Digital twins for water distribution

A practical guide to smarter planning, operations, and infrastructure investment.

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01

Digital twins: What are they and why do you need one?

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Part 01

Digital twins are having a transformative impact on the planning and operations and maintenance of water distribution networks.

Many industries are already seeing the value of digital twin technology, including construction, manufacturing, and engineering. Now water industry professionals are adopting their own digital twins, helping them to improve water distribution from reservoir to faucet.

SWAN's way

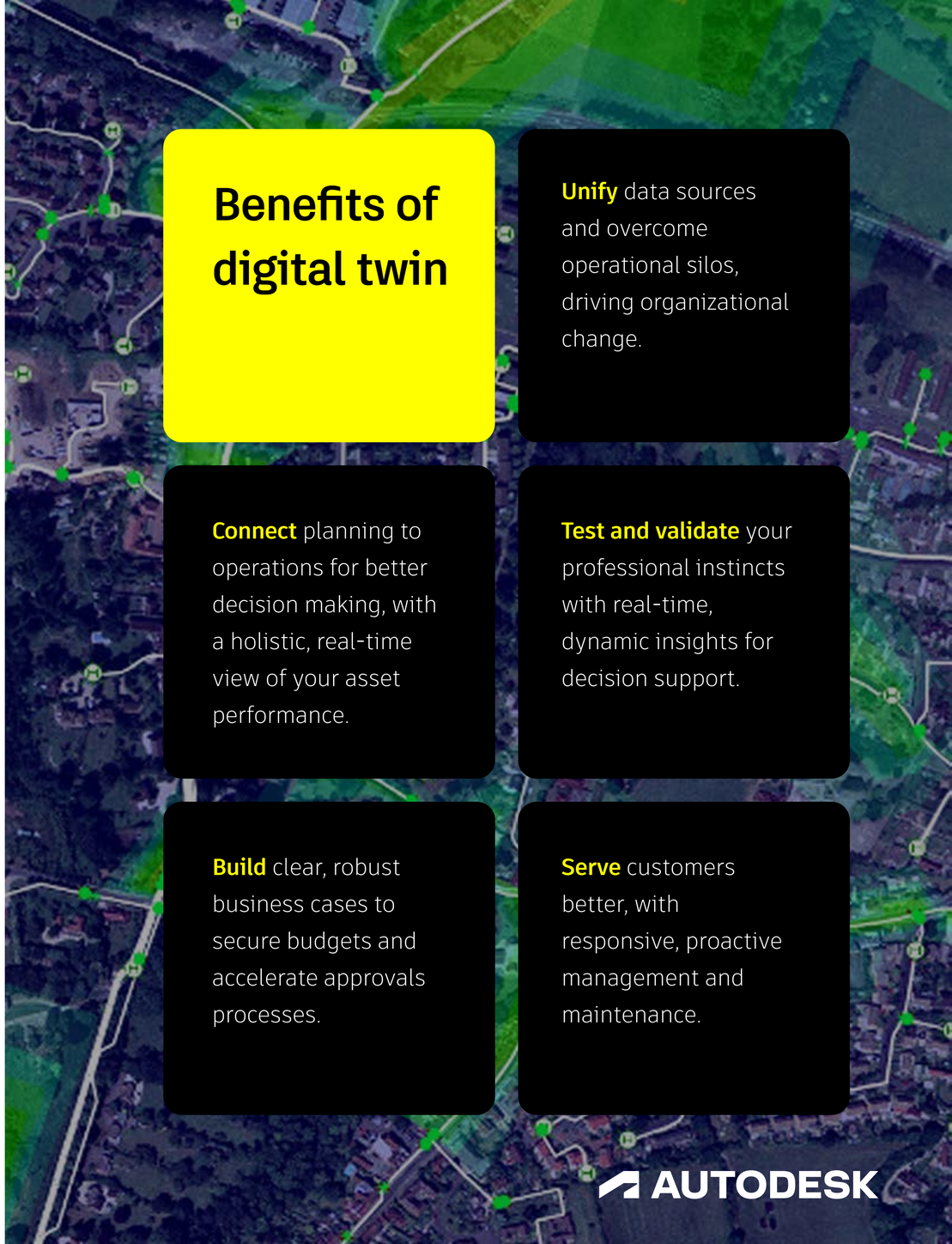
SWAN, the Smart Water Networks Forum, describes digital twins as:

> **A dynamic digital representation of real-world entity(s) and their behaviors, using models with static and dynamic data that enable insights and interactions to drive actionable and improved outcomes.**

Partner with your digital twin

A digital twin can operate as your virtual partner, helping you create value throughout the asset and water lifecycle, including planning and design, procurement, operations, maintenance, and renewal or decommissioning.

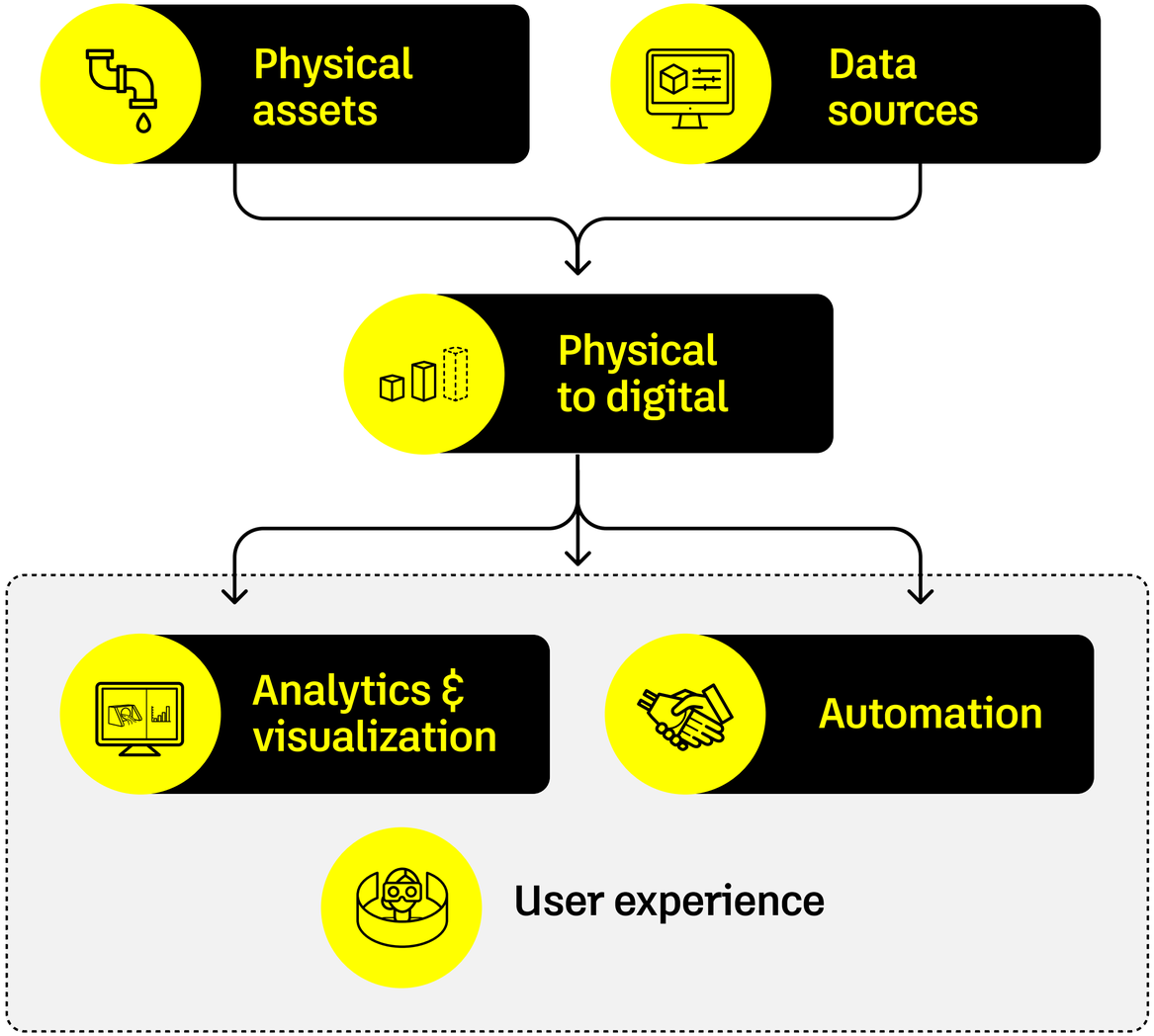
With sophisticated visualizations and simulations, powered by AI and machine learning, you can apply advanced analytics to tasks such as real-time monitoring of pipes, pumps, and hydrants, helping to minimize non-revenue water and keep customers satisfied.



