

# Demystifying Intelligent Water: Realizing the Value of Change With Advanced Asset Management

Celine Hyer and Eric Bindler

Like their counterparts in other parts of the country, Florida’s water and wastewater utilities face an array of pressures and pain points, including deteriorating infrastructure assets, an aging workforce, the need for in-demand skillsets, and changing social and cultural dynamics. Further challenges—diverging demands in cities and rural areas, depleting aquifers, emerging contaminants, escalating extreme weather disruptions, and expanding affordability gaps—continue to mount.

With the odds seemingly stacked against utilities, it’s no wonder that the people leading them are looking to modernize their game plans. Achieving today’s goals, while preparing for tomorrow’s challenges, means reimagining how utilities manage their assets—pipes, people, and everything in between. Technology for monitoring, managing, and predicting asset health and performance is giving rise to a new paradigm of digitally enabled asset management. Data-informed

decisions around operations, maintenance, and capital investment across multiple time horizons empowers utility leaders to optimize scarce financial and staff resources, service levels, and value for customers.

Adoption of advanced asset management remains limited to a relatively small group of innovative, technology-savvy utilities. More widespread acceptance could help narrow the funding gap of utilities in the United States by as much as \$62.4 billion over the next decade by eliminating \$27.5 billion from capital expenditure (CAPEX) burden and \$34.9 billion in unnecessary operating expenditures (OPEX)<sup>1</sup>. In Florida, adoption of advanced asset management tools and frameworks could save water and wastewater utilities as much as \$1.5 billion in CAPEX and \$1.8 billion in OPEX between 2019 and 2030, equaling \$3.3 billion in cumulative total expenditure (TOTEX) savings over the next decade.

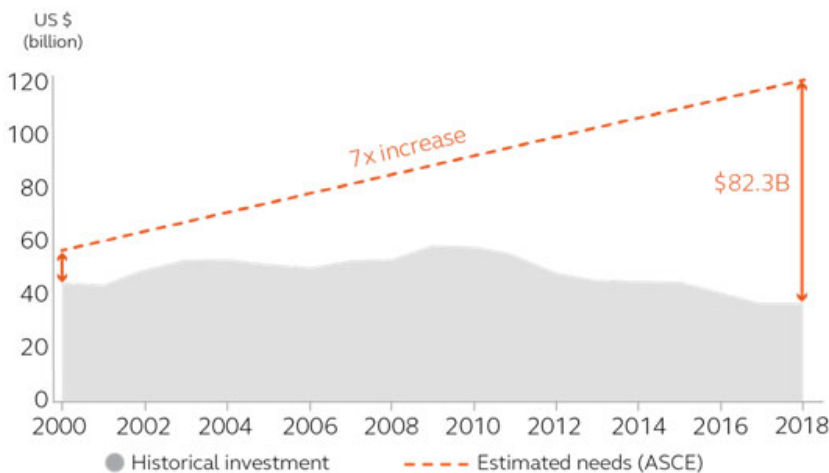
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## What’s Driving the Demand for Change?

The shift toward advanced asset management practices in the water and wastewater utility sector is being driven by four key trends.

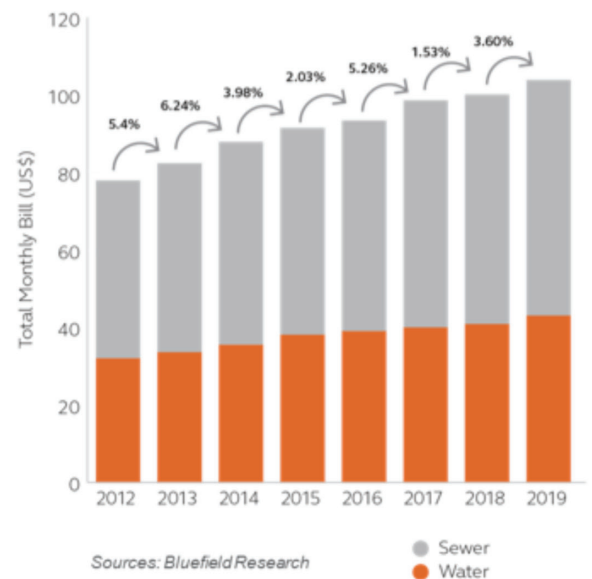
### Investment Gap

First, the investment gap is growing. Total public and private capital investment in U.S. water and wastewater infrastructure reached an estimated \$36.6 billion in 2018, less than a third of the nearly \$119 billion in annual investment the American Society of Civil Engineers (ASCE) projected would be necessary by 2018 (Figure 1). The \$82.3 bil-



Sources: American Society of Civil Engineers, U.S. Congressional Budget Office, Bluefield Research

Figure 1. Water and wastewater capital needs versus historical investment.



Sources: Bluefield Research

Figure 2. Water and wastewater monthly bills for the largest cities in the United States by population served (2012-2019).

lion investment gap is the highest it's ever been after two decades of steady growth, increasing nearly sevenfold since 2000, when the gap was \$11.9 billion<sup>1</sup>. Though ASCE has given Florida's water, wastewater, and stormwater infrastructure higher grades than the national average, the organization has stressed that more investment is needed to keep up with the state's rapid population growth, renew its aging infrastructure, and protect its sensitive ecological environments, which are critical for public health and Florida's tourism economy.

### Affordability Issues

Second, affordability issues continue to challenge utilities and their customers. Average U.S. monthly water and sewer rates increased 31 percent in real terms since 2012, more than double the growth in median household income between 2012 and 2018<sup>1,2</sup> (Figure 2). Despite rate increases, utility revenues are still falling short, with only 21 percent of U.S. utilities able to fully cover the cost of providing services<sup>3</sup>. If these trends continue, 36 percent of households will not be able to afford water within the next five years<sup>4</sup>.

### Institutional Knowledge

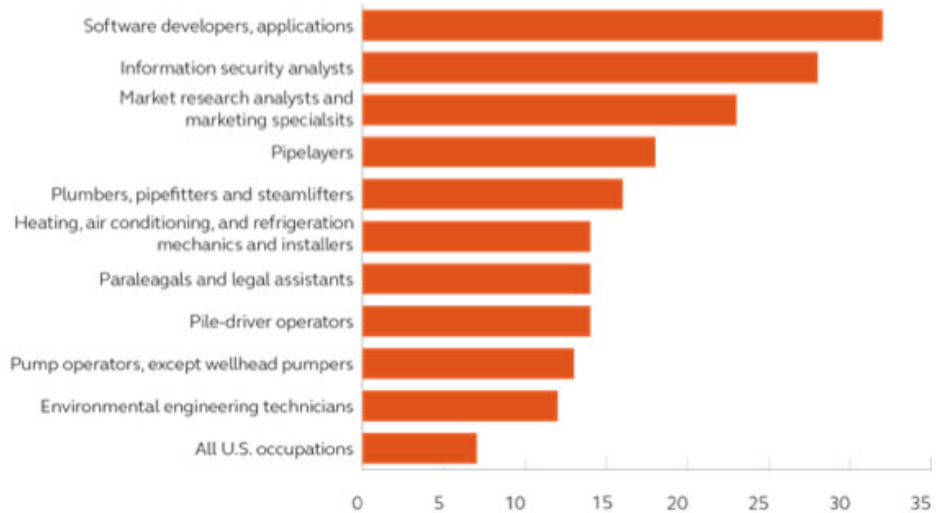
Third, institutional knowledge is leaving the industry. An estimated 10.6 percent of water sector workers will retire or transfer each year between 2016 and 2026, with some utilities expecting as much as half of their staff to retire in the next five to 10 years<sup>5</sup>. This will drain utilities of the institutional knowledge that veteran system operators have built up over decades, not to mention that the competition to attract and retain the next generation of leaders is heating up.

### Regulations

Fourth, regulations are slow to evolve. While utilities in countries like the United Kingdom, Australia, and Canada must adhere to robust asset management planning and reporting requirements, the U.S. regulatory climate is much different; some states are enacting rules around asset management, with ties to funding and/or operating permits, but the process is slow and may only address one utility service (water or sewer). For example, Florida's Senate Bill 712 (also known as the Clean Waterways Act), which recently passed both chambers of the Florida Legislature, will require wastewater utilities to develop five-year pipe assessment, repair, and replacement action plans, and proactively survey pipe integrity throughout their collection systems in order to reduce pipe leakage,



Figure 3. Traditional versus advanced asset management.



Source: National Centers for Environmental Information, Bluefield Research

Figure 4. Projected employment growth in the United States water sector (2016-2026).

sewer overflows, and inflow/infiltration. This is Florida's third attempt to pass legislation regarding asset management rules for sewer collection systems.

