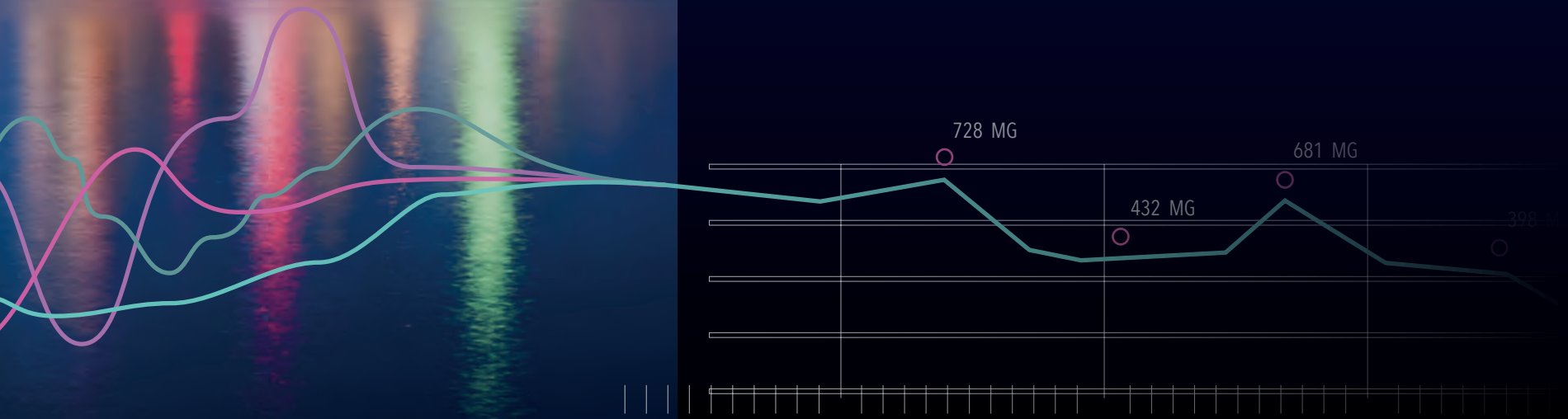
From digital twin to decision intelligence

How the digital twin can deliver transformative outcomes to water utilities



Water utilities are on a path to transformation. How can the digital twin fast-track progress?

Around the world, water utilities are embracing data analytics and digital technologies to deliver transformative outcomes for their communities. Digital solutions, many powered by digital twins, are helping water operators and managers solve their most pressing challenges: minimizing water and revenue losses; reducing capital spend to lower costs to communities; decreasing the impact of climate events; bringing down the costs of safely reclaiming wastewater; and reducing emissions associated with water and wastewater management.

But every innovation brings a learning curve – and digital twins are no different.

Traditional models for simulating infrastructure were cumbersome and costly to build. Today, sophisticated machine learning tools better represent the infrastructure by automatically calibrating to match historical data. Coupled with the right expertise, advanced digital twin technology can improve network visibility, performance and compliance, and deliver significant cost savings. In many cases, however, a lack of frameworks to connect digital twins to holistic decision intelligence solutions makes it challenging for utilities to unlock their full value.

Drawing on the experience of the pacesetters, this guide explores how digital twin technology can be maximized to deliver the most powerful operational and environmental outcomes – and steps utilities can take to start achieving better results, today.

This guide aims to help utilities answer three key questions:

What role can digital twin technology play in optimizing operations?

How can utilities apply this technology to maximum effect?

What can we learn from those utilities leading the way?

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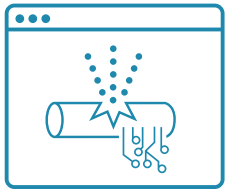
Digital twins explained

A digital twin is the **assimilation of data and a computer model** that helps operators **understand how a physical asset, process or system should be performing**, and helps to **predict performance under changing conditions.**



Detect and diagnose anomalies

Test different scenarios

Predict outcomes

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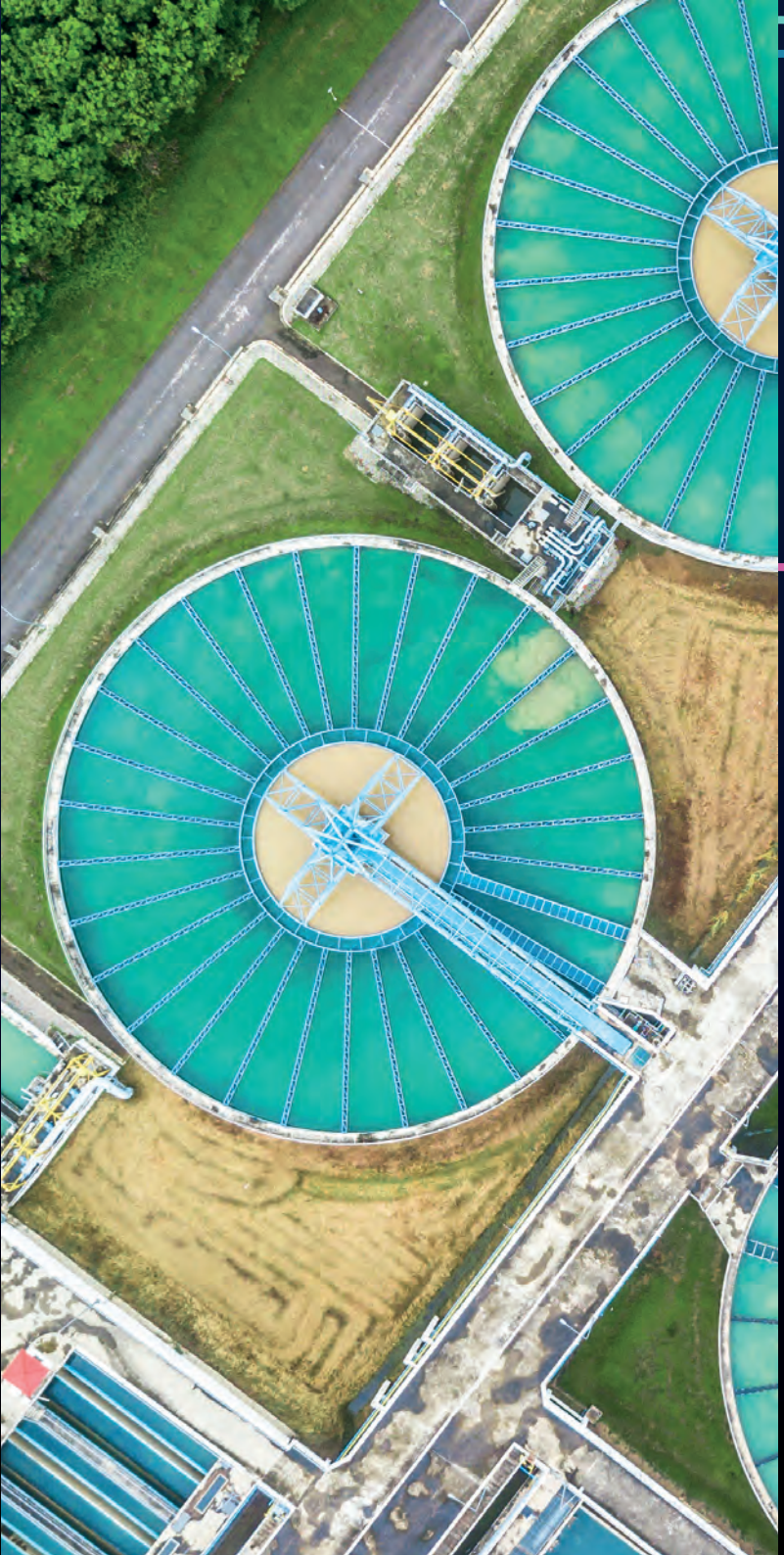

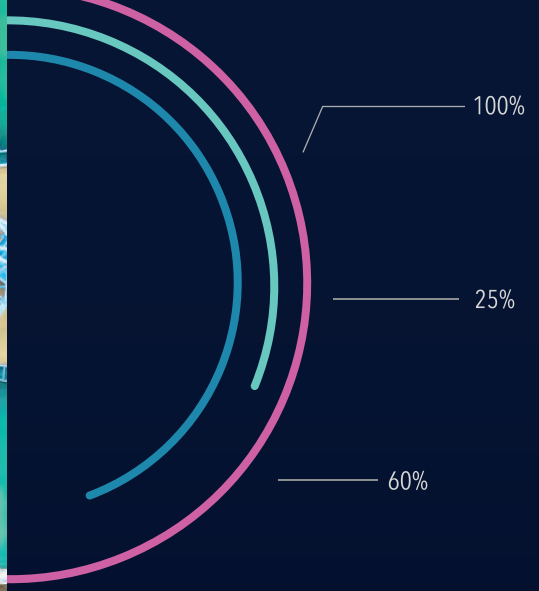

It’s what you do with the data that matters

When **digital twin technology** is coupled with **advanced data science** like **hydroinformatics** and **water system expertise**, utilities are empowered to meet their communities’ needs reliably, affordably and sustainably.

