwater** sources

28.6%
Adding reuse capabilities

15.9%
Seeking **new surface water sources**

11.1%
Seeking **new desalination/ brackish sources**

30.2%
We are **not taking any such steps**

Utilities have a nuanced relationship with water reuse. It represents an effective way to manage the demand and supply balance and offers potential revenue streams. Yet, these factors appear to be outweighed by the fact that utilities must prioritize needs, which can shift depending on external factors. To bolster resilience, the benefits of other water sources may be preferred in transitional periods when these needs shift.

However, there are regional exceptions. The need for a robust water supply outweighs other issues and priorities, predominantly in the water-scarce Southwest.

When asked about steps to bolster water supply resiliency, respondents to a survey of more than 200 U.S. water industry stakeholders for Black & Veatch's *2021 Strategic Directions: Water Report* revealed that they viewed seeking new groundwater sources as a more attractive option than reuse in regions where such resources are available. Respondents also indicated interest in seeking new surface water sources to bolster resiliency. The appetite for pursuing new resources to bolster existing programs rather than reusing existing ones is clear *(Figure 23)*.

In 2020, 20 percent of respondents were not taking steps to improve resilience, and this increased to 30 percent of respondents for 2021. Just as much as water supply resilience has not been the highest priority for many utilities the past two years, reuse programs also have not been a focus. This is a trend or development to watch in the coming years to assess whether this was a COVID-19 pandemic-driven outcome.

For utilities with reuse programs, the predominant driver by a significant margin is to reduce water scarcity; this is true throughout most of the Northeast, Midwest, South and West regions.

A greater understanding of water's value may help increase willingness to implement and accept rate increases to fund water reuse programs, but such benefits may not be the most impactful.

Primary markets for reused water typically are commerce, agriculture and industrial. Black & Veatch's survey found that although insufficient revenues were cited as a significant barrier to more reuse, a lack of public acceptance and reuse program's costs were the chief barriers. So, reuse is insufficiently priced, lacks public acceptance in specific geographies and can be costlier than other alternatives due to its limited customer base.

Despite that, the tide may be about to turn in favor of reuse as it still is recognized as a meaningful contributor to utilities' demand/supply balance management strategies.

Potable Reuse Levels to Grow

Reuse's lack of public acceptance typically can be attributed to potable reuse. Despite this, in regions except the Midwest, utilities anticipate a rise in potable reuse. In the West, an overwhelming 88 percent of respondents expect an increase in potable reuse due to years of public education campaigns and trusted regulatory frameworks. Another resason may be the success of drought-driven water conservation measures.

As increasing populations and industrial activity add to pressure on water supplies, an emphasis on new water sources, rather than conservation, may be necessary to supplement the supply.

Successfully delivering the predicted increases in potable reuse requires ongoing education programs to build public confidence and acceptance. This already has been achieved in some areas, and the best practices developed in the most arid communities will need to be implemented beyond these regions. Such programs will need to foster an understanding of the value of water as part of the strategy to underpin the acceptance of potable reuse.

The Impact of Federal Funds

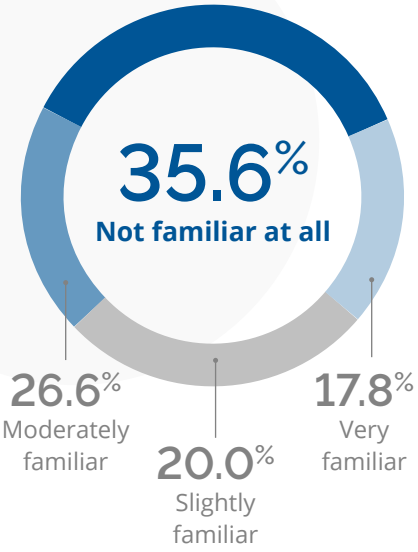
A greater understanding of water's value may help increase willingness to implement and accept rate increases to fund water reuse programs, but such benefits may not be the most impactful. Of greater significance in addressing the cost barrier to reuse programs may be the Water Infrastructure Act of 2020 and the Drinking Water Infrastructure Act of 2020. The bills propose multi-billion dollar planned authorizations for infrastructure projects. Under the bills, the U.S. government hopes to reauthorize a water reuse program called the Alternative Water Source Grants Program. This program would be available nationwide to help communities invest in and implement water recycling projects.

In June 2021, the House Transportation and Infrastructure Committee also passed the Water Quality Protection and Job Creation Act of 2021 (H.R. 1915), which will take the first step

Figure 24

How familiar are you with the term "circular economy"? *(Select one)*

Source: Black & Veatch



in authorizing major investments in water recycling programs and resources while helping communities across the country adopt water reuse as a resource management tool. The package includes two key priorities for WateReuse Association members: language authorizing Congress to appropriate up to $1 billion for the Alternative Water Source Grants program, and a provision creating a federal interagency working group on water reuse.

In addition, the U.S. Senate in April 2021 voted to adopt the Drinking Water and Wastewater Infrastructure Act of 2021, which will make major investments in water recycling programs and resources.

Barriers to More Reuse

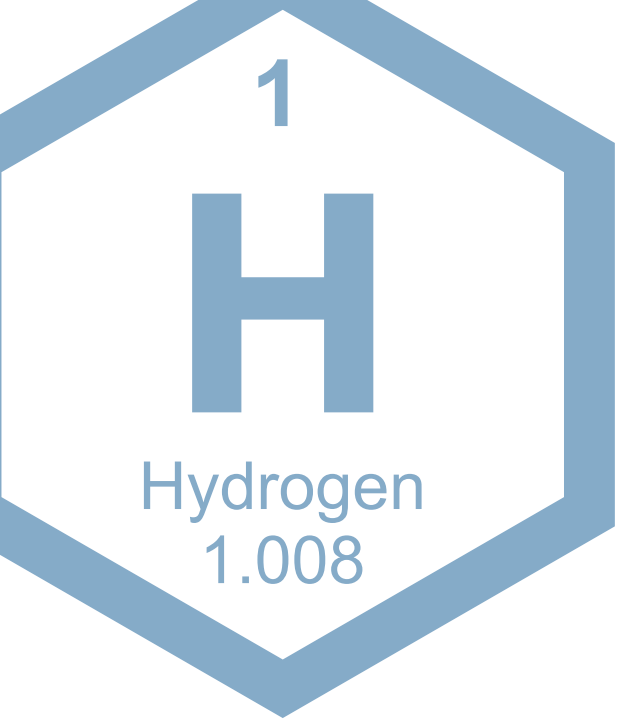
When it comes to their perceived chief barriers to doing more reuse, more than six in 10 respondents (62 percent) pointed to it as being cost prohibitive to build and execute, followed by the lack of public acceptance (46 percent).

Regulatory reform could be helpful, with 27 percent of respondents citing regulatory complications as a barrier to reuse. An additional 19 percent pointed to a lack of regulatory support. There currently are no federal standards for potable water reuse, and some states still have no framework for it. The creation of a national guideline or standards may enable more reuse. The development of guidelines and standards that reflect technological advances in our ability to implement, monitor and control reuse systems while also ensuring public safety and resiliency will be critical.

As outlined by the World Economic Forum, a circular economy is "an industrial system that's restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals that impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models."

Across the U.S. water sector, familiarity with that appears to be growing. In 2020, nearly 60 percent of respondents were entirely unfamiliar with the concept; by 2021, this had fallen to 36 percent. Most utilities — some six in 10 — see themselves as participating in the circular economy *(Figure 24).*

Four in 10 respondents saw their biogas and nutrient removal programs as an element of the circular economy. Few utilities, however, believed they were taking full advantage of biogas as a resource, including, most notably, none of the respondents in the South. However, this does not trouble the utilities; asked whether they believed they were missing an opportunity with regard to



biogas, the majority of respondents felt they were not. It would seem many utilities believe the amount of biogas generated was insufficient to make such projects worthwhile.

Hydrogen and Decarbonization

According to the National Renewable Energy Laboratory, demand for hydrogen in the U.S. could reach as much as 41 million metric tons per year by 2050, a four-fold increase over current requirements. Biogas reforming is a proven pathway to renewable hydrogen. In the latest Black & Veatch survey, for the first time, 6 percent of utilities reported seeing hydrogen production as part of their contribution to the circular economy. The amount by which that figure increases in the coming years will significantly be governed by the extent to which utilities adopt a more product-orientated mindset.

Looking ahead to our 2022 report, we'll be monitoring the impact of water infrastructure and drinking water infrastructure legislation on the affordability of reuse programs, the growth of potable reuse driven by growing drought conditions in Southwest and beyond, and the value that water companies ascribe to participation in the hydrogen economy.

ABOUT THE AUTHORS

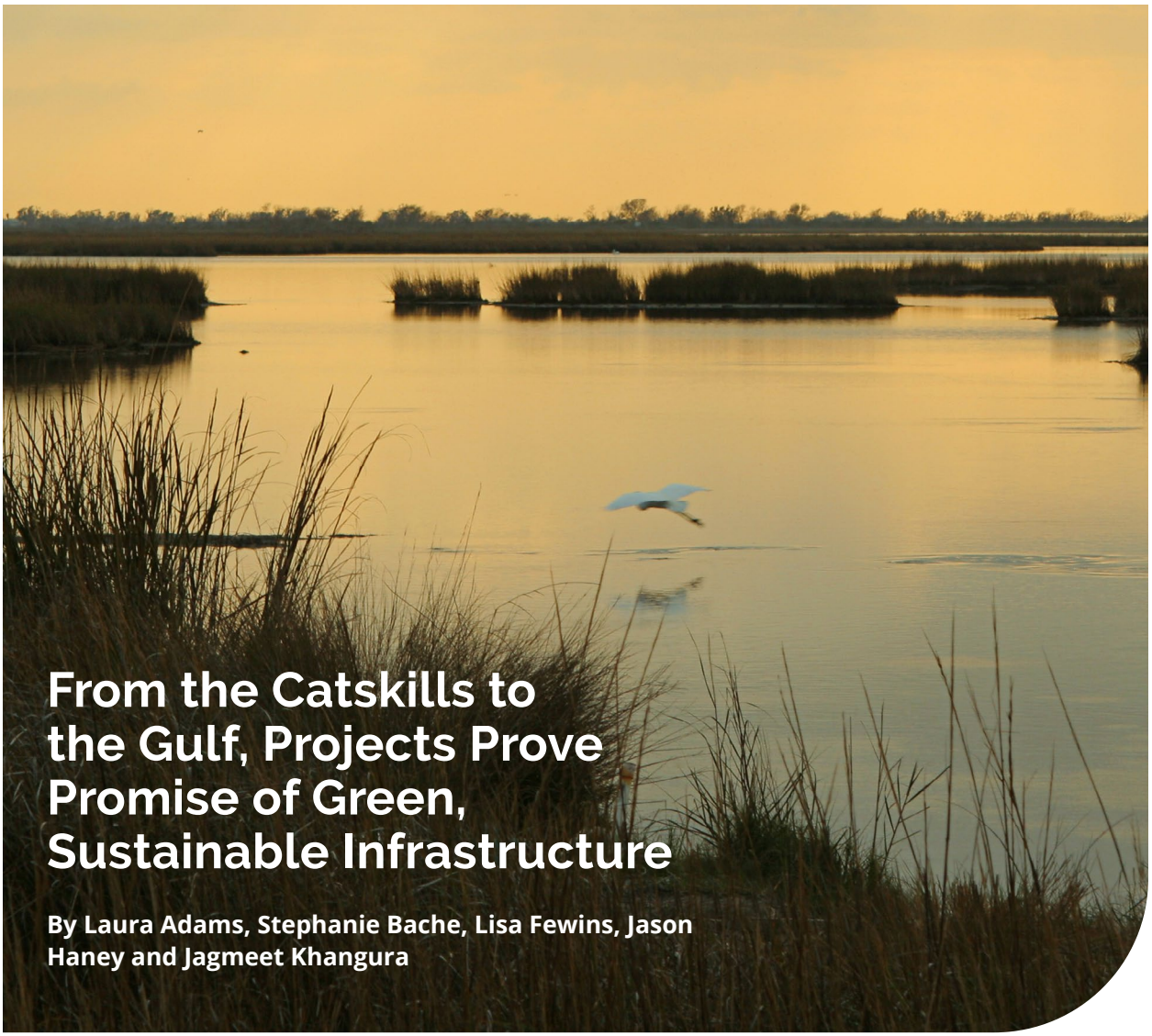
Zeynep Erdal *leads integrated solutions for Black & Veatch, where she specializes in water infrastructure solutions that integrate resource recovery and resilience. She has 25 years of experience in water reclamation projects around the world and is a recognized expert in treatment technologies and innovation, focusing on the water-nutrient-energy nexus as well as integration of water system solutions.*

JoAnn Jackson *leads Black & Veatch's National One Water Planning Practice. She brings more than 35 years of experience developing integrated solutions to wastewater, stormwater and water supply projects across the U.S. Her experience includes six years in the public sector, where she helped implement Florida's first direct potable reuse pilot and served as a utility representative on Florida's Potable Reuse Commission.*

Andrew Shaw *is a global practice and technology leader in sustainability and wastewater for Black & Veatch. He has 28 years of experience in wastewater treatment design projects in the United Kingdom, Australia, Asia and North America. His expertise includes nutrient removal, computer modeling, instrumentation, process optimization and life-cycle assessments.*

Ann Bui *is a managing director and co-leads Black & Veatch Management Consulting Group's strategy advisory water market business. Besides providing clients with strategic financial management strategies, her responsibilities include driving growth and innovation to water utilities in the areas of financial and advisory planning, advanced metering, customer experience, asset integrity and enterprise risk management services. Bui has more than 30 years of experience with clients in North and South America, Europe and Asia.*

Robert Chambers *is a principal consultant on Black & Veatch's Management Consulting Group strategic advisory team. Chambers has served and supported municipalities in developing, communicating and educating various stakeholders about the purpose and value of business plans, which have included long term financial plans, capital acquisitions and system expansion alternatives, customer rate and affordability scenarios, energy management planning and strategic planning roadmaps.*



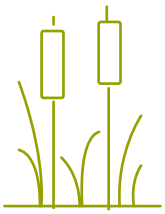
From the Catskills to the Gulf, Projects Prove Promise of Green, Sustainable Infrastructure

By Laura Adams, Stephanie Bache, Lisa Fewins, Jason Haney and Jagmeet Khangura

In order to protect source water, respond to climate change manifested in rising sea levels, or to mitigate the increased risk and frequency of inland flooding, utilities tasked with handling stormwater are awakening to the promise of green infrastructure.

The problem: The movement to a newer way of thinking remains slow, given the urgency of addressing stormwater runoff that the U.S. Environmental Protection Agency (EPA) calls "one of the fastest growing sources of pollution." Rainfall on roofs, parking lots and roads means pollutants flow into storm sewers and ultimately into rivers and streams. But the issue with these pollutants could be mitigated through the planned use of wetlands, forests and grasslands.

Green, sustainable infrastructure is a solution not just for contamination of water; it also can support resiliency to climate change and the increasing frequency of flood events. Environmental activists, elected leaders and governmental overseers are taking note, pressing for better, more environmentally friendly ways of managing stormwater through such strategies as permeable pavement and open channels instead of pipes — or soil, vegetation, wetlands and other natural elements to store and infiltrate stormwater. Stormwater managers hope for funding relief, perhaps from federal taxpayers through infrastructure spending bills pending in Congress.



More than three years ago, New York City unveiled a $1 billion investment in that water system by reinforcing and broadening programs that protect the one million acres of watershed land surrounding the reservoirs, focusing on green solutions meant to protect water supplies.

To the EPA, green infrastructure is cost-effective, resilient and replete with community benefits, including the risk-management equation of reducing potential hazards to property that could be flooded or otherwise impacted. Some locales and regions have dived aggressively into using green infrastructure, either at a regional scale or as a distributed solution to reduce stormwater contamination, combat climate change and protect against more frequent flood events.

In Louisiana, the state's $50-billion, 50-year "Coastal Master Plan" includes a remarkable vision: the "Mid-Barataria Sediment Diversion" project, which calls for punching a large hole in a Mississippi River levee and letting the sediment-rich water rebuild wetlands eroded by rising sea levels. The project is expected to build up to 28 square miles of marsh in Barataria Bay by 2050.

According to a Christian Science Monitor report in May 2021, the resulting wetlands would serve as a barrier, protecting the coast and cities such as New Orleans from storm surges, a safeguard against another catastrophe similar to Hurricane Katrina that decimated the city in 2005. The project would be paid for with remaining fines and settlements from the 2010 Deepwater Horizon oil spill.

