

CASE STUDY

ETRA SpA Sb Italy

Integrating Physical Inspections and Artificial Intelligence (AI) to Improve Pipe Renewal Planning

Key Points

- **Hybrid Approach:** Combined extensive field inspections, soil and water analysis with asset and leaks/breaks history data for an AI-enhanced risk modeling aiming at improved pipeline management.
- **Data-Driven Risk Models:** Developed Likelihood of Failure (LoF) and Consequence of Failure (CoF) models using diverse data inputs and participatory stakeholder process.
- **Scalable Optimization:** Applied multi-criteria optimization to build and compare pipe replacement plans under budget constraints.
- **Impactful Results:** Delivered an optimized renewal plan removing 6% of network risk, compared to previous planning method that removed only 1%.

System Description

ETRA SpA Sb operates a drinking water network serving almost 600,000 residents across Northern Italy (roughly 1,700 km²). Their 5,400 km network includes aging infrastructure in varied environmental conditions. The multi-utility aimed to modernize its asset management approach across its Ambito region. The project focused on assessing pipe condition, evaluating risks, and optimizing renewal strategies in a representative regional section of the system.

Purpose

The primary challenges the utility was facing were infrastructure degradation, increasing of leak & burst repair costs and of non-revenue water volumes.

Regulatory pressures, such as the PNRR (Italy's adaptation of the NextGenerationEU plan), emphasized the need for modernization through digital solutions. ETRA responded through strategic, risk-informed renewal planning that could justify and guide efficient capital investment.



HIGHLIGHTS:

6 times greater reduction of
Network Risk Compared to
Manual Plan

€2M in Projected
Break-Repair Savings
Over 25 Years

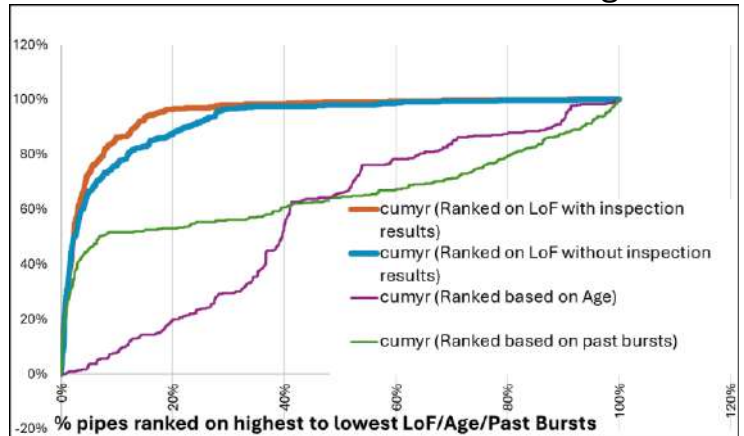
Project Scope

SUEZ Italy, SUEZ CIRSEE Research Center and Optimatics delivered a pilot using AssetAdvanced™ to create a comprehensive pipeline condition assessment and risk-based planning initiative.

The foundation of the project began with a physical and environmental diagnostics program including 80 soil and pipe samples, water quality analysis, pressure monitoring, and targeted inspections—with AI-driven modeling.

A Likelihood of Failure (LoF) model incorporated asset, operational (leaks and pressure), and environmental data, while a Consequence of Failure (CoF) model was co-developed with Etra to prioritize critical risk factors. These models were integrated into the AssetAdvanced Planning and Prioritization (P&P) module to evaluate over 100,000 renewal scenarios, optimizing investment plans for maximum risk reduction, cost efficiency, and alignment with regional infrastructure priorities.

Likelihood of Failure Modelling



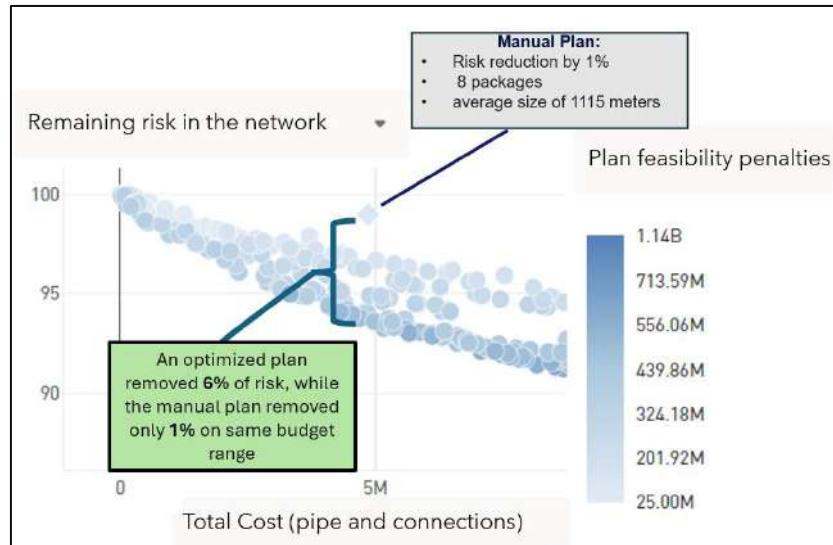
The model correctly identified 71% of historical breaks within the top 5% of high-risk pipes. In comparison, a model without inspection data achieved 64%, ranking by age alone captured only 3%, and ranking by past breaks captured 46%.

Outcomes

The study (phase 1) modeled 3,008 km and achieved high predictