(More than) Plugging Leaks: A Holistic Approach to Water Operations Management

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INTRODUCTION

Water is a precious and finite resource, essential for life, economic development and environmental sustainability. As global populations grow, water scarcity challenges become more pronounced and climate change intensifies, the pressure on water utilities to manage this vital resource efficiently has never been greater. Traditional methods of water loss management, while effective to a degree, often fall short in addressing the complex and interconnected challenges faced by modern water utilities.

A holistic approach to water loss management offers a comprehensive solution that integrates multiple strategies to optimize water use and minimize losses. This approach encompasses non-revenue water (NRW) mitigation, with a focus on leak detection; pressure management; pipe asset management; and consumer engagement.

Learn More: Non-Revenue Water

Want to know more about NRW, how it impacts your operations and revenue—and how you can address it? Download this white paper today.

With this type of water management strategy, utilities can achieve significant improvements in operational efficiency, cost savings and service reliability, while also contributing to broader environmental and sustainability goals. Key elements of a holistic approach include:

- **Leak Detection:** Advanced leak detection technologies enable utilities to identify and address leaks promptly, reducing water loss and preventing potential damage to infrastructure. This also helps protect utility revenue and can help promote customer satisfaction.
- **Pressure Management:** Effective pressure management helps to minimize the stress on pipes, reducing the likelihood of bursts and leaks, and extending the lifespan of the water distribution network.
- **Pipe Asset Management:** Proactive maintenance and timely replacement of aging infrastructure ensure the reliability and efficiency of the water supply system.
- **Consumer Engagement:** Providing greater insights and outreach to consumers can bolster relationships. Educating and involving consumers in water conservation efforts fosters a culture of sustainability and encourages responsible water use.

By integrating these elements into a cohesive water management strategy, utilities can not only enhance their operational performance but also play a crucial role in safeguarding water resources for the communities they serve.

To best manage their water distribution network and meet their goals of revenue protection, resource conservation and customer satisfaction, today's utilities must make use of the most effective tools for monitoring and analyzing water distribution across all these facets.

Revenue can be lost due to many factors including inaccurate measurement and billing, tampering, harsh environment and leaks caused by many problems including aging infrastructure.

A three-pronged approach, starting with the highest quality metering technology, real-time data analytics reporting and software, and predictive intelligence delivers the needed combination to help utilities manage costs and maintain a healthy water delivery ecosystem for their communities.

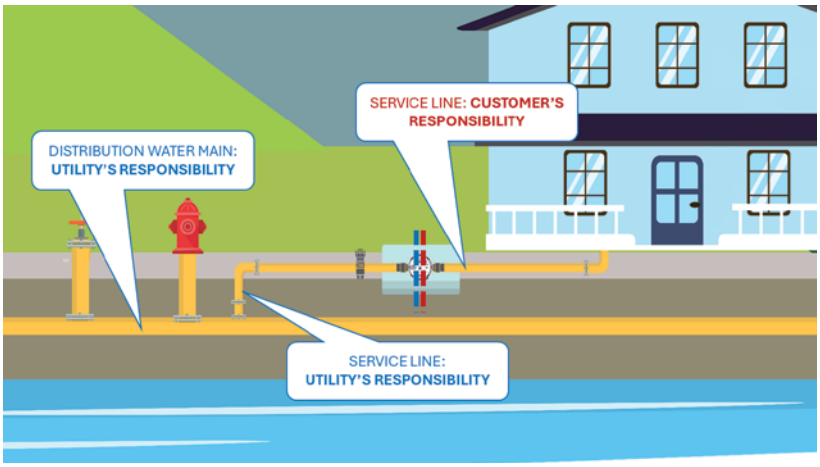
1. LEAK DETECTION: INSIGHTS FROM ACROSS THE DISTRIBUTION SYSTEM

Leak detection is critical at every level of the system, not just at the metering device (service point) or at a few select locations throughout the network. To properly locate and remedy leaks, **system-wide intelligence is crucial.**

Meters with either embedded leak detection sensors or add-on modules can help detect leaks within the service line (leading directly into the customer premise) and behind the meter into the consumer's home or business. Detecting leaks in these pipes can help reduce NRW levels for the utility as well as water loss for customers—which can also lead to increased customer satisfaction by communicating with consumers about potential leaks that are their responsibility to repair and providing solutions to repair these leaks, save money and conserve water.

However, leak sensors placed only at the meter service point do not provide visibility to a much larger part of a utility's distribution system: the primary water mains and secondary mains leading to a customers' property. Leaks in these lines are typically substantially larger and far costlier to utility operations than those on service lines or behind the customer meter.

Global estimates place 7-8% of all leaks within mains—issues that directly impact utility revenue and must be addressed quickly (sometimes within two hours before a leak becomes a major issue). A utility in Australia has found that ~10% of its leaks comes from distribution mains, with the remaining ~90% in service lines in front of the meter. Even though the percentage might seem small, leaks from distribution mains are much more impactful in terms of water loss and overall damage and are considered a priority.



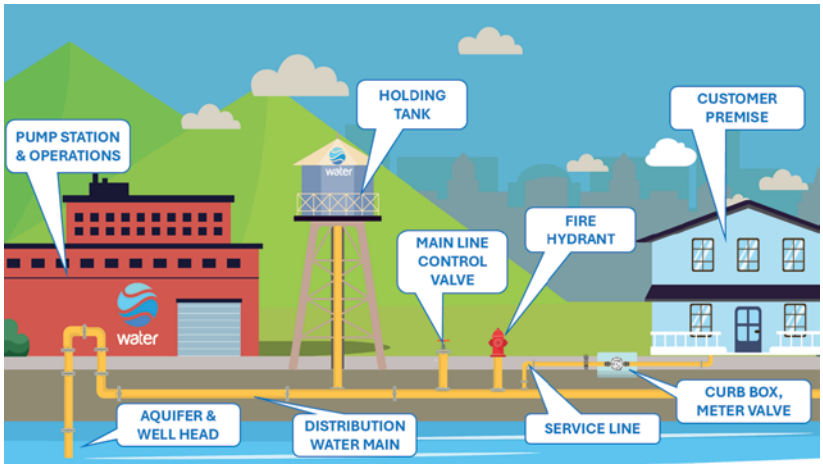
Typical leak locations and responsibility for fixing a leak.

For the most reliable leak detection methods, data must be collected throughout the delivery system, from beginning to end, with sensors present in key strategic locations of the network to provide actionable data, at the right time, to the analytics platform. With sensor data collected throughout the system—including from mains, service lines and at customer homes or business—leaks can not only be detected but in some cases even prevented.

There are two primary types of leak detection technologies available, both of which can be successful at detecting and helping locate leaks: acoustic leak sensors and pressure sensors. Each has its own pros and cons, including placement in the system, total cost and other considerations. Hybrid deployments that include both acoustic loggers and pressure sensors leverage the best of technologies and provide the best insights into issues throughout the system.

Regardless of the technology deployed, it is critical to have keen intelligence throughout the network to pinpoint leaks not just where they start or at the meter, but everywhere water flows through the network to identify the source of the problem and fix it quickly. Gathering and analyzing data end-to-end is critical to help manage the entire distribution system.

Leak sensors are extremely critical and beneficial for leak detection success—and overall NRW reduction. Their location is essential—the diagram below shows the many different strategic points in a water network where utilities might want to track leakages.



Water distribution system locations where leak detection is beneficial.

For reliable leak detection across the distribution system, there are several key components that should be considered:

» Meters

» Data collection systems

» Software and analytics

SMART METERING: QUALITY MATTERS

One essential device in the leak detection value chain is the meter itself. As one of the primary—and most valuable—data collection points throughout the entire network, the right meter is a long-lasting intelligence asset that can help monitor and manage the health of your water distribution network for decades.

There are multiple types of utility-grade water meters available today—such as turbine, velocity, volumetric displacement and ultrasonic—as well as communications protocols and modules to connect these meters to utility data collection systems.

As part of a holistic solution, smart water meters must serve two essential functions: collecting granular and accurate data and delivering that data to an analytics platform.

Smart metering is quickly becoming the technology of choice for several reasons:

» Water meters, depending on technology and vendors, can achieve high accuracy even at low flow rates. A highly accurate meter can detect small leaks in customers' homes while some meters may struggle to accurately detect leaks at lower flow rates.

» Faster detection of household leaks enhances customer satisfaction by enabling utility service representatives to help customers identify potential leaks, recommend remedies and help customers save both money and water. Reduction of household leaks also helps utilities reach water conservation goals.

» Meter resiliency and reliability are critical, especially in harsh conditions such as high humidity, temperature extremes or when particles, limestone or chlorine are present. These factors often determine the choice of meter technology and vendor. Solid-state metering, for example, are well-suited for environments with the presence of particles in the water since they have no moving parts.

» A well-designed meter ensures durability and reliability, often performing effectively for 15 years or more, saving time and expense from continual maintenance and replacement. This 15-year life span can only be met if the meter (or communications module) benefits from a robust design, encompassing quality materials and assembly practices, dependable battery management, water tightness, and stringent testing for quality assurance.