Building blocks of digital twins

A digital twin is made from many elements. It brings together multiple applications and data sources to create a flexible, adaptable modeling platform. Breaking down these digital silos calls for the buy-in of a diverse group of stakeholders, which means that implementing a digital twin can have a transformative, unifying impact on an organization, extending far beyond the technology itself.

Note that creating a digital twin does not necessarily require all the components shown here. Digital twins only need the data sources and analytics relevant to their specific functions.



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The building blocks of digital twins

Physical assets

Sensors

Pressure, temperature, flow, etc

Actuators

Hydraulic, electrical, mechanical, etc

Advanced monitoring

IoT, AMI, edge devices, etc

- The physical system encompasses the real-world equipment and software from which data is collected
- These can include pressure, temperature, and flow sensors; hydraulic, electrical, and mechanical actuators; and IoT or AMI devices for advanced monitoring

Data sources

Business & operational systems

LIMS, CIS, GIS, CMMS, CAD, BIM, etc

Automation systems

SCADA, telemetry, etc

Attributes

Spatial, transactional, temporal

- Business and operational systems such as LIMS, GIS, and CMMS, as well as SCADA, telemetry, and other automation systems are also part of the physical system
- Attributes like spatial, transactional, and temporal data also feed into the data pool from which the digital twin is constructed

Physical to digital

Data ingestion and integration

Data management

- This incorporates the integration of the data, involving ingestion, cleansing, and optimization
- The maintenance and management of the integrated pool also form part of this element

Analytics & visualization

Data-driven models

Machine learning, AI, etc

Physics-based models

Hydraulic, biological, etc (static and dynamic)

Simulation & decision support tools

- This is where the digital twin comes to life, with data-driven input from machine learning and AI, and physics-based or hybrid models
- The digital twin can bring multiple sources together, rather than treating them as separate processes
- This element also includes the visualization of the output from the digital twin, providing simulations and visual models that can be manipulated and tested in near real-time to support decision-making

Automation

Data

Collect, process, respond

Processes

Analyze, simulate, integrate operations

- The optimization and management of data
- Automation of multiple management and incident-prevention processes
- Integration of operational assets for automated activations, such as sluices vand overflows, in response to flow and weather conditions

User experience

What-if scenarios

Real-time performance dashboards

Augmented & virtual reality

Mobile alerts

Advanced automation

- The final critical element of the digital twin is the user experience. Once the building blocks are in place, it is the interaction with the model that unlocks its full productive power.
- Customizable dashboards, mobile alerts, and virtual and augmented reality capabilities all serve to create a secure, connected environment that can deliver higher levels of performance, reduced risk, and greater operational efficiency

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Team building

The teams involved in creating the digital twin can all benefit from the insights and simulations it provides. Operations teams, engineers, consultants, and all other specialist functions can create the dashboards and specify the outputs they need. This is where the digital twin implementation really begins to impact the organization.

The digital twin opportunity

> **The water industry has historically been data rich but information poor. To derive more value from data we need to break down silos (across asset lifecycle, across department, etc.), so compiling data in a common data environment or data lake, for instance, and utilities will likely end-up with a significant amount of data. The challenge is less and less how to collect and store this vast amount of data, instead how to derive fewer but tangible and actionable insights in a timely manner, in a way that can help manage and operate assets more efficiently.**

Thomas Debruyne, APAC Technology Integration Lead for Water at GHD

Digital twins are at the forefront of innovation in the industry. They provide viable, effective solutions to some of the most pressing challenges faced by utilities and their partners, including the increasing pressures on aging infrastructure, the shortage of skilled labor and rising operating costs.

A digital twin enables faster and better-informed decisions, unlocking strategies that drive improved operational efficiency, greater resilience, and better customer experiences.

The human element

Most water utilities are still in the earlier stage of digital twin adoption. The process calls for input from subject matter experts and experienced operators who bring a deeper, more nuanced understanding of the data, models, and analytics involved.

In turn, the adoption journey helps to build trust within the teams using the technology. As they gain confidence in the data, the value of using advanced analytics in managing and improving operational efficiency becomes clear.

02

Immediate impact: How digital twins are transforming water distribution

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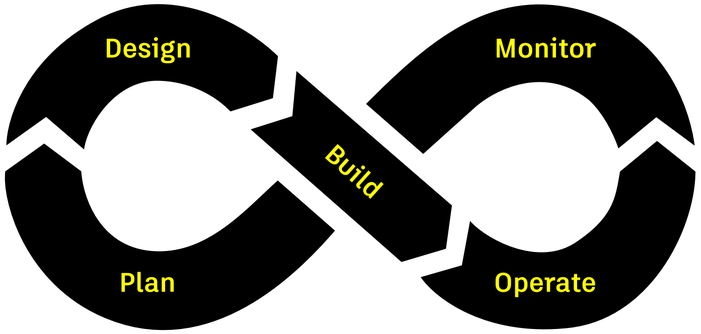
Part 02

Water industry professionals are already working with digital twins. They are using them to combine water models with real-time data and predictive analytics, so they can forecast demand and monitor asset conditions, detecting and resolving issues before they escalate.

Digital twins offer powerful, connected insights that support every stage of water management from *planning* and *design* to *operations and maintenance* (O&M), They can turn water distribution assets—such as pipelines, pump stations, valves, and storage tanks—into virtual and data-driven assets. This modeling supports decision-making at every stage of an asset's lifecycle, enhancing efficiency and responsiveness.



Planning

Long-term infrastructure simulation

- Aging main pipelines and pump stations can be modeled to forecast how continued use might lead to degradation. Simulations can show that a particular pipeline segment will undergo pressure drops due to material fatigue over time.
- Planners can model scenarios where a critical transmission main's failure will compromise supply to a growing urban area, helping them to prioritize planned upgrades or bypass installations.

Demand forecasting and capacity analysis

- The impact of planned urban expansion on reservoirs and distribution networks can be simulated under different scenarios.
- A projected surge in water demand during peak summer months can be modeled, allowing teams to identify stress points along the network ahead of time.

Risk assessment and resilience

- Key strategic assets such as main junction valves can be monitored for performance deviations.
- The impact of a localized pressure drop, such as a potential pipe burst, can be simulated to help with contingency planning, and provide guidance with preventative reinforcements.