Home to the largest unfiltered water supply in the U.S., New York City's roughly 9.5 million residents rely on a sprawling network of reservoirs, aqueducts and tunnels to get fresh water. Some 90 percent of that water doesn't require filtration, given that it comes from the pristine reservoirs in the Catskill Mountains some 125 miles away, as reported by The New York Times in 2018.

It's a water supply that the state of New York has devoted more than $1.7 billion to since the early 1990s in exchange for state and federal waivers sparing it the prospect of having to build costly filtration plants. More than three years ago, New York City unveiled a $1 billion investment in that water system by reinforcing and broadening programs that protect the one million acres of watershed land surrounding the reservoirs, focusing on green solutions meant to protect water supplies.

As part of that watershed protection effort, an additional $180 million was directed to reducing pollution from farms and managing forests by removing old growth, making room for young trees that absorb more nutrients from rain and snowmelt bound for the reservoirs.

Millions of dollars also have been directed at shoring up eroding streams to improve water quality and support flood mitigation projects, as well as to safeguard land from development, notably in streamside areas.

From Minnesota to Louisiana and the Gulf of Mexico, a coalition of mayors and other leaders of cities along the Mississippi River are lobbying for a new federal program that would create a "comprehensive plan" for management of the waterway — a key corridor of U.S. commerce — across local communities and states.

Colin Wellenkamp, executive director of the Mississippi River Cities & Towns Initiative (MRCTI), told Wisconsin Public Radio in March that because the waterway spans 10 states, federal and state governments have taken an "ad-hoc approach" to investments in natural resources and infrastructure rather than trying to get all stakeholders involved in a single program. MRCTI is working to protect and restore the Mississippi River as a natural system that supports culture, economies and the river's unique ecosystem and wildlife.

Black & Veatch has joined a consortium of industry leaders partnering with Two Degrees Adapt to complete an innovative research project aimed at finding and evaluating nature-based solutions for the Mississippi River corridor.

All too often, resolving the complexities of stormwater and flood management has been stymied by challenges of collaborating across jurisdictions, competing priorities and lack of funding. Given these challenges, what's the best course of action? Is it employing green infrastructure solutions such as wetlands and stormwater storage measures or adopting infrastructure resilience strategies such as floating infrastructure? Could it be relocating infrastructure away from coastal or flood-prone regions, or building or fortifying levies or other barricades? Or perhaps a combination of multiple strategies?

According to our survey of more than 200 U.S. water utility stakeholders for Black & Veatch's *2021 Strategic Directions: Water Report*, nearly six in 10 respondents said climate change probably or definitely isn't influencing where they site projects or plan for new infrastructure. The remaining 4 in 10 said they are probably or definitely being influenced by climate change *(Figure 25)*.

When asked separately about their utility's resilience to flooding, fires and drought, roughly two-thirds of respondents identified these issues as a concern in the long-term. This perhaps

Figure 25

Is the changing climate impacting how you site projects and plan for new infrastructure? *(Select one)*

Source: Black & Veatch

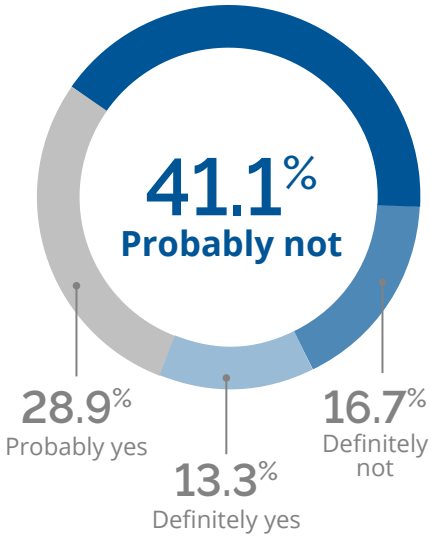


Figure 26

Is resiliency (to flood, fire, drought) a concern to your organization in the near or long term? *(Select all that apply)*

Source: Black & Veatch

67.0%	**Yes,** in the **long term**
37.5%	**Yes,** in the **short term**
13.6%	**No,** not considered about resiliency of infrastructure

reflects the belief that a different presidential administration, congressional makeup or budgetary climate will be more favorable. Or perhaps this response indicates competing priorities that demand short-term or immediate resolution *(Figure 26).*

Developing green infrastructure as a resilience strategy is a long-term process that begins with thoughtful planning that's ultimately paired with building a community-wide consensus for action and the development of the rationale for funding.

From New York to Louisiana — and in Milwaukee, Memphis and Maryland's Prince George's County — projects involving green infrastructure are in high gear, proving that being proactive isn't an anomaly. Across the country, in fact, Black & Veatch is managing the development and construction of more than $150 million worth of such projects, adding to the global critical infrastructure leader's decades-long portfolio of planning, design and construction.

In concert with traditional engineering solutions, many communities are exploring or adopting green infrastructure. Some even are gravitating to the philosophical approach that maybe the best tactic is to live with water rather than trying to send it away.

ABOUT THE AUTHORS

Laura Adams *is Black & Veatch's green infrastructure practice lead. A 15-year veteran of the company, Adams leads a multi-disciplinary team with deep experience in program development and planning, design and construction and the maintenance of green infrastructure. The team is creating innovative solutions to revitalize communities, restore natural resources and address climate resilience.*

Stephanie Bache *is associate vice president and sub-region director for Black & Veatch's water business. She oversees a portfolio of projects for stormwater, water and wastewater, including a major stormwater project in Houston that was initiated in response to Hurricane Harvey and will help reduce impacts of future major flood events. Bache has worked on high-profile projects and programs in Texas, California, Nevada and in the Middle East.*

Lisa Fewins *is managing director of Black & Veatch's environmental business. When clients engage Black & Veatch's environmental team, they benefit from its experience across markets, the project lifecycle and all environmental media — air, land, water and noise. The environmental team focuses on helping clients achieve environmental solutions that provide optimal financial, operational and sustainable benefits by delivering tailored solutions to meet business needs.*

Jason Haney *is a co-founder of the Innovative Floating Solutions team with Black & Veatch's growth accelerator. The team is focused on developing the next generation of sustainable infrastructure to address the world's most important needs in an affordable, sustainable and resilient manner. Prior to starting this initiative, Haney trained project managers and executed performance improvement strategies. With more than 25 years in the military, public and private sectors, he has experience in management, operations and program analysis.*

Jagmeet Khangura *is a co-founder of the Innovative Floating Solutions team with Black & Veatch's growth accelerator. The team strives to develop the next generation of sustainable infrastructure to address the world's most important needs in an affordable, sustainable and resilient manner. Khangura previously worked in the power, water and wastewater industry for more than 15 years on matters involving resiliency and utility planning, microgrids, transportation electrification, energy storage and renewable energy.*

Food for Thought: NextGen Agriculture May Help Satisfy World's Growing Appetite

By Roy Johnson, Laura Adams and Samantha Price

As the United Nations projects that the global population will surge by 2 billion people by the middle of this century, millions of people are impacted by food shortages occurring for various reasons, some climate-related and resulting from flooding, persistent rains, high temperatures and drought. Curbing the need or demand for food could mean relying on innovations in next-gen agriculture, which provides a pathway for collaboration between utilities and the agricultural sector.

Next-gen agriculture solutions are highly diverse and include components of big data, artificial intelligence, robotics, scientific breakthroughs, genomics, biological advances and new tech capabilities. For water and

Figure 27

What types of water reuse/ reclamation does your utility offer or facilitate? *(Select all that apply)*

Source: Black & Veatch

33.3%
Industrial reuse

27.0%
Agricultural reuse

27.0%
Environmental enhancement

25.4%
Urban reuse

23.8%
Groundwater recharge

12.7%
Potable reuse

7.9%
Surface water augmentation

23.8%
None of the above

sewer utilities striving to meet "One Water" goals, this increasing adoption of agricultural innovation represents a more impactful collaboration between their operations and agricultural neighbors. Both sectors have a similar goal — better use of increasingly precious water and nutrient resources.

According to a survey of more than 200 U.S. water industry stakeholders for Black & Veatch's *2021 Strategic Directions: Water Report,* many utilities have an eye toward agricultural reuse. More than one-quarter (27 percent) of respondents chose agricultural reuse as one of the top three types of water reuse that their utility offers or facilitates. Industrial reuse led the way, cited by one-third of respondents *(Figure 27)*.