» With networked deployments and meters/sensors equipped with optimized battery management that balances longevity with data transmission frequency, more data can be collected more frequently from more endpoints across the system. This enables faster insights to water loss—not just from leaks, but from other factors affecting the distribution system, such as aging infrastructure and water tampering.

The Itron Intelis® wSource™ Meter and Cyble™ 5 communications module

Intelligence starts here.

» Smart metering with onboard communications (Intelis wSource) or add-on communications module (Cyble 5).

» Revenue protection for the life of the meter.

» Household leak detection features to help utilities achieve water conservation goals

» Durable components to extend device life and lower operating costs.

» Integrated network communications with AMR backup options.

» Interoperable with open standards.

DATA COLLECTION SYSTEMS

Meters and leak sensors installed in the field are only part of the solution. To achieve actionable insights, these devices must integrate into a robust data collection system that gathers and transmits water intelligence to back-end utility systems for analysis.

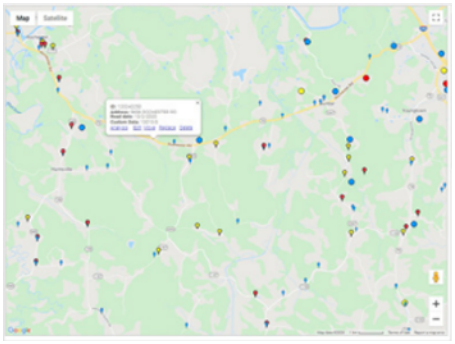
Modern water automation and control solutions can detect leaks, accurately report consumption and manage non-revenue water within minutes instead of weeks. These systems achieve this by communicating through either a fixed advanced metering infrastructure (AMI) network or mobile data collection (automated meter reading, or AMR) system at more frequent intervals. AMI systems increasingly leverage cellular endpoints for communication and can provide data as frequently as every 15 minutes.

Severn Trent Water, which serves over 8 million people in the United Kingdom, has been able to reduce customer consumption and household leaks thanks to their smart water program. In just over 2 years, with less than 10% asset base under AMI, Severn Trent has achieved more than a 2-million-litre reduction in water loss from identifying and repairing supply-side leakages—and a 4-million-litre reduction from identifying and repairing leaks at customer homes. Read more about Severn Trent's smart water program here.

SOFTWARE FOR ANALYSIS, REPORTING AND ACTIONABLE DATA INSIGHTS

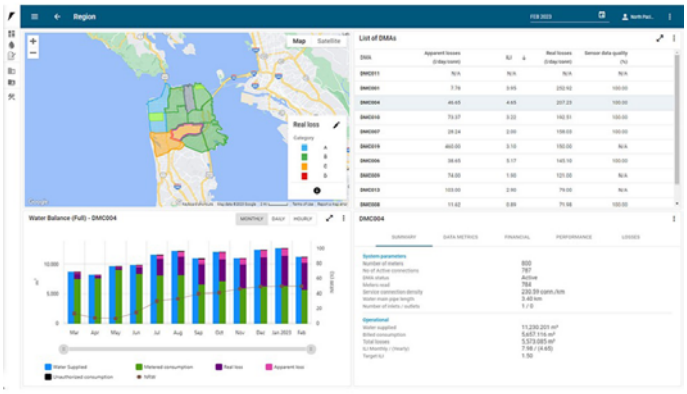
Once data is collected from the meters or sensors and transported to the utility headend system for analysis, it can be harnessed to identify and address leaks throughout the distribution system. This data also enables a range of utility-side benefits, including improved asset management, revenue protection, operational efficiency, regulatory compliance and enhanced customer service.

The more data collected across the network, the more powerful software applications and analytics platforms become. With access to larger datasets, these applications can generate deeper insights and actionable outcomes, empowering utilities to address both supply-side and customer-side leaks effectively[1].



Leak detection dashboard identifying potential leak locations.

Visibility into the entire water system or district metered areas (DMAs) can come from all levels of the network, including field sensors, SCADA systems, hydraulic modelling software, geographic information systems (GIS), customer information systems (CIS) and meter data management (MDM) solutions.



Dashboards and reporting bring together data in one unified platform, to show water management mapping, account information, DMAs and water balance levels.

For more detailed information about Itron's solutions to reduce Non Revenue Water, please read our NRW white paper.