This holistic approach enables utilities to seamlessly integrate digital twins within their digital ecosystem, delivering **enhanced visibility** and **predictive capabilities** that enable **dramatically improved capital and operational decision-making.**

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Spotlight on Hydroinformatics

Hydroinformatics engineers are multidisciplinary experts who combine **hydraulic modeling skills**, engineering and an **in-depth understanding of the water cycle** to **tackle age-old water problems in new ways.**

A hydroinformatics engineer works with the digital twin outputs to develop powerful algorithms that produce recommendations for a utility. These might include real-time operational recommendations through a real-time decision support system, or off-line recommendations pertaining to assets and planning initiatives.

Today's utilities are inundated with data collection and analysis. Hydroinformatics engineers help cut through the deluge by designing algorithms that deliver the most useful data to the operator in the right way, at the right time, every time.

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Digital twin technology can deliver benefits at four levels

Control

When combined with decision support systems and water expertise, the digital twin has the potential to deliver autonomous, optimized control, freeing up operators to focus on other tasks. Think self-driving car!

Recommendations

In sophisticated applications, the digital twin generates multiple scenarios and provides operational recommendations to achieve set KPIs. The operator then chooses a course of action based on these recommendations. Think GPS.

Scenarios

At this level, the digital twin is capable of processing variables to predict an outcome, but it still requires the operator to manually optimize the asset, process or system.

Visibility

At its most basic level, a digital twin shows operators what is happening within an asset, process or system right now. This application relies on the operator to take action based on visibility of current operations.

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...unlocking powerful outcomes

When combined with **deep domain knowledge** and **hydroinformatics**, the digital twin becomes a decision support system to improve outcomes.

Lowering OPEX and CAPEX

By using past data and automatically 'calibrating' to better represent the infrastructure, the digital twin enables continuous, real-time optimization and highly accurate predictions to improve the efficiency and resilience of an asset, process or system.

Minimizing downtime and maintenance costs

Operators are empowered with decision intelligence to quickly detect and diagnose operational anomalies and trigger proactive maintenance or asset replacement.

Empowering utility leaders to get ahead of workforce challenges

Rather than starting from scratch, data from the digital twin helps new operators pick up where their predecessors left off, driving incremental improvements as turnover in workforce happens.

Delivering insight on the interrelationship of assets

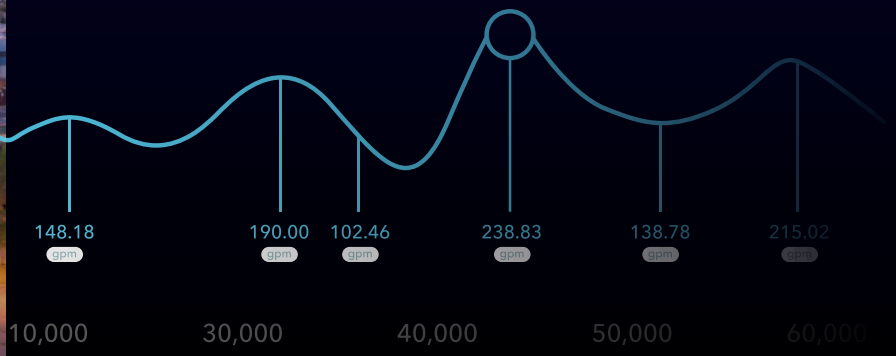
For example, how does an underperforming pump impact a drinking water network and what strategy is needed to compensate in the short term and enable optimization?

Utilities can deliver big results across assets, processes and systems, no matter where they are in their digital transformation.