While these individual policies help raise asset management awareness, a comprehensive regulatory framework, like the one found in the U.K., is nowhere on the horizon in Florida, or the U.S. more broadly. Rather, utilities can look beyond the regulations to focus on the lessons learned from three decades of asset management maturity in the U.K.:

- ◆ Include more than just physical assets.
- ◆ Leverage data and technology.
- ◆ Take a TOTEX perspective.

### Advanced Asset Management Surpasses Traditional Limits

Traditional asset management's greatest limitations are that they don't consider all of the assets that a utility manages, nor do they leverage the power of advanced technology, such as artificial intelligence and predictive analytics, to do so. Embracing a new "Intelligent Water" framework, which combines advanced digital technologies with skilled

workforces and innovative workplace cultures, can help push utilities into new forward-looking territory, where advanced asset management becomes business as usual, all while addressing critical affordability, workforce, and regulatory challenges (Figure 3).

The first limitation of traditional asset management approaches is that they are focused strictly on physical infrastructure—they don't look past the pipes, plants, and equipment, which hampers a utility's abilities to leverage its entire cache of strengths and leaves unexplored the opportunities to maximize resources or create cost savings.

Advanced asset management, meanwhile, takes a total asset focus, recognizing the substantial value that utility workers create for their organizations, customers, and communities. The advanced asset management paradigm prioritizes investments, not just in treatment and conveyance infrastructure, but also in people, skills, and safety, and leverages the experience and institutional knowledge of veteran utility operators for long-term asset management planning. This expanded view leads to a better understanding of how to

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apply strengths to prioritized risks—before infrastructure fails, instead of after.

The second limitation of traditional asset management frameworks is that they fail to capture and share data effectively and rely too heavily on historical data and industry standards, rather than real-time information on asset health and performance. Disparate datasets on utility assets are housed across multiple platforms and databases, like geographic information systems (GIS), computerized maintenance management systems (CMMS), supervisory control and data acquisition (SCADA), and hydraulic models, and many organizations struggle to break down these data silos. Meanwhile, the differ-

ing standards that different utility departments—finance, engineering, planning, or operations—apply to asset identification, valuation, and life cycle planning make collaboration difficult. Reflecting these diverging, siloed approaches to asset valuation, most U.S. utilities have not yet incorporated systematic measurements of risk into their asset management planning workflows, with many relying solely on asset age when prioritizing capital replacements.

Advanced asset management approaches instead emphasize openness and integration, bringing together data from multiple sources and silos in order to optimize asset operations, maintenance, and investment decisions. In addition, advanced asset management re-

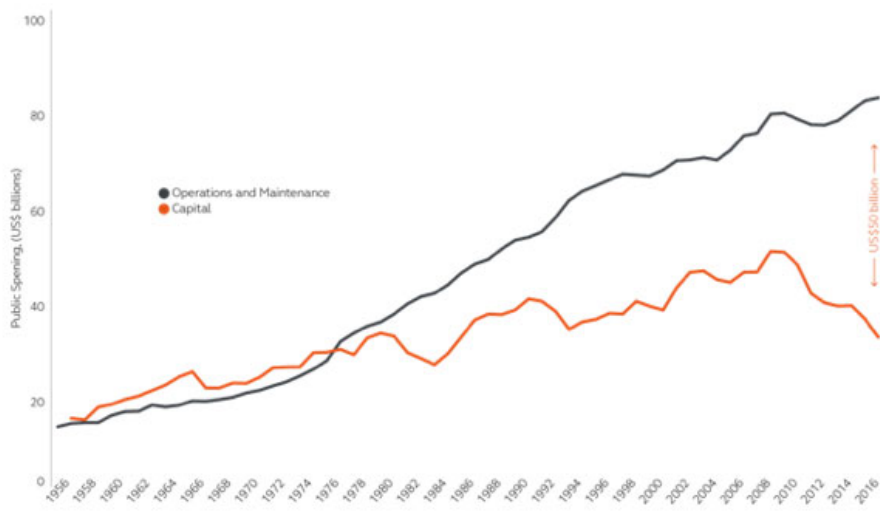
lies on real-time data on asset health and operations—from remote meters, sensors, and other Internet-of-Things (IoT) devices—rather than static snapshots of historical data alone, and leverages advanced analytics to immediately detect deviations in asset condition, predict future asset failures, analyze what-if scenarios, and prescribe optimal maintenance or replacement interventions.