But the question remains: Can utilities and agriculture find better ways to work together in the future?

Agriculture Innovating to Meet Looming Food Security Challenges

The need for sustainable resource solutions for growing food is increasing. The Intergovernmental Panel on Climate Change special report on food security found that already-observed climate change — higher temperatures, more droughts and increasing floods — has impacted food security. Moreover, projected increasing global temperatures will result in more problems for meeting the world's future food needs.

Recognizing the urgent need for better water resource management for U.S. farmers, the U.S. Department of Agriculture (USDA) announced in July 2020 a commitment to expanding water reuse capabilities. The USDA promised to stimulate innovation to increase agricultural production to 40 percent by 2050 while simultaneously cutting in half the environmental footprint of agriculture. Agriculture production is the number one user of the U.S. water supply, accounting for 80 percent of the nation's total water consumption.

Against that backdrop, it's not surprising that agtech innovations are receiving unprecedented financial support from the private sector. Total global investment in agrifoodtech companies has been increasing at a 50 percent compound annual growth rate from 2010 to 2020, surging to a record-breaking $22.3 billion in 2020, according to Finistere Ventures' 2020 AgriFoodTech Investment Review.

Utilities should take a critical look at what agriculture's needs are and seek ways to capitalize on the food system's shifting priorities, new concepts and high-tech capital infusion.

Plants in a hydroponic system successfully take up wastewater nutrients supporting their growth, but they also store toxic materials and contaminants in their roots without translocating them to their stems and leaves.

Figure 28

Who do you see as the main recipient for your recycled or reclaimed water? *(Select all that apply)*

Source: Black & Veatch

39.1%
Private sector, commercial/other use

37.0%
Your utility

37.0%
Private sector, agricultural use

34.8%
Private sector, industrial use

23.9%
Another utility

21.7%
Public sector

Forward-Thinking Agriculture, Utility Partnership Set the Stage

Many utilities, especially those in vital agricultural regions, already are working with the agricultural sector as part of a water reuse strategy. When respondents were asked to identify the main recipients of their recycled or reclaimed water by sector, the survey found agricultural interests tied with the utility itself (each 37 percent) behind only commercial users (39 percent) *(Figure 28).*

The collaboration between California's Salinas Valley and the Monterey Peninsula — known as "Monterey One Water" — is a leading example of agriculture reuse of reclaimed water, according to "Integrated Water Management at the Peri-Urban Interface: A Case Study of Monterey, California." Using water from four sources — urban stormwater runoff, irrigation drainage, food processing and traditional municipal wastewater — the region provides one-third of all its drinking water plus irrigation water for 12,000 acres of high-value crops via treated and reused wastewater.

Elsewhere, *WaterWorld* reported that "Wider Uptake," a joint, multinational project is aiming to recover nutrients — such as phosphorus and nitrogen — left over from wastewater sludge and leverage them as fertilizer for crops. The project involves water and sewage treatment companies, research institutes and private sector businesses in five countries. The goal is to develop financially viable business models for reselling the reclaimed nutrients to farmers at a lower price than equivalent fertilizers.

Phosphorous, which is becoming globally scarce, is especially sought after because it is a critical nutrient supporting agricultural production in many regions globally.

Another potential future collaboration is through hydroponics — a highly productive method of growing vegetables, herbs and flowers in controlled environment agriculture (CEA) facilities using a circulating nutrient solution. Hydroponic production, also known as vertical ag or indoor ag, is a way to sustainably produce high volumes of food in relatively small indoor facilities unaffected by weather disruptions. These facilities can be placed in or near the urban centers that these indoor farms feed, decreasing travel time and distances.

Hydroponics can use the nutrients in wastewater to grow food, plus be used as a treatment process for partially treated wastewater, according to a study published in the May 2021 edition of the Water and Environment Journal. Plants in a hydroponic system successfully take up wastewater nutrients supporting their growth, but they also store toxic materials and contaminants in their roots without translocating them to their stems and leaves.

Finistere reports that investment in indoor ag companies doubled from 2019 to 2020, reaching $1.3 billion. A spiking interest in hydroponic ventures opens the door to new opportunities for collaboration between wastewater treatment and hydroponic growing facilities.