Design

Optimized network layouts

- Engineers can digitally prototype different routing options for new underground pipes in dense urban landscapes, optimizing for friction and head losses.
- Alternate pipeline alignments can be analyzed to show the routes that mitigate the risk of pressure surges during high consumption periods.

Integration with GIS and hydraulic models

- Using GIS data, a digital twin can overlay geographic features with critical assets like booster pump stations and valve locations.
- Simulations can show how repositioning a key valve junction might reduce the risk of network disruption during maintenance works, or unexpected operating conditions.

Energy efficiency and sustainability

- Digital twins assess the efficiency of pump operations by analyzing the energy use of pump stations.
- Monitoring pump performance over time highlights pump impeller health, allowing for planning of impeller replacement prior to failure and a reduction in costly inefficiency.

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- Designers can identify opportunities to cut costs and reduce carbon footprint, without compromising water delivery, by simulating various pump cycles and responses to load changes

Operations and maintenance

Real-time monitoring and anomaly detection

- Sensors embedded within pipelines, flow meters, and pressure gauges can feed continuous data into the digital twin.
- An unexpected drop in pressure along a critical distribution line might indicate a developing leak or minor rupturing event, triggering an automated alert.
- Water quality monitoring allows for fast decisions on hydrant flushing to ensure standards are met.
- The tank water age can easily be monitored and pump operations adjusted to meet water health regulations.

Predictive maintenance

- Monitoring vibration levels and operational metrics at pump stations enables the digital twin to forecast maintenance needs.
- If analysis suggests that a backup pump is likely to fail soon, based on performance anomalies, maintenance teams can address the issue proactively before a failure causes service interruptions.
- Sensor health provides information on sensor drift, so sensors can be calibrated to maintain accuracy. This also allows insight into sensors that are erroneous due to repeat drift, allowing for planned replacement without information disruption.

Emergency response optimization

- Digital twins can model the behavior of control valves and storage tanks under stress.
- In the case of a sudden valve malfunction or unexpected demand spike, the digital twin can simulate alternate water flow paths to stabilize network pressure and ensure continuity of service.

Joined-up thinking in action

Digital twin technology fosters a joined-up approach across planning, design, and operations. For instance, hydraulic models of water distribution networks can be directly integrated with asset performance dashboards. This allows operational teams to monitor how distribution systems are responding under varying operating conditions and adjust maintenance schedules accordingly.

Engineers and operations teams can make accurate, swift decisions by drawing on clear, actionable insights from their digital twins. They can plan and prioritize capital investments more accurately and allocate resources more effectively, all while ensuring regulatory compliance and delivering reliable, sustainable services for the communities they serve.

03 Customer stories: Working with digital twins

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Davidson Water: Transitioning away from transients

Davidson Water is a membership-based non-profit organization serving the popular Piedmont corridor of commerce and trade. It operates 1,900 miles of pipeline over 578 square miles, with 66,000 connections and 23 pump stations. Over the past 20 years, Davidson has been replacing its PVC infrastructure with ductile iron, to reduce main breaks caused by water hammer and transient events.

Elements of digital twin employed

Physical assets

- Pump stations
- Open & closed surge tanks
- Discharge tanks
- Standpipes
- Pressure relief valves
- Air release & vacuum valves
- Pump bypass lines

Data sources

- GIS
- Field data

Physical to digital

- Hydraulic modeling within InfoWater Pro

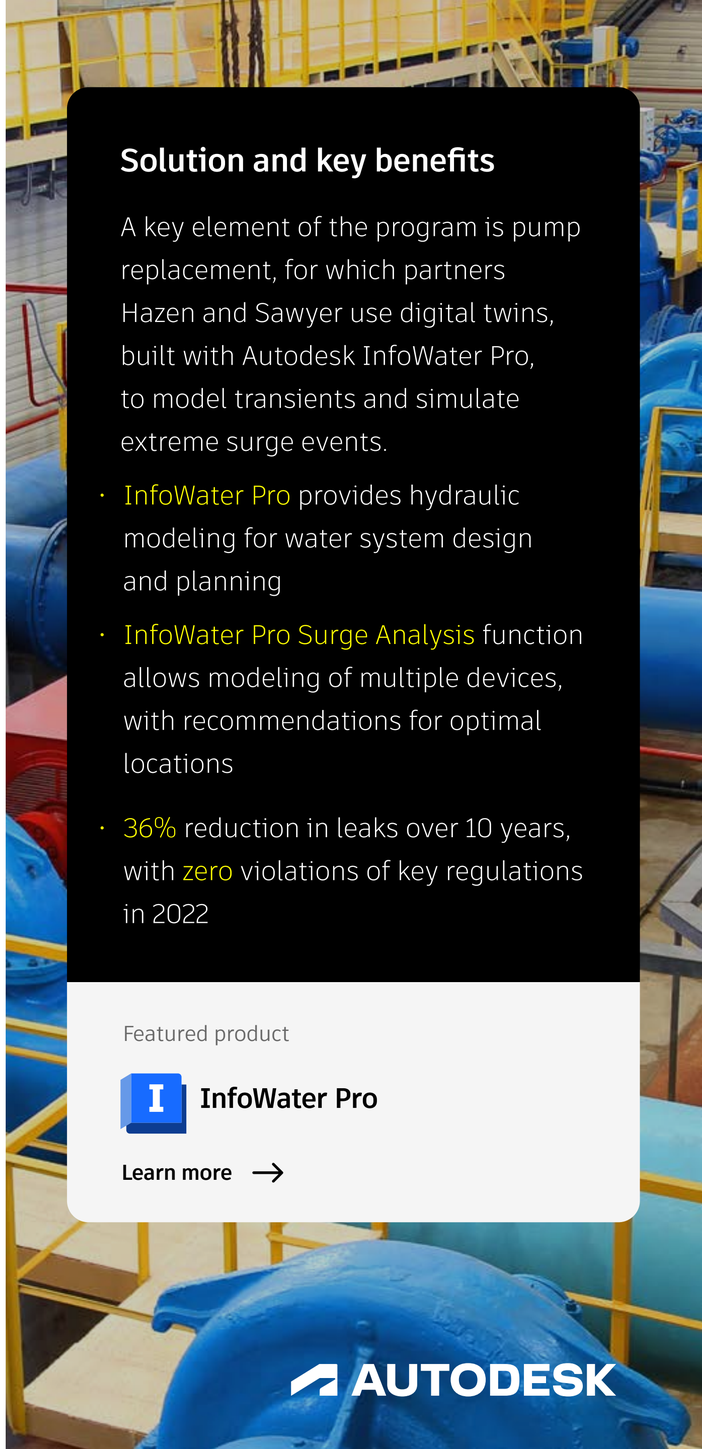
Analytics & visualization

- Surge control modeling
- Testing multiple solutions, including optimum location of assets

Full distribution surge models are important in identifying issues not just at pump stations but throughout the system. Creating an accurate transient model allows us to understand the dynamics of the entire system. It can also help you perform what-if scenarios without actually going into the field to try things with experimentation.

Crystal Broadbent, Senior Associate, Hazen and Sawyer

Read full story



Solution and key benefits

A key element of the program is pump replacement, for which partners Hazen and Sawyer use digital twins, built with Autodesk InfoWater Pro, to model transients and simulate extreme surge events.