As more and more vendors come to the market with new solutions for collecting, analyzing, and learning from real-time water and wastewater asset data, utilities are under increasing pressure to have clear frameworks in place for the management, integration, and use of disparate asset data streams. Leveraging these new solutions also requires harnessing new skillsets to complement the financial, engineering, and operation and maintenance resources central to traditional asset management.

Anticipated demand for software developers and information security analysts in the water sector will grow more than 25 percent from 2016 to 2026, more than double the growth rate of more conventional roles, such as pump operators and environmental engineers<sup>6</sup> (Figure 4). Water utilities will face significant competition from other industries for these in-demand digital skillsets, increasing pressure to create workplace cultures conducive to digital growth and innovation.

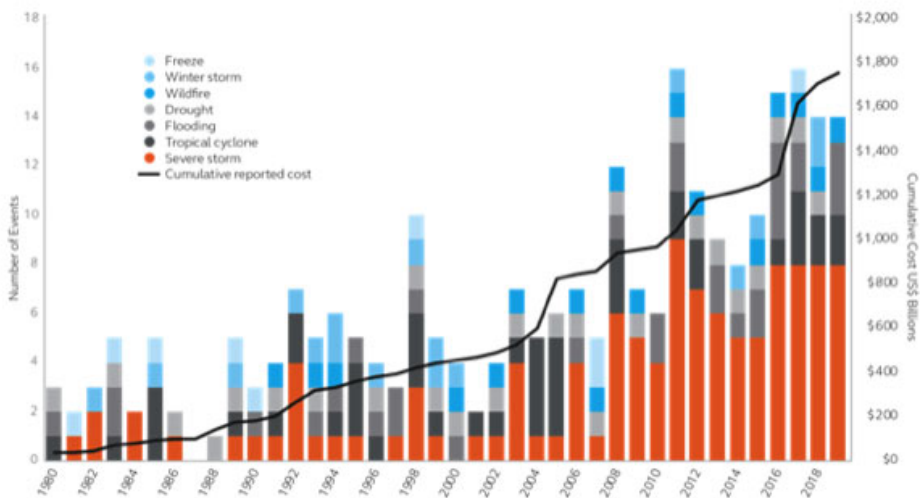
The third and final limitation of traditional assessment management paradigms is that they prioritize upfront CAPEX considerations without accounting for the OPEX costs associated with operating and maintaining an asset over its full life cycle. This creates an untenable scenario where maintenance is predominantly reactive (i.e., in response to asset faults or failures) or preventive (i.e., on a static, time-based schedule, determined by historical data or standard industry assumptions about the mean time between failures for a specific asset type).

This traditional approach is failing for four main reasons. First, U.S. water and wastewater infrastructure is deteriorating faster than utilities can rehabilitate or replace it, with the estimated average age of U.S. water pipes reaching 45 years. A relevant example of this in Florida is the sewer force mains that are failing faster than the City of Ft. Lauderdale can design and construct replacements, leading to over 126 mil gal of sewage spilled. Second, water sector maintenance costs reached an all-time high of \$50.2 billion above capital in 2017<sup>7</sup> (Figure 5), with utilities increasingly forced to operate in a more-reactive mode, exacerbating affordability challenges.



Source: U.S. Congressional Budget Office

Figure 5. Water sector operations and capital costs (1956-2016).



Sources: Brookings Institution, U.S. Bureau of Labor Statistics

Figure 6. Billion-dollar weather disasters and cumulative costs in the United States (1980-2019).

Third, investments in physical infrastructure renewal and replacement often take a replace-in-kind approach to sizing and capacity needs, while population, wet weather intensity, and water usage trends continue to shift, with indoor water consumption falling and U.S. population growth slowing. Finally, environmental shocks and stressors (e.g., droughts, wildfires, extreme weather events) strain utilities' assets and budgets, and prevent their workforces from focusing on programmatic asset replacement and renewal.