Utilities Must Play Their Part in Food Production

Future food production needs are looming. New, next-gen agricultural innovations are working to meet those needs. But even the most high-tech food systems solution still will depend on two basic components — water and nutrients.

Within a circular economy, water and sewage utilities operate as more than a source of clean water and sewage management. They play a critical role in feeding the world.

ABOUT THE AUTHORS

Roy Johnson *is a business strategist for the Black & Veatch NextGen Ag team committed to helping companies implement sustainable solutions. That team helps companies develop sustainable solutions to support the agriculture industry and meet community food quality and resilience goals. Johnson has knowledge of the food, beverage and agriculture markets through previous experience at Dairy Farmers of America, Campbell Soup Company and Smithfield Foods.*

Laura Adams *is Black & Veatch's green infrastructure practice lead. A 15-year veteran of the company, Adams leads a multi-disciplinary team with deep experience in program development and planning, design and construction and the maintenance of green infrastructure. The team is creating innovative solutions to revitalize communities, restore natural resources and address climate resilience.*

Samantha Price *is a climate-solutions, environmental and sustainability business leader for Black & Veatch's environmental team. While helping companies navigate complex environmental regulations, the team supports implementation of sustainable solutions for an increasingly mobile, urban and affluent world. Its work ranges from driving the decarbonization of industries and supply chains on a global scale and alleviating flood risks to delivering solutions to improve air quality and remediate hazardous waste.*

LEGAL NOTICE

Please be advised, this report was compiled primarily based on information Black & Veatch received from third parties, and Black & Veatch was not requested to independently verify any of this information. Thus, Black & Veatch's reports' accuracy solely depends upon the accuracy of the information provided to us and is subject to change at any time. As such, it is merely provided as an additional reference tool, in combination with other due diligence inquiries and resources of user. Black & Veatch assumes no legal liability or responsibility for the accuracy, completeness, or usefulness of any information, or process disclosed, nor does Black & Veatch represent that its use would not infringe on any privately owned rights. This Survey may include facts, views, opinions and recommendations of individuals and organizations deemed of interest and assumes the reader is sophisticated in this industry. User waives any rights it might have in respect of this Survey under any doctrine of third-party beneficiary, including the Contracts (Rights of Third Parties) Act 1999. Use of this Survey is at users sole risk, and no reliance should be placed upon any other oral or written agreement, representation or warranty relating to the information herein.

THIS REPORT IS PROVIDED ON AN "AS-IS" BASIS. BLACK & VEATCH DISCLAIMS ALL WARRANTIES OF ANY KIND, EXPRESSED OR IMPLIED, INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT. BLACK & VEATCH, NOR ITS PARENT COMPANY, MEMBERS, SUBSIDIARIES, AFFILIATES, SERVICE PROVIDERS, LICENSORS, OFFICERS, DIRECTORS OR EMPLOYEES SHALL BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR RELATING TO THIS REPORT OR RESULTING FROM THE USE OF THIS REPORT, INCLUDING BUT NOT LIMITED TO DAMAGES FOR LOSS OF PROFITS, USE, DATA OR OTHER INTANGIBLE DAMAGES, EVEN IF SUCH PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

In addition, user should place no reliance on the summaries contained in the Surveys, which are not intended to be exhaustive of the material provisions of any document or circumstances. If any point is of particular significance, reference should be made to the underlying documentation and not to this Survey. This Survey (and the content and information included therein) is copyrighted and is owned or licensed by Black & Veatch. Black & Veatch may restrict your access to this Survey, or any portion thereof, at any time without cause. User shall abide by all copyright notices, information, or restrictions contained in any content or information accessed through this Survey. User shall not reproduce, retransmit, disseminate, sell, distribute, perform, display, publish, broadcast, circulate, create new works from, or commercially exploit this Survey (including the content and information made available through this Survey), in whole or in part, in any manner, without the written consent of Black & Veatch, nor use the content or information made available through this Survey for any unlawful or unintended purpose.

BLACK & VEATCH

P +1 913 458 2000
E MediaInfo@bv.com
W bv.com

© Black & Veatch Corporation, 2021. All Rights Reserved. The Black & Veatch name and logo are registered trademarks of Black & Veatch Holding Company. REV 2021-08