

# Building Smarter, More Resilient Water Networks Through Advanced Risk Analysis

## The Growing Challenge of Aging Water Infrastructure

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It's no secret that aging infrastructure is a critical issue for water utilities in the United States. More than half of America's public water systems identify aging infrastructure as their primary challenge, and the American Society of Civil Engineers (ASCE) awarded our nation's drinking water infrastructure a C- grade in its 2025 Report Card, noting that some \$625 billion of investment is necessary during the next 20 years to bring it to standard.

Water utilities are acutely aware of the need to modernize and upgrade, but with limited resources they're forced to prioritize. Budgetarily constrained to replacing approximately 0.5-1% of the network in any given year, the simplest approach is to replace the oldest pipes first. However, pipe age isn't a reliable predictor of failure, and utilities using age alone are exposing themselves to the risk of costly, disruptive and damaging main breaks.

Identifying and quantifying risk within the network is key to effective, efficient asset management, planning and resource allocation. However, critical assets being buried underground presents a unique challenge. To address this, utilities typically employ one of the following commonly used risk-assessment methods.

### Traditional Approaches and Their Limitations

**Asset condition assessment** relies on a combination of field inspections, condition ratings and a degree of expertise to assess likelihood of failure. Traditionally the method used by most utilities, it's a manual process, limited by the experience of the teams conducting the assessment. An aging workforce places this technique at increasing risk to loss of expertise through retirement.

**Statistical analysis** uses statistical failure models to estimate the probability of failure based on asset age, material, environment and historical break rates. Its great strength is also its biggest weakness: data. A lack of historical data limits its effectiveness by oversimplifying complex, multi-factor failures.

Hydraulic and water-quality **simulation risk modeling** employs hydraulic network models to simulate how failures would impact service levels, pressure and water quality, overlaying failure probability to derive risk. While beneficial for "what if" modeling and emergency planning, it doesn't directly quantify the risk of failure.

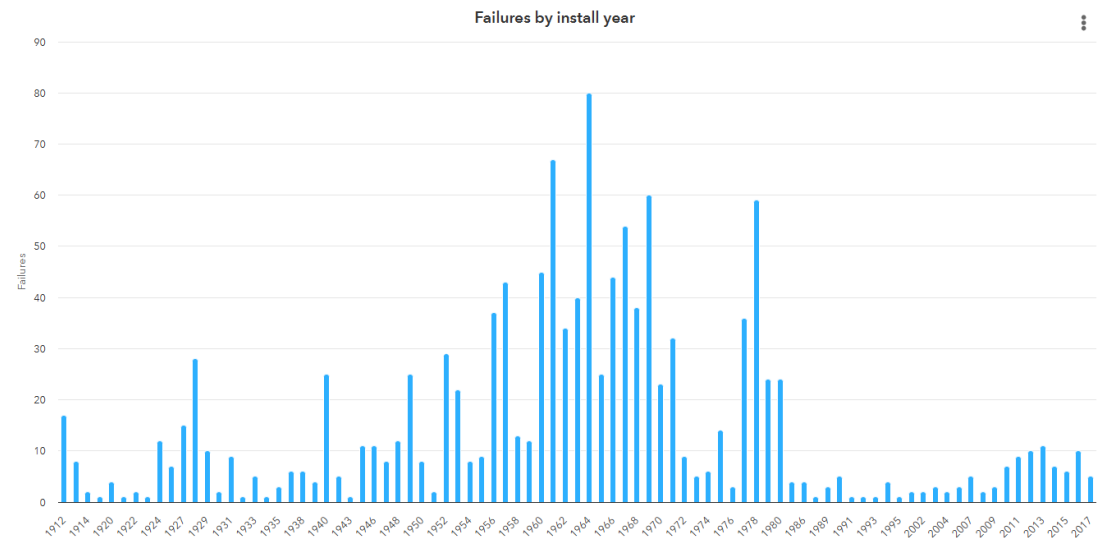
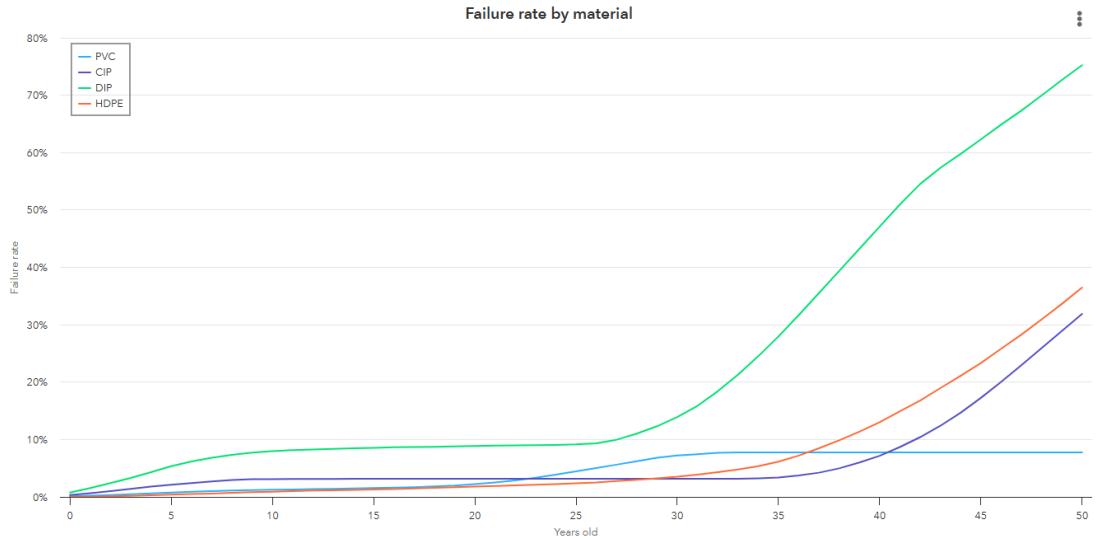
**GIS-based risk mapping** uses spatial datasets such as pipe age, leak history, soil characteristics and so on to display “heat maps” of relative risk throughout a network. While valuable for simplifying and visualizing complex data, it’s typically more backward-looking than predictive and relies upon subjective weighting of risks.