[1] For an introduction of general practices for Non Revenue Water reduction (including water balancing and district metered area monitoring) we suggest the following presentation from the World Bank: Microsoft PowerPoint - 1 Basics in NRW & Water Balance_GS_final.pptx

2. PRESSURE MANAGEMENT: NAVIGATING THE HIGHS AND LOWS

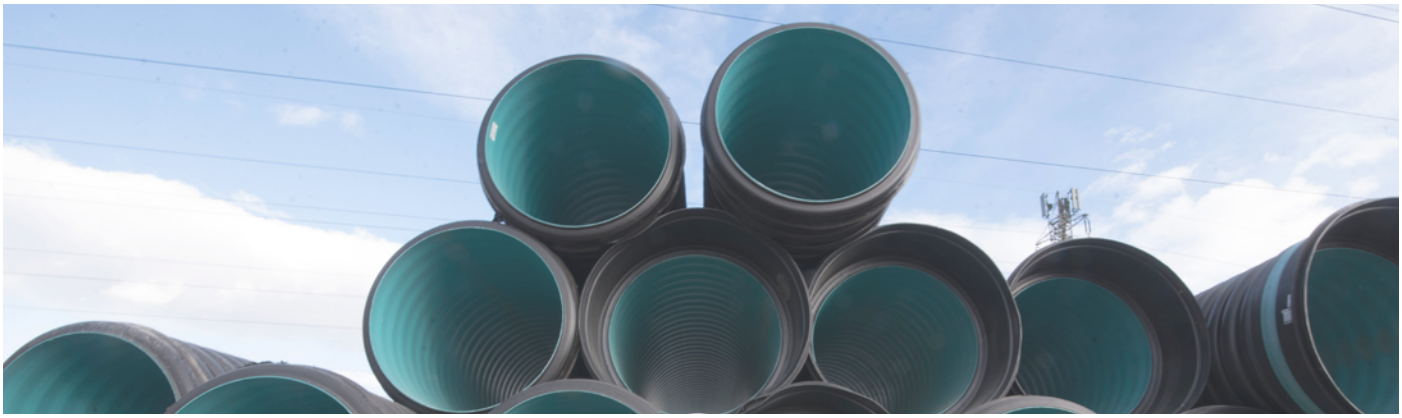
Water pressure—both high and low—in the distribution system strongly influences burst frequency and leak flow rates on mains and service connections, and therefore also influences expenditure on active leakage control, repairs and asset replacement. Pressure management solutions are crucial for water providers aiming to optimize their water distribution systems and reduce water loss. Key benefits include:

- **Reduction of Leaks and Bursts:** By maintaining optimal pressure levels, water utilities can significantly reduce the stress on pipes, which helps to minimize leaks and prevent pipe bursts. This is particularly important in aging infrastructure where high pressure can exacerbate weaknesses.
- **Enhanced Water Quality:** Effective pressure management helps maintain consistent water quality throughout the distribution system. By avoiding pressure fluctuations, utilities can prevent contaminants from entering the system through leaks or backflow.
- **Energy Efficiency:** Managing pressure efficiently can lead to energy savings. Lowering pressure reduces the energy required for pumping water, which can result in lower operational costs and a smaller carbon footprint.
- **Extended Infrastructure Lifespan:** Reducing the pressure on pipes and other components of the water distribution system can extend their lifespan. This means fewer repairs and replacements, leading to long-term cost savings and more reliable service.
- **Improved Customer Service:** Consistent and optimal pressure levels ensure that customers receive a reliable water supply with adequate pressure for daily use. This can enhance customer satisfaction and reduce complaints related to water pressure issues.
- **Water Conservation:** By minimizing leaks and bursts, pressure management directly contributes to water conservation efforts. This is critical in areas facing water scarcity or drought conditions.

As part of a holistic approach to water operations, pressure management plays an important role in the overall health of the water distribution network. There are several key technologies involved in successful pressure management implementation:

- **Pressure Reducing Valves (PRVs):** These devices automatically adjust the pressure to optimal levels, reducing the risk of leaks and bursts.
- **Variable Speed Pumps (VSPs):** These pumps adjust their speed based on the demand, ensuring that pressure remains consistent without wasting energy.
- **Advanced Monitoring Systems:** Integrating pressure management with Supervisory Control and Data Acquisition (SCADA) systems allows for real-time monitoring and adjustments, ensuring optimal performance across the network.

By adopting these pressure management solutions, water providers can achieve a more efficient, reliable and sustainable water distribution system.



3. PIPE ASSET MANAGEMENT: PUTTING THE POWER OF AI TO WORK

When pipe failures happen, they are often unpredicted and, in the case of non-surfacing leaks, go undetected. Across the E.U., much of the 7 million kilometers of pipe have been in operation for over 100 years. Modernizing this aging infrastructure to safeguard health, protect the environment, and to reduce costs would require a doubling of the annual investment of €45 billion.