- InfoWater Pro provides hydraulic modeling for water system design and planning
- InfoWater Pro Surge Analysis function allows modeling of multiple devices, with recommendations for optimal locations
- 36% reduction in leaks over 10 years, with zero violations of key regulations in 2022

Featured product

InfoWater Pro

Learn more →

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Hunter Water Corporation: Analyzing risk profile, minimizing customer impact

Hunter Water Corporation is the second largest water and sewerage utility corporation in New South Wales, Australia. The state-owned corporation serves a population of almost 600,000 people across 6,671 square kilometres, delivering an average of 188 megalitres of water a day. Its annual risk review is a critical decision support tool for capital and operational planning, as well as helping to determine regulatory compliance across the infrastructure.

Elements of digital twin employed

Physical assets

- Reservoirs
- Pump stations
- Valves, meters, and hydrants

Data sources

- Water network zone hierarchy
- Individual zones
- Growth areas

Physical to digital

- Hydraulic modeling within InfoWorks WS Pro
- All-mains digital representation of the entire network

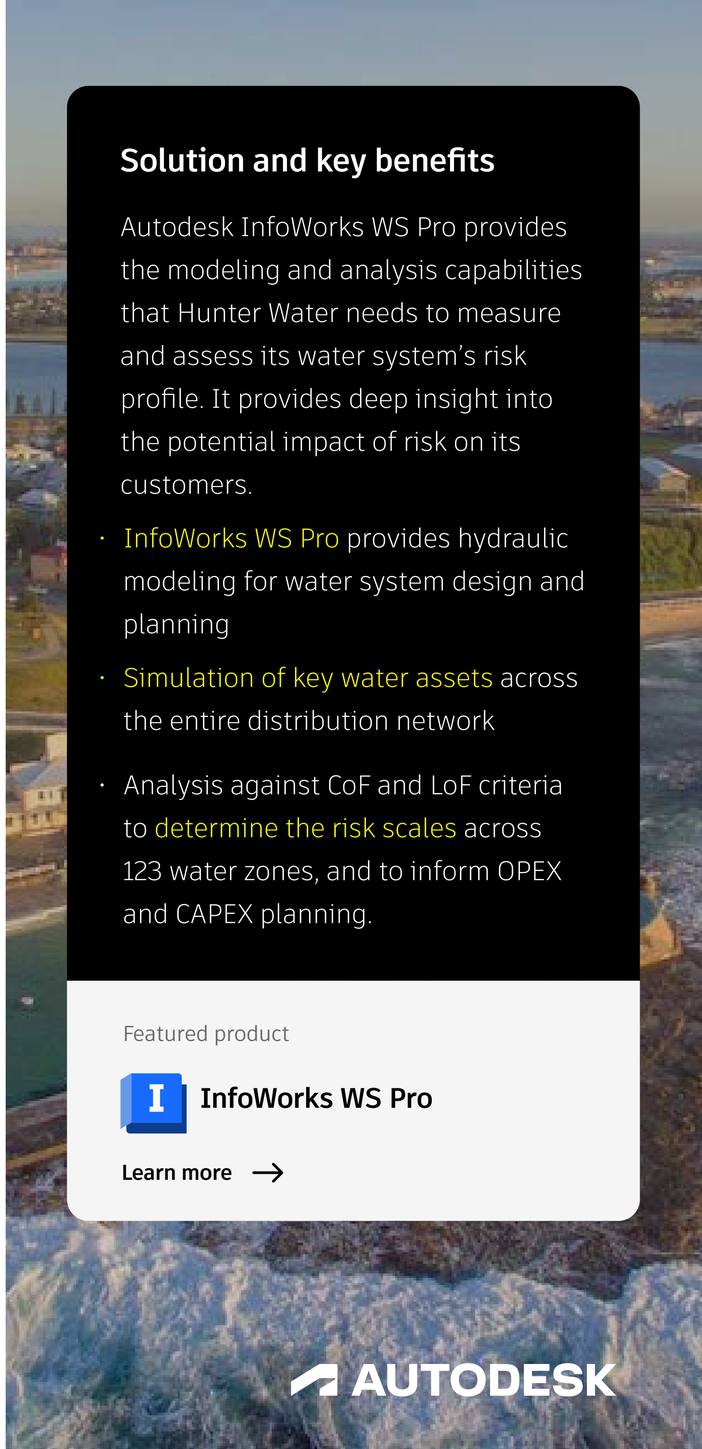
Analytics & visualization

- CoF and LoF for different demand scenarios
- Red, amber, and green flagging based on supply continuity and asset criticality
- Simulation of asset performance
- Reservoir performance under Average Day Demand, Peak Day Demand, Extreme Week Demand

“The hydraulic model using InfoWorks WS Pro is a hugely useful tool to identify and quantify the consequence of asset failure to our customers. This knowledge gives us time to plan ahead and allocate the correct resources that would mitigate the identified risks.”

Andrew Tjiptadi, Project Engineer, Hunter Water Corporation

Read full story



Solution and key benefits

Autodesk InfoWorks WS Pro provides the modeling and analysis capabilities that Hunter Water needs to measure and assess its water system’s risk profile. It provides deep insight into the potential impact of risk on its customers.

- InfoWorks WS Pro provides hydraulic modeling for water system design and planning
- Simulation of key water assets across the entire distribution network
- Analysis against CoF and LoF criteria to determine the risk scales across 123 water zones, and to inform OPEX and CAPEX planning.

Featured product

InfoWorks WS Pro

Learn more →

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InfoWorks WS Pro and IWLive Pro:

Deeper insights into water loss and leakage

The integration of Autodesk InfoWorks WS Pro and IWLive Pro helps to minimize non-revenue water by enabling closer collaboration between planning and operations teams. Hydraulic modeling within InfoWorks WS Pro provides planners with more detailed network results and analysis, connecting f ield telemetry data with assets within the model.

Modeled expected data and live data can be compared within the platform, and operations teams can connect telemetry and SCADA systems to run forecasts of the network behavior in the coming hours and days. Warning and alerts help teams to identify operational problems in the hydraulic model in real-time, allowing them to test optimal what-if scenarios before problems even occur.

Learn more

Solution and key benefits

- **Pinpoint where leaks are likely located** by comparing simulated and observed pressures at monitored locations
- **Demand area analysis** can indicate the volume of excess revenue water and the volume that can be reduced in each area
- **Optimize rehabilitation** by driving the focus of project programmes to the areas where leakage can be reduced the most and targets achieved the quickest