Utilities in the early stages of digital transformation are achieving big results with smaller-scale applications of digital twin technology. **Smart condition monitoring solutions help operators optimize the performance of individual assets like pumps in real time and predict failures long before they happen.**

These solutions combine multiple data points, such as voltage and current from electric-motor power lines, with important parameters like pressure, level or flow, to create actionable insights. A powerful algorithm detects discrepancies at the earliest stage – with a level of precision beyond what's possible with manual detection – to pinpoint their exact location and elements driving the alerts.

The result? Operators are empowered with the intelligence they need to make crucial decisions, earlier.



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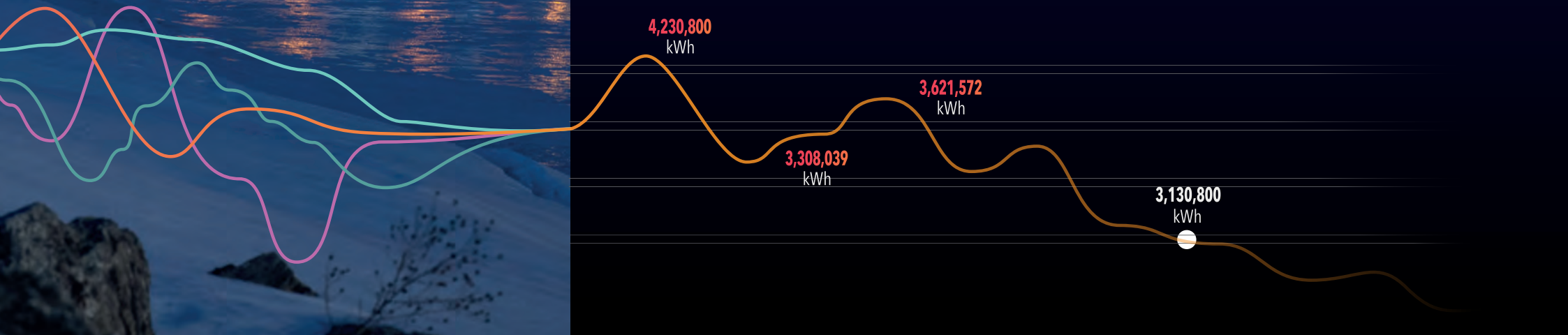
Learning from the pacesetters



Leveraging digital twin technology for process optimization

EWE WASSER GmbH (EWE) in **Germany** wanted a system to optimize the energy consumption associated with aeration and improve safety with better system control of chemical usage, while ensuring compliance with local effluent limits at the Cuxhaven treatment plant. EWE partnered with Xylem to develop and deploy the Xylem Treatment System Optimization, which uses machine learning to create models of the carbon, nitrogen and phosphorous elimination processes based on data from the plant's SCADA system. Several "virtual sensors" were developed to calculate an estimate of the incoming carbon, nitrogen and phosphorous loads of the influent.

Since implementing Xylem Treatment System Optimization solution, the Cuxhaven treatment plant has shown a 30% reduction in aeration energy usage, corresponding to 1.2 million kWh annually, while ensuring that all plant effluent concentrations continue to maintain regulatory compliance.

>30%

reduction in aeration energy usage

1.2 million

kWh saved annually

"We worked hand-in-hand with EWE WASSER GmbH to develop a real-time digital twin of the entire plant. **Now, each process receives optimal aeration and chemical inputs to match the chemical and biological oxygen demand.** It's a new level of control that has helped the plant accurately estimate influent concentration and optimize the aeration process while meeting regulatory requirements. **It's a win-win.**"

Gunnar Brueggmann
Director of Business Development at Xylem

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Optimizing networks with the digital twin

Faced with climate variability that stressed the performance of existing infrastructure, the **City of South Bend, Indiana** built an operational digital twin that optimized its existing infrastructure network with artificial intelligence, creating a smart system capable of predictably reacting to sudden wet weather events.