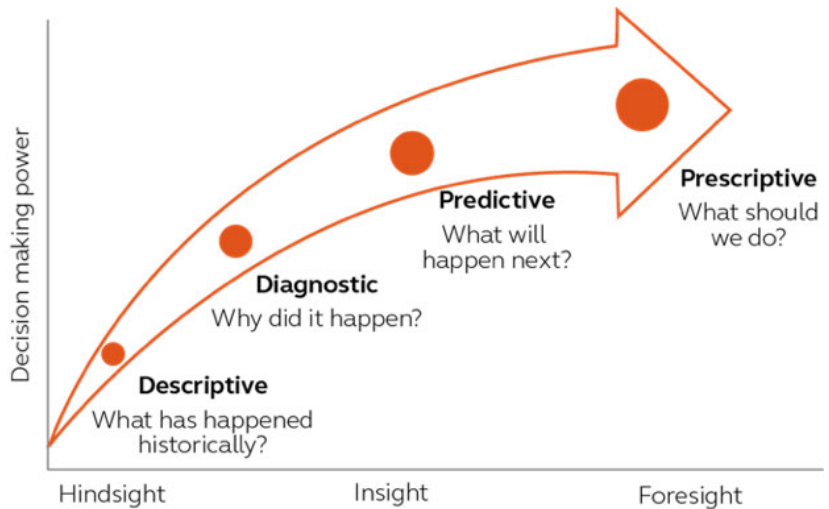
The 2010s saw an average of 12 billion-dollar disasters each year, up from only three such events per year in the 1980s<sup>8</sup>. Utilities in Florida are particularly vulnerable to these environmental shocks, with Florida absorbing \$232.6 billion in damages from billion-dollar disasters between 1980 and 2019—roughly 13 percent of the national total of \$1.8 trillion (Figure 6).

Advanced asset management, by contrast, takes a more expansive view of asset costs, optimizing TOTEX over the life cycle of an asset, rather than upfront CAPEX alone. Introduced by U.K. water industry regulator Ofwat in 2013, TOTEX equates to the sum of CAPEX and OPEX, which encourages utilities to make more-holistic asset management and investment decisions that maximize value over an infrastructure asset's full operating life. For large-scale assets, such as water and wastewater treatment facilities, for example, OPEX costs (such as operation and maintenance labor, supplies, and energy) can account for 75 to 85 percent of total life cycle costs<sup>9</sup>. Optimizing these day-to-day operating costs creates significant long-term savings.

The TOTEX optimization requires a shift in maintenance philosophy from reactive or preventive maintenance modes to predictive or prescriptive approaches that prioritize real-time asset condition (Figure 7). Condition-based or reliability-centered maintenance approaches generate OPEX savings (as both labor and asset performance are optimized) and CAPEX savings (as asset life is prolonged and replacement expenditures are deferred), driving down overall TOTEX.

Though uptake of advanced, digitally enabled asset management tools and frameworks is still limited among U.S. utilities, the results from early adopters are promising. For example, digital asset investment planning and risk analysis tools have allowed utilities to reduce annual CAPEX by as much as 20 percent. Using a median estimate of 11.3 percent in CAPEX avoidance, these platforms could help utilities to save a cumulative total

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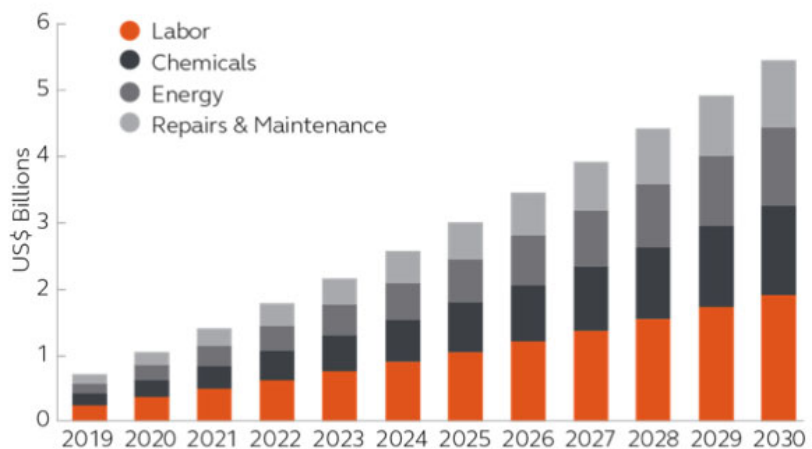
Source: Arcadia Gen

Figure 7. Journey from descriptive to prescriptive analysis.



Source: Bluefield Research

Figure 8. Advanced asset management capital expenditure savings forecast (2019-2030).