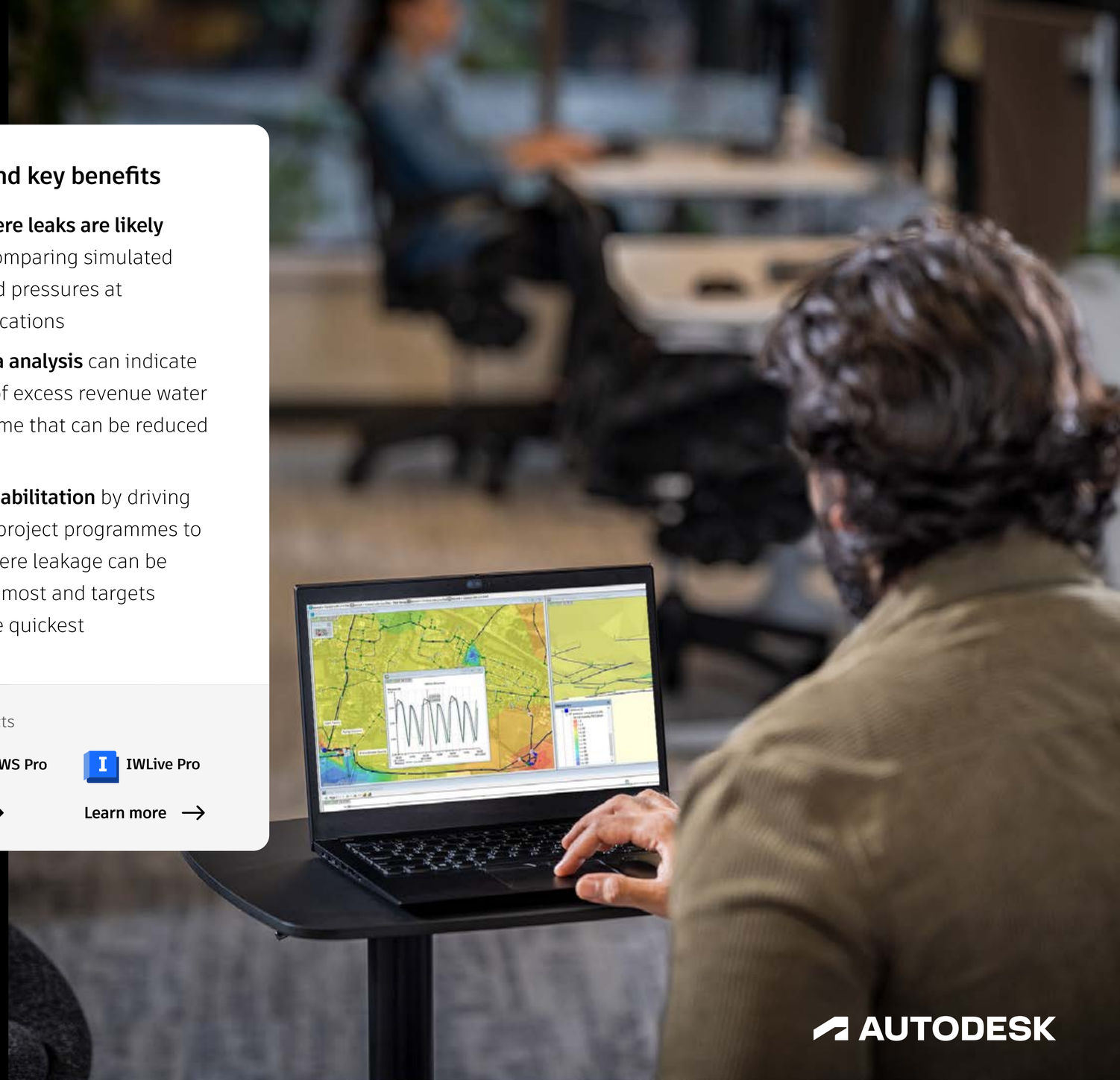
Featured products

InfoWorks WS Pro

Learn more →

IWLive Pro

Learn more →



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InfoWater Pro and Info360 Insight: Dynamic operational modeling with digital twins

Autodesk's integrated approach overcomes data silos, while making digital twin modeling accessible even to less experienced users. The combination of InfoWater Pro and Info360 Insight enables advanced hydraulic simulation, bringing together real-time sensor data, hydraulic models, and GIS-based visualizations within user-friendly, customizable interfaces. This results in fast, efficient calibration and validation of models using the bi-directional connection between InfoWater Pro and Info360 Insight.

Utilities can proactively address system inefficiencies and operational challenges by applying established hydraulic principles through new dynamic modeling technologies, helping to optimize performance, reduce energy costs, and enhance leak detection.

Generate dynamic digital twin hydraulic models with InfoWater Pro and Info360 Insight

Learn more

Solution and key benefits

- **InfoWater Pro** provides seamless integration with ArcGIS Pro, incorporating spatial analysis and visualization, as well as detailed modeling via EPANET 2.2, with precise simulation of hydraulic behaviors across complex networks
- **Info360 Insight** integrates SCADA and real-time sensor data with hydraulic models, enabling immediate operational adjustments
- Regular model updates maintain **continuous calibration and accuracy**, ensuring that the digital twin remains reflective of actual network conditions

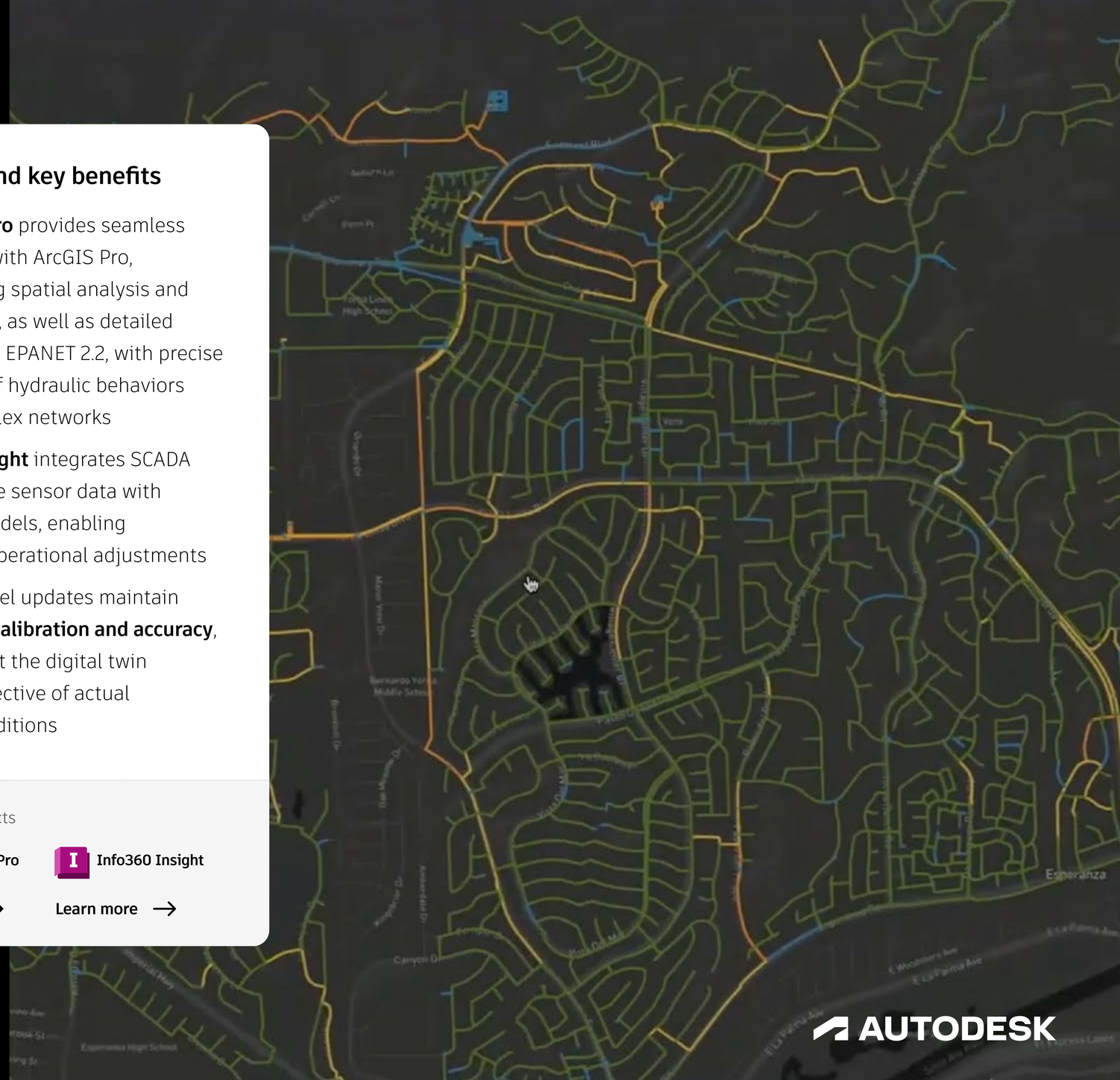
Featured products

InfoWater Pro

Learn more →

Info360 Insight

Learn more →



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InfoWorks WS Pro, InfoWater Pro, and Info360 Asset: Digital twins for asset management

Users of InfoWorks WS Pro and InfoWater Pro (versions 2025 and up) can now share simulated operating conditions for pipes with Info360 Asset. This integration is particularly valuable in scenarios where limited sensor data is available, enabling simulations to guide risk analysis and decision making. It also helps to break down functional silos, by streamlining the collaboration tools between modelers and asset managers.