**Predictive modeling** uses artificial intelligence (AI) to analyze large, complex datasets and derive likelihood and impact of failure throughout the network. By training it on key asset, operational and environmental data—including SCADA data, soil corrosivity, weather patterns and pipe attributes—the AI can identify hidden patterns it can use to assess the risk of future pipe failures. This machine learning improves its accuracy and reliability and means that every new piece of data enhances its understanding of the network.

## How Predictive Modeling Transforms Infrastructure Management

Of the above methods, predictive modeling using AI is emerging as the most effective and efficient approach. Its ability to analyze vast datasets and identify patterns and correlations—both within and between them—replicates decades of human experience and expertise, while its machine-learning capability continuously incorporates new data and refines and improves its analyses.

Having worked extensively with the CivilSense™ risk-analysis tool, I can attest to such performance firsthand. On a recent project in California, the utility wanted to assess the accuracy of CivilSense™ vs. traditional risk-analysis methods, using known data as a benchmark. It provided recorded failure data for 2023-2024, and CivilSense™ was assessed against the utility’s traditional methods of pipe-age and prior-failure assessments.



Failures per 100 miles by install year

After training on the network data, CivilSense™ achieved **97.6% median accuracy**, meaning it accurately predicted nearly all failures in 2023-2024. This was **3.4 times more accurate** than the prior-failures method, and **8.5 times more accurate** than the pipe-age method. Needless to say, the utility was confident in the results and were happy to deploy CivilSense™ to optimize their water distribution network.

## Beyond Accuracy: The Broader Benefits of AI-Driven Risk Assessment

The benefits to the utility of an AI-driven solution extend beyond the accuracy of the risk assessment. Water utilities are short on resources, so by taking on complex, time-consuming activities, the AI enables teams to be redeployed to address other priorities. And as experienced operators retire, knowledge, experience and expertise are lost; an AI-led approach helps fill that gap quickly and easily.

Learn more by scanning the accompanying QR code.