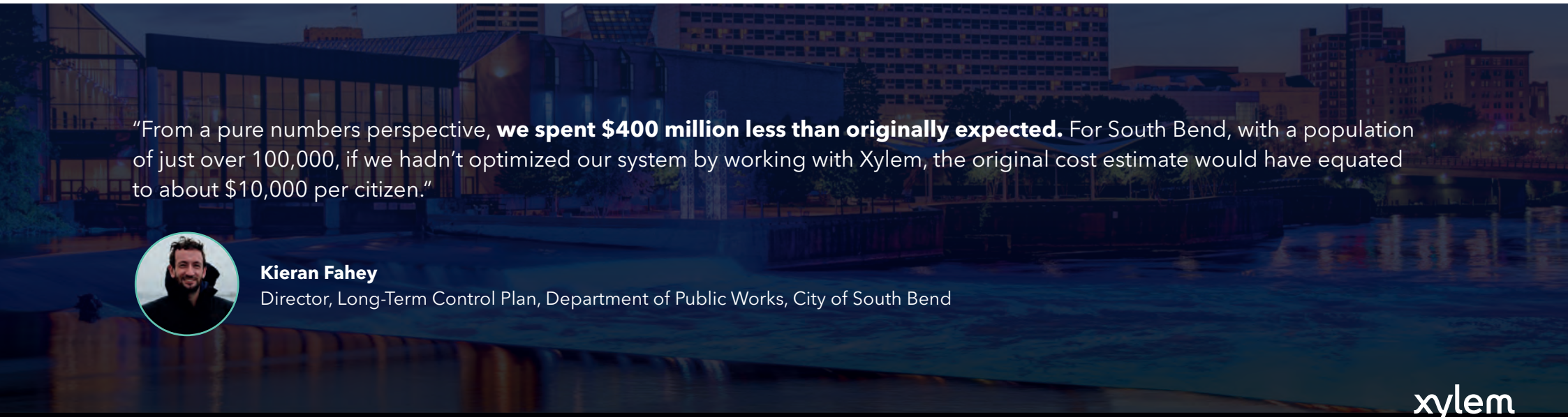
The City's digital twin also enabled scenario analysis to determine investment pathways that would be most acceptable to the community through fact-based public consultations. Xylem is now working with South Bend on a revised plan consisting of a monitoring system of more than 165 sensors and software agents located throughout the City's urban watershed. The smart sewer system will enable the City to exceed the requirements of a wastewater consent decree for 60% less capital investment than originally planned.

$400M+

in estimated CapEx savings

80%

reduction in combined sewer overflows



"From a pure numbers perspective, **we spent $400 million less than originally expected.** For South Bend, with a population of just over 100,000, if we hadn't optimized our system by working with Xylem, the original cost estimate would have equated to about $10,000 per citizen."

Kieran Fahey
Director, Long-Term Control Plan, Department of Public Works, City of South Bend

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Optimizing networks with the digital twin

When the **City of Columbus, Ohio**, was seeking new control strategies to help reduce sewer overflows, and determine ways to reduce operational and maintenance costs while achieving maximum use of its assets, the City's **Department of Public Utilities** partnered with Xylem to design a solution. The City has two interconnected treatment plants, and a chemically enhanced primary system for wet weather treatment. As a result, its network is complex, with a number of gates in the collection system that allow control. Xylem worked with the City to design a solution, rooted in digital twin technology and underpinned by a hydroinformatics approach, that would offer precision guidance on when the utility should utilize wet weather treatment facilities at its two wastewater treatment plants.

The Xylem Wastewater Network Optimization solution calibrates data from various sources across the City's network of assets to provide recommendations to guide operations and achieve maximum utilization.

Greater collection
system insight

Guided control recommendations

to balance flows between plants during wet weather

"Working with Xylem, we are now able to combine data from multiple sources within our complex network, allowing us to maximize use of our existing assets. **The solution has improved coordination and insight across our entire sewer system**, and it is now a vital tool in our management of sewer overflows."

Stacia Eckenwiler
Assistant Administrator, City of Columbus Department of Public Utilities

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Applying digital twin technology at the asset level

When a **major wastewater utility** in **Europe** was facing cavitation issues at one of its treated sewage water pumping stations, an asset-level digital twin application was deployed as part of the utility's control strategy. The pumping station was responsible for transporting water over a long and complex network towards the ocean, which ultimately led to variable water levels. Due to this variability, the pumps were operating in an uncontrollable state of cavitation. Variables in ocean tide levels and treatment outputs also made it impossible for operators to set the right pump control strategy.

SAM PRO – Xylem's Smart Asset Management Performance & Reliability Optimization solution – was used to define the acceptable operating parameters for the pumps. By optimizing the pump station system performance, the utility was able to increase the reliability and total lifetime of its assets. Not only did this eliminate unplanned service visits to the site, but it also improved overall system efficiency, resulting in significant OpEx and CapEx savings.

Eliminated
unplanned service visits to the site

Significant
OpEx and CapEx savings

"Using digital twin technology, **the SAM PRO solution provided real-time performance insights** that allowed the utility to easily identify when assets were operating outside of their best efficiency zone. Working in collaboration with the team on the ground, we were able to integrate the data sets from across the utility's assets and systems. By optimizing their systems, we could **accurately predict and prevent pump failures** caused by excessive cavitation. For the first time, the total cost of ownership of the assets is fully under control."

Mike Otten
Director, Systems Intelligence at Xylem

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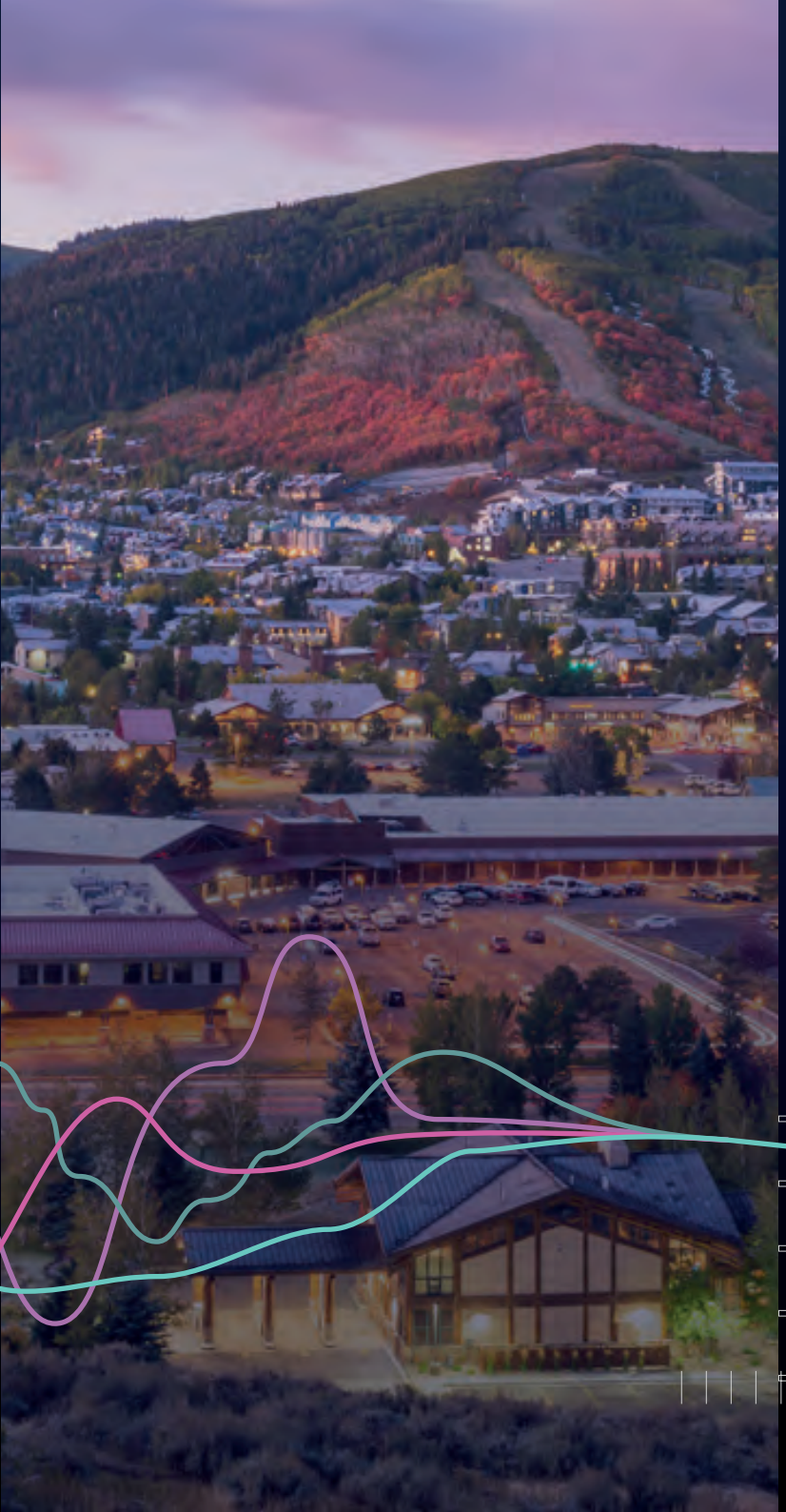