InfoWorks WS Pro and InfoWater Pro are capable of in-depth pipe failure and isolation analyses, which can also be shared directly with Info360 Asset to provide Likelihood of Failure (LoF) and Consequence of Failure (CoF) metrics of risk analysis. The parallel cloud computing capabilities allow users to run thousands of test cases, providing comprehensive reporting of asset criticality.

Water distribution modeling integration with asset management for InfoWorks WS Pro and InfoWater Pro

Learn more

Now you can use InfoWorks WS Pro and InfoWater Pro simulation results in Info360 risk analyses

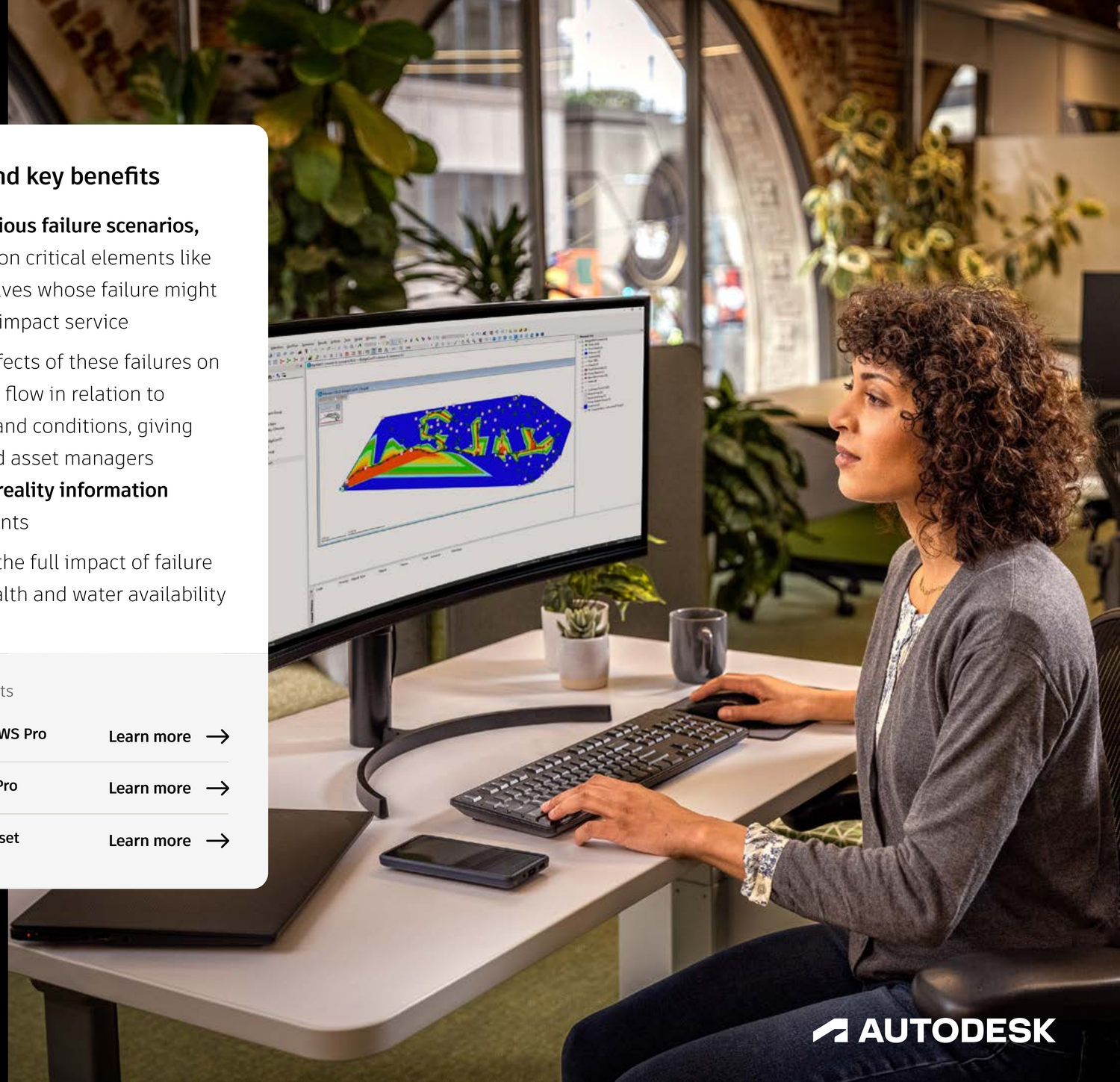
Learn more

Solution and key benefits

- **Simulate various failure scenarios,** and focus in on critical elements like pipes and valves whose failure might significantly impact service
- Model the effects of these failures on pressure and flow in relation to various demand conditions, giving modelers and asset managers **accurate-to-reality information** of failure events
- **Understand** the full impact of failure on public health and water availability

Featured products

InfoWorks WS Pro	Learn more →
InfoWater Pro	Learn more →
Info360 Asset	Learn more →



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Case study #3

Western Virginia Water Authority: Making management software work for everyone

Western Virginia Water Authority has an Asset Management Program covering around 1,200 miles of distribution infrastructure, serving over 200,000 people in a region about 240 miles southwest of Washington DC. Having implemented new asset management software, the next key step was to introduce quality control for the acquisition and maintenance of data across the networks.

Elements of digital twin employed

Physical assets

- Geometric and physical characteristics of assets—GPS surveys, manhole surveys, CCTV surveys