Source: Bluefield Research

Figure 9. Advanced asset management operating expenditure savings forecast (2019-2030).

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of \$27.5 billion in CAPEX between 2019 and 2030 (Figure 8).

Meanwhile, early adopters of advanced asset management practices have seen OPEX savings of as much as 30 percent of annual maintenance and chemical and labor costs, and as much as 50 percent of annual energy and contract service costs. Using these figures, advanced asset management could save U.S. utilities a cumulative total of \$34.9 billion from 2019 to 2030<sup>1</sup> (Figure 9).

Altogether, advanced asset management practices stand to help U.S. water and wastewater utilities save as much as \$62.4 billion in TOTEX costs between 2019 and 2030, with annual savings increasing from \$1.3 billion in 2019 to \$9.8 billion by 2030—6 percent of total projected utility expenditures nationwide by the end of the decade. In particular, adoption of advanced asset management tools and frameworks could save Florida’s water and wastewater utilities as much as \$1.5 billion in CAPEX and \$1.8 billion in OPEX between 2019 and 2030, equating to \$3.3 billion in cumulative TOTEX savings over the next decade.<sup>1</sup>

## Improving the Journey

In order to meet the challenges of the coming decades, utility leaders will need to move away from siloed, traditional asset management philosophies to more-holistic understandings of, and transparent communication regarding, their assets, data, workflows, and priorities (Figure 10).

These guidelines can support effective change, but it takes action to realize value. Investing in new ways of working and advanced

technology is essential to creating a sustainable water future. Together, they can empower the workforce to overcome affordability and resilience challenges, seize optimization opportunities, and foster thriving communities.

Change doesn’t need to be instant or revolutionary to be worthwhile. Evolving in increments can help organizations fine-tune their strategies using lessons learned along the way. For utilities looking to begin their journeys, here are the critical first steps to take and tools that can help.

### Know who you are and where you’re at.

*Create or update your strategic plan.* When implementing an advanced asset management program, a key measure of success is whether it helps the utility achieve its strategic goals and objectives. Alignment between the program and the plan provides a line of sight for employees to understand how the higher-level strategy fits into the day-to-day activities required to execute it.

A strategic plan should identify internal and external strengths, weaknesses, opportunities, and threats (SWOT) to the organization. Key examples of internal and external factors include rate constraints, workforce skillsets, regulatory requirements, data availability, customer expectations, and resistance to change.

*Conduct a formal assessment on asset management maturity.* The Water Environment Research Foundation (now the Water Research Foundation [WRF]), developed an asset management knowledge base focused on utility members’ needs called SIMPLE, which stands for Sustainable Infrastructure Management Program Learning Environment. The members of WRF can access the frame-

work and decision-support tools, such as the WRF Strategic Asset Management (SAM) gap analysis tool, developed specifically for the water sector. The analysis assesses practice levels for seven core quality elements of asset management: processes and practices, information systems, data and knowledge, commercial tactics (service delivery), people issues, organizational issues, and asset management planning.

Another useful benchmarking tool is based on the International Organization for Standardization (ISO) 55000 series of asset management standards. This series describes the elements of a management system for asset management, including leadership, planning, support, operation, performance evaluation, and improvement. The Institute of Asset Management provides a self-assessment tool based on these standards.

### Understand your workforce and the roles people play.

*Foster a culture of innovation.* One of the disciplines of the utility innovation framework is maximizing workforce engagement, which allows utilities to create an agile environment that encourages new ideas and adopts new concepts. In turn, these new ideas can accelerate the growth and support of advanced asset management programs.

Creating and maintaining a culture of innovation can be a challenge. More than 100 utilities have used an innovation environment self-assessment survey to benchmark their innovation environments. When combined with fact-based validation, it provides a clear understanding of where to begin.

*Employ change management best practices.* It’s estimated that 70 percent of change programs fail, mostly due to employee resistance<sup>10</sup>, so it’s crucial to put people at the center of the change to ensure that the solution is utilized in the long term. Change management is not simply a task to be completed near the end of the project or program; it must be consistently addressed throughout the entire process to ensure acceptance and adoption. Many successful change management models can be applied, including the ADKAR model by Prosci, which defines five tangible outcomes that people need to achieve for lasting change: awareness, desire, knowledge, ability, and reinforcement.

Key elements of change management for an asset management program include creating and communicating an overall mission and vision, defining roles and responsibilities, documenting a communications plan, providing training, and measuring progress on a routine basis.

Do's	Don'ts
<ul style="list-style-type: none"> <li>• <b>DO</b> recognize the value of your organizations human assets and capital, and involve them in asset management and investment decisions</li> <li>• <b>DO</b> prioritize and optimize full lifecycle TOTEX costs (i.e., CAPEX + OPEX) when making asset management and investment decisions</li> <li>• <b>DO</b> incorporate real-time asset condition and performance data into maintenance programs, and leverage predictive analytics tools (e.g. AI, ML) to inform decisions</li> <li>• <b>DO</b> supplement your organization's workforce with trained data scientists and analysts to help you unlock the potential of advanced, digitally enabled asset management</li> </ul>	<ul style="list-style-type: none"> <li>• <b>DON'T</b> base your organization's asset management and investment on physical linear and vertical assets alone</li> <li>• <b>DON'T</b> make asset management and investment decision on the basis of upfront CAPEX costs alone</li> <li>• <b>DON'T</b> wait for failures, or rely on industry standard assumptions or asset age alone, to determine which assets to prioritize for maintenance or replacement</li> <li>• <b>DON'T</b> rely on traditional utility skillsets alone to confront the challenges of 21st century water and wastewater infrastructure operations and asset management</li> </ul>

Source: Arcadis, Bluefield Research

Figure 10. Do's and don'ts for advanced asset management.

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## Weave resiliency into asset management, and vice versa.

*Recognize synergies in planning processes.* Resiliency and asset management planning require identifying the assets most critical to the water system, or those that have the highest consequence of failure; doing this once (thoroughly) can be used for both. Asset management best practices evaluate asset performance against all potential failure modes, including mortality (from natural causes), capacity, efficiency, and level of service to determine risk and drive the CAPEX or OPEX needs. Resiliency planning, meanwhile, requires an evaluation of assets against external threats from malevolent actions and natural causes, which can also be viewed as performance failure modes for an asset.

Evaluating all the performance failures together and identifying the most likely to occur first provides a comprehensive look at the timing of potential CAPEX and OPEX needs, and a potential for savings. A perspective that combines resiliency and advanced asset management frameworks is especially critical for Florida's water and wastewater utilities, given their heightened exposure to climate-related threats, such as extreme weather, hurricanes, flooding, and sea level rise.

## Sources

For more information on the key components of the advanced asset management paradigm, and case studies and best practices from utilities across the U.S. and U.K., visit <https://www.arcadis.com/en/united-states/our-perspectives/2020/advanced-asset-management/>.

## References

1. Bluefield Research. <https://www.bluefield-research.com/>.
2. "Income Data Tables." U.S. Census Bureau. <https://www.census.gov/topics/income-poverty/income/data/tables.All.html>.
3. "2018 State of the Water Industry Report." American Water Works Association, 2018. [https://www.awwa.org/Portals/0/AWWA/Development/Managers/2018\\_SOTWI\\_Report\\_Final\\_v3.pdf](https://www.awwa.org/Portals/0/AWWA/Development/Managers/2018_SOTWI_Report_Final_v3.pdf).
4. Mack, Elizabeth A., and Wrase, Sarah. "A Burgeoning Crisis? A Nationwide Assessment of the Geography of Water Affordability in the United States." *PLoS ONE*, Jan. 11, 2017. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0169488>.

5. U.S. Bureau of Labor Statistics.
6. Kane, Joseph, and Tomer, Adie. "Renewing the Water Workforce." Brookings Institution, June 2018. <https://www.brookings.edu/research/water-workforce/>.
7. U.S. Congressional Budget Office.
8. Smith, A. B. "2018's Billion Dollar Disasters in Context," Feb. 7, 2019. <https://www.climate.gov/news-features/blogs/beyond-data/2018s-billion-dollar-disasters-context>.
9. "Achieving a 26 Percent Reduction in O&M Costs Through Reliability-Centered Maintenance." Pinnacle Art, Oct. 31, 2017. <https://pinnacleart.com/optimizing-costs-through-rcm-based-om/>.
10. Ewenstein, Boris; Smith, Wesley; and Sologar, Ashvin. "Changing Change Management." McKinsey & Company, July 2015. <https://www.mckinsey.com/featured-insights/leadership/changing-change-management>. ◊