In the U.S. and Canada, it is estimated that over 450,000 miles of water pipes have exceeded their useful lifespans and require replacement. Meanwhile, in water-scarce Australia, non-revenue water (NRW) accounts for approximately 10% of total water delivered annually.

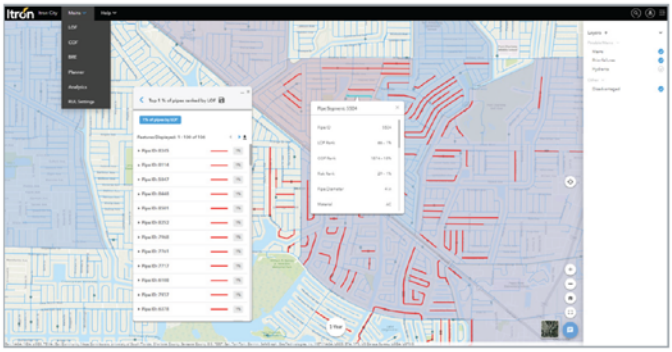
Main breaks can cost utilities up to $6 million in some regions, factoring in pipe repairs and damages caused by water, while also attracting negative media attention and leading to dissatisfied customers. Undetected pipe failures are equally costly, with millions of gallons of water lost daily around the world.

To address these challenges, leading technology companies are leveraging AI and machine learning combined with distribution system data to improve leak detection and predict where—and when—underground pipes are most likely to fail.

Innovative platforms leverage machine learning to develop analytics capable of identifying, predicting, and prioritizing potential water pipe failures BEFORE they occur. It is critical to establish system wide data collection to properly leverage AI technology.
The more robust and timely the data, the greater the accuracy and effectiveness of the platform's predictive capabilities for utilities.

A solution dashboard exemplifies the valuable insights that can be gained through a system-wide approach to leak detection and preventative maintenance.

By leveraging data collected throughout the water network, AI becomes a powerful tool for utilities, enabling them to prioritize the repair and replacement of vulnerable water mains, allocate asset management resources more effectively, and significantly reduce the risks of pipe failure and major leaks.



The red pipes outlined in this interactive map show risk areas where AI has identified potential pipe failure.

Itron + VODA.ai

Itron's latest partnership with VODA.ai brings a revolutionary solution, **Pipe Asset Management**, to water utilities to help them prioritize the replacement of vulnerable water mains, optimize asset management resources and reduce destructive risks. The innovative platform uses machine learning to build analytics that can identify, discover and predict leaks from aging infrastructure, tampering or other sources of water loss.

4. CONSUMER ENGAGEMENT: INFORM, EDUCATE, CONSERVE

Consumer engagement also plays a crucial role in the effective management of water distribution networks. Engaging with consumers can increase education about water-related issues, encourage conservation and even improve customer satisfaction scores. Better consumer engagement can lead to:

- **Increased Awareness and Education:** Share knowledge about water conservation and the importance of efficient water use.
- **Enhanced Trust and Transparency:** When consumers understand the challenges and efforts involved in water management, they are more likely to support initiatives and comply with regulations.
- **Improved Leak Detection and Reporting:** Reduce lost water by encouraging customers to report leaks and providing easy channels for doing so.
- **Behavioral and Consumption Changes:** Promote water conservation through better behavior.
- **Feedback and Continuous Improvement:** Utilities can make informed decisions to enhance service quality and operational efficiency
- **Support for Infrastructure Projects:** When consumers understand the benefits and necessity of upgrades or new projects, resistance is reduced for smoother implementation.

Ongoing consumer engagement—during infrastructure projects as well as throughout day-to-day water utility operations—requires a multifaceted and well-executed approach that leverages communication, transparency and meeting customers where they are. By prioritizing consumer engagement, water utilities can create a more informed, cooperative, and proactive community, leading to better management of water resources and a more sustainable future.

CONCLUSION

In the face of increasingly scarce water resources, developing and deploying an effective water management strategy takes a multi-faceted approach. Today's utilities must harness intelligence across the entire water delivery system to gain insights and actionable data. This enables them to address leaks and NRW, maintain balanced pressure throughout the network, predict pipe and asset failures, perform preventative maintenance before issues arises, and engage consumers to promote satisfaction, conservation and sustainability initiatives.

The foundation of this strategy starts with the highest quality solid-state metering technology, complemented by software solutions that collect data across all points in a water network. These solutions consolidate data into actionable insights on user-friendly platforms enhanced by machine learning, enabling predictive, cost-saving actions.

Armed with data from the entire delivery system—not just at the metering service point—utilities can achieve common goals of revenue protection, resource conservation and customer satisfaction.

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