Data sources

- Repair work orders, as-built drawings, development plans

Physical to digital

- Flow monitoring, hydraulic modeling, capacity report

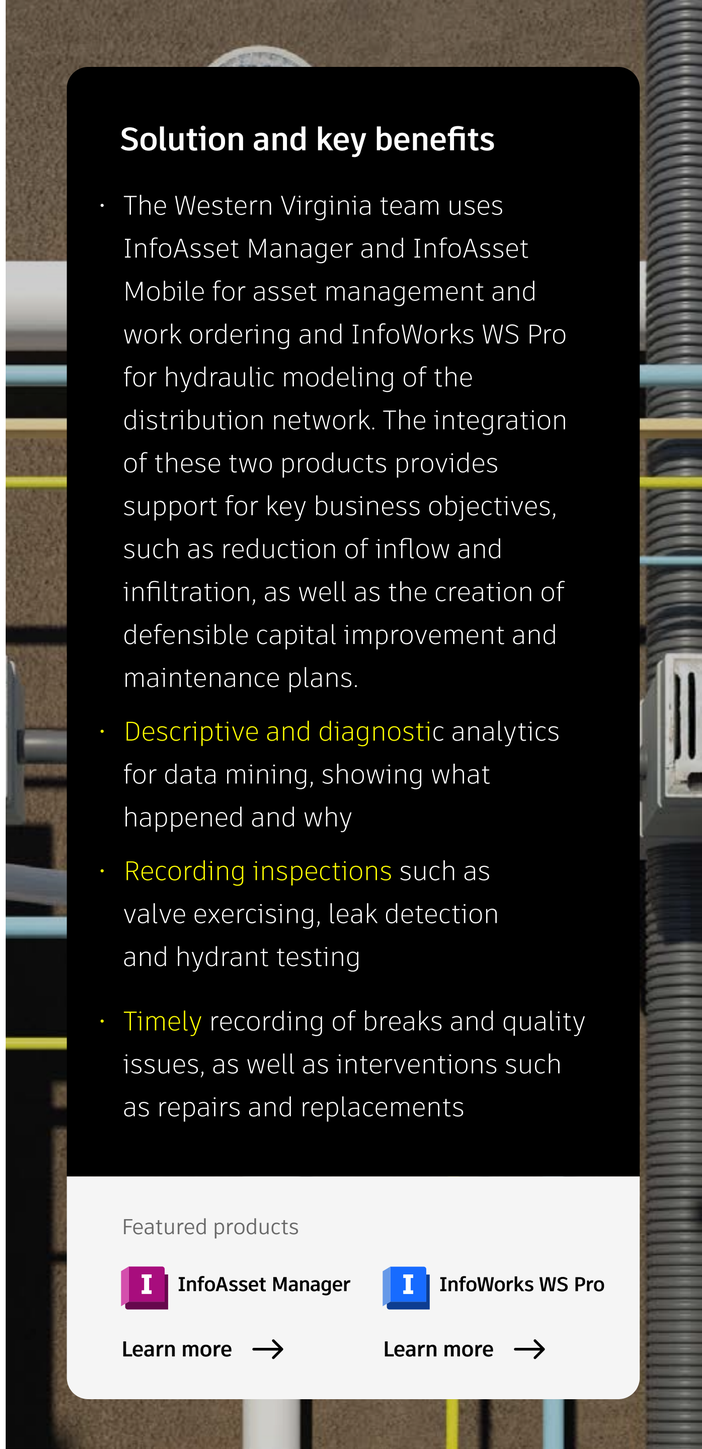
Analytics & visualization

- Scheduling of proactive inspection work, including valve maintenance, hydrant testing, and flow testing
- Recommendation and scheduling of interventions such as pipe, valve, and hydrant renewals

> **In our system, there is no bad project. Over the years, we have developed analytics using the InfoAsset data to quickly identify areas of concern and come up with solutions. I like to keep things simple, understandable and defensible. If I feel that I wouldn't be able to explain a methodology to a Roman engineer from 2,000 years ago, I'm over-complicating matters.**

Jim O'Dowd, PE, AECOM—formerly Water Infrastructure Asset Manager, West Virginia Water Authority

Read full story



Solution and key benefits

- The Western Virginia team uses InfoAsset Manager and InfoAsset Mobile for asset management and work ordering and InfoWorks WS Pro for hydraulic modeling of the distribution network. The integration of these two products provides support for key business objectives, such as reduction of inflow and infiltration, as well as the creation of defensible capital improvement and maintenance plans.
- Descriptive and diagnostic analytics for data mining, showing what happened and why
- Recording inspections such as valve exercising, leak detection and hydrant testing
- Timely recording of breaks and quality issues, as well as interventions such as repairs and replacements

Featured products

InfoAsset Manager Learn more →

InfoWorks WS Pro Learn more →

Info360 Insight: Cloud-based operational intelligence for water treatment plants

Info360 Insight is a cloud-based operational analytics solution built to improve a plant's performance, regulatory compliance, and improvement planning. It allows utilities to take the wealth of data and insights generated by the plant across the infrastructure and turn them into authoritative reports, breaking down functional and technological barriers to provide a single source of truth.

Users can utilize treatment plant asset data, live data, and sensor data to create a digital twin of the treatment plant. Customizable workflows, with personalized workspaces, meet both individual and team needs. Integrated analytics help to measure and improve business performance and keep costs down, by tracking energy usage, optimizing chemical usage, and giving deeper insights into the costs of downtime. Sensor health is also monitored to alert operations to calibrate or plan replacement of the affected sensor.

Learn more

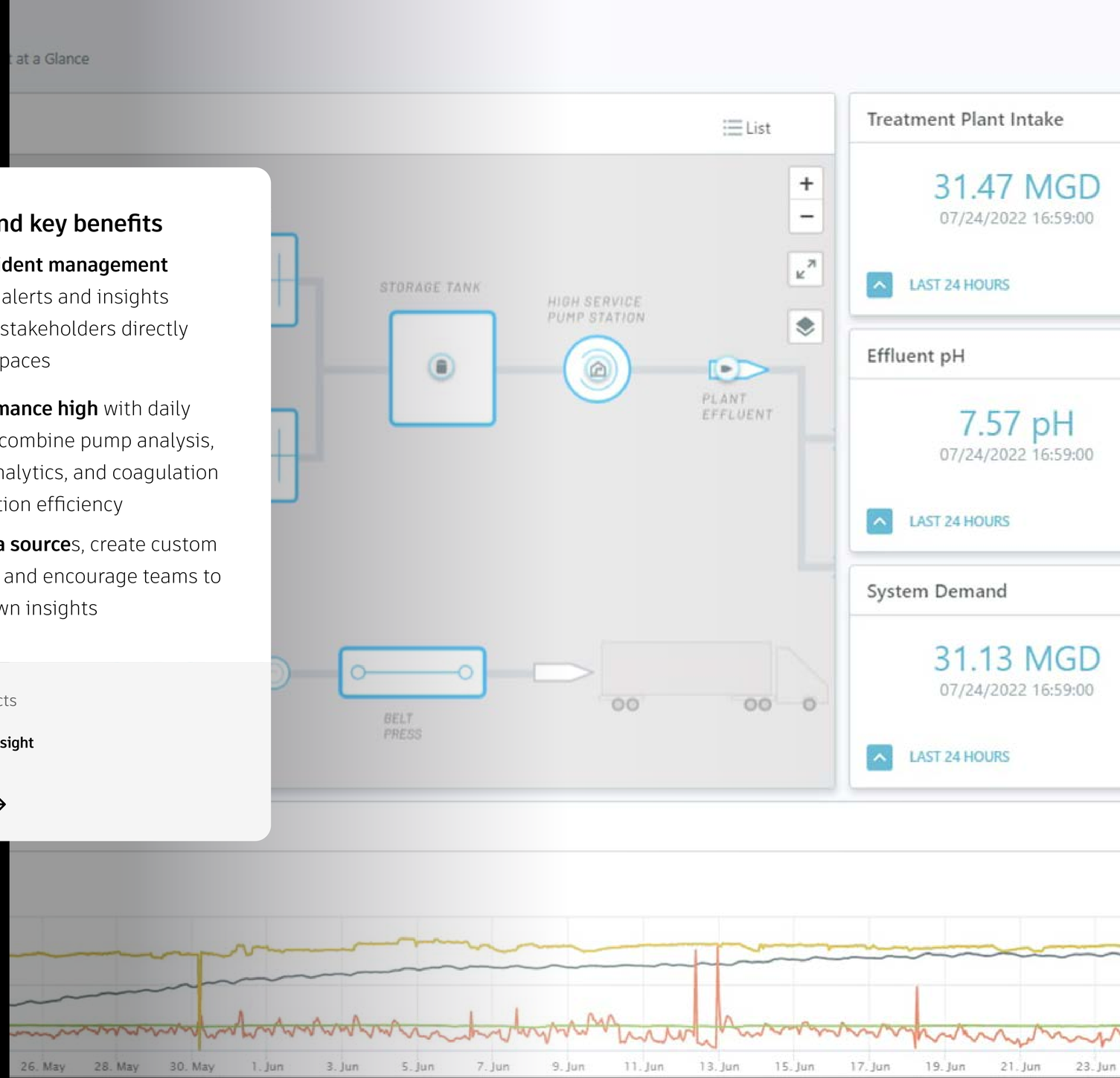
Solution and key benefits

- **Improve incident management** with custom alerts and insights gained from stakeholders directly inside workspaces
- **Keep performance high** with daily reports that combine pump analysis, bioreactor analytics, and coagulation and flocculation efficiency
- **Connect data source**s, create custom calculations, and encourage teams to track their own insights

Featured products

Info360 Insight

Learn more →



04

Digital twins: Reliable, high-precision modeling and simulation for an unpredictable world

Part 04

More than ever, the water distribution sector needs innovation. But the associated risks must not be too high. Economic and political uncertainties, combined with extreme climate events, are intensifying challenges across water distribution engineering and operations management. Any new solution must be time-tested and easily adaptable to meet the specialized requirements of water distribution professionals.

Digital twins have demonstrated their value. They are widely embraced in other fields of engineering and, as our case studies confirm, they are already delivering impressive results in some of the most complex settings worldwide.

Focused adoption

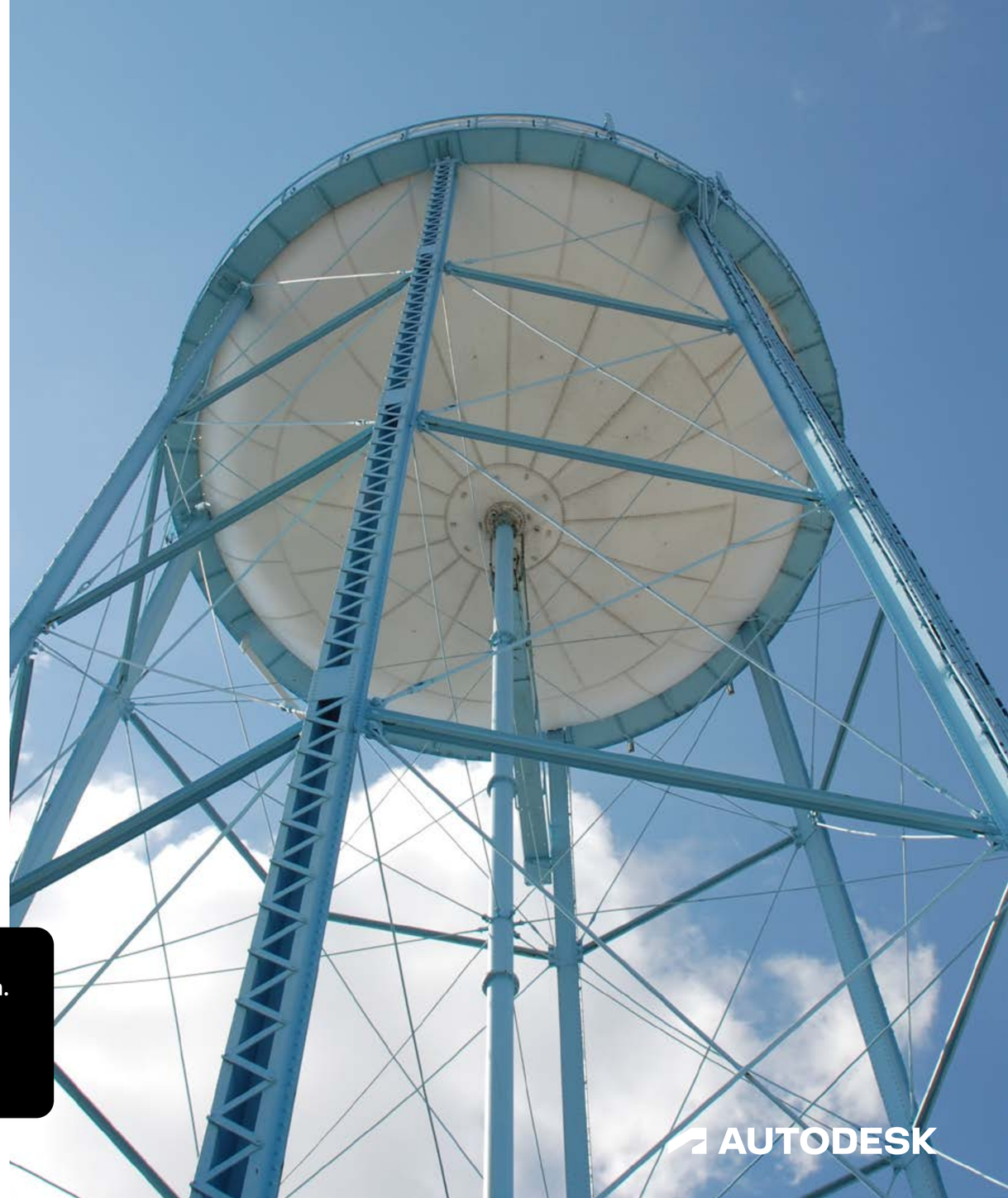
The initial step towards adoption need not be on too grand a scale. Many organizations are rolling out digital twins in niche areas, where a smaller data set is sufficient to build a functional and valuable model. For example, addressing localized pressure issues, handling specific service disruptions, or managing new distribution projects can all benefit from digital twins that operate effectively without requiring enterprise-wide data inputs.

Securing the future

To unlock the full potential of digital twins, it's crucial to integrate data analytics with your organization's long-term strategic objectives. When these insights align with your broader goals, the complete range of operational, financial, and cultural advantages begins to emerge.

We can help you get started with your digital twin.

Talk to us



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Autodesk technologies deliver versatile, scalable digital twins

InfoWater Pro

Hydraulic modeling tool for water distribution networks that runs cloud or local simulations, built in Esri's ArcGIS Pro. It provides users with a wide range of analyses to plan, extend, and manage the water distribution system effectively by modeling a digital twin of their water network.

Learn more

InfoWorks WS Pro

Water distribution modeling software that allows data to be managed effectively in the cloud or locally. Models can be built efficiently, with results presented clearly through a digital twin model. As a workgroup application, multiple users can work in the same model simultaneously, benefiting from the scalability of the cloud as needed for very fast compute-heavy simulations.

Learn more

IWLive Pro

Real-time simulation and management software for water distribution systems. It integrates with SCADA systems to utilize real-time data from sensors and control systems to provide sophisticated hydraulic modeling capabilities. Users can accurately simulate network behavior to support operational decision-making, emergency response, and maintenance planning.

Learn more

Info360 Insight

SaaS application for operational analytics, incident management, and compliance reporting, which unifies water distribution and treatment plant data in the cloud. Users can work with sophisticated analytics, modeling, and alerting tools, to make operational information more accessible, reliable, and actionable.

Learn more

Info360 Asset

Cloud-based application for condition and performance monitoring and assessment. It delivers connected assets together with historic and current inspections, in an easy-to-use, easy-to-access web application. Asset intervention plans can be based on simple or complex decision queries by using asset, condition, and risk data, and supporting external data.

Learn more

InfoAsset Manager

Comprehensive asset management suite that helps integrate, manage, and optimize water distribution assets. It provides robust visualization, reporting, and risk-based prioritization capabilities to support operational decisions, proactive maintenance, and efficient emergency response.

Learn more

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