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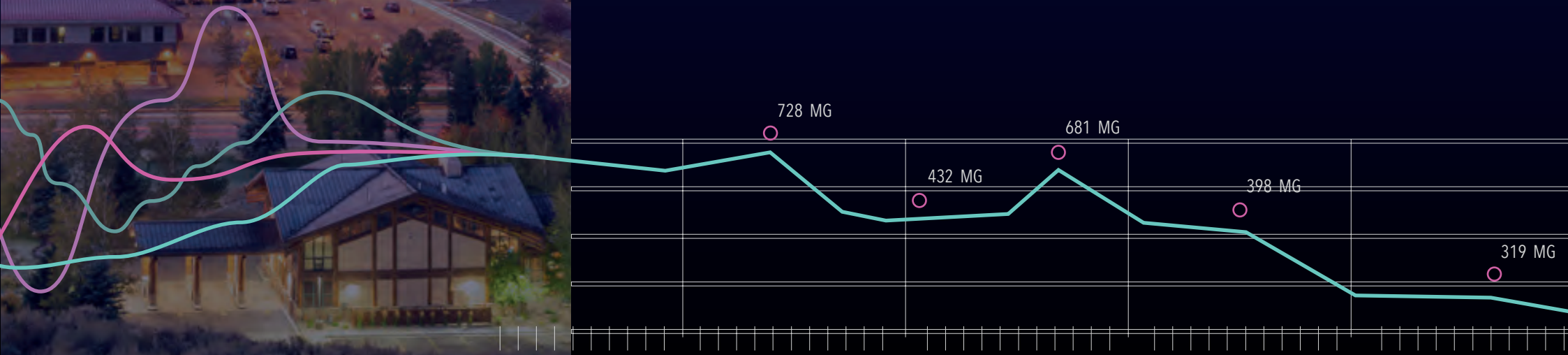
How to get there: 3 steps to supercharge your digital twin



1. Audit

your current situation by reviewing all areas where forecasted or more detailed data and information can help your utility make faster or more efficient operational or planning decisions.

What real-time data do we currently have access to? For example, do we have the visibility to track flow, pressure, and water quality in the drinking water network, or flow and level in the collection system? Are we using that data to make improvements?

Do we have accurate flow forecasts for water distribution systems or collection networks?

Are we acting on our data and leveraging it to make informed operational or business decisions?

Where could we apply tools to save energy and chemicals without compromising water quality?

How could we leverage existing infrastructure to deliver more affordable capital improvement programs?

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2. Evaluate

how much value a digital twin can bring to your utility by starting with a "Discovery Project". This is a low-cost way to gain an understanding of the challenges and data requirements for implementing a digital twin, and a rationale for implementation, possibly including a return-on-investment analysis. A Discovery Project can also help to articulate the value of a partnership engagement with your technology provider.

Does the digital twin provide real-time decision support, giving operators recommendations based on current or predicted conditions to further optimize the water, wastewater or treatment system?

Can the digital twin automatically optimize and control assets in the network, and provide alerts when anomalies occur in the system?

Are there limitations to the types of data the digital twin can leverage (i.e. SCADA, GIS, sensors, etc.)?

How can our utility efficiently and accurately assess the ROI of deploying a digital twin in our unique context?

3. Prioritize

projects appropriate to your unique requirements. It might make sense to start by optimizing a single asset or area of the utility. Or, there could be an opportunity to move faster if there is an established understanding of how a digital twin can be leveraged to provide operational guidance, automation and control across your network. Every community, utility, and system are unique.

Does the digital twin offer rounded expertise – water & wastewater, data science and civil engineering – to allow you to fully leverage the technology's potential?

Will the provider partner with you to optimize the digital twin as operating conditions change over time?

Is the provider appropriately resourced to serve your utility and provide ongoing support?

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Looking to the Future

As water utilities around the world embed digital solutions throughout their networks, digital twin technology is accelerating digital transformation.

A potent blend of digital twin data, decision science and hydroinformatics is enabling utilities to cut through the data deluge to make smarter capital and operational decisions.

Whether at the asset, process or system level, water operators are delivering big results quickly – and setting up for a more resilient and sustainable water future.

Let's see what's possible for your utility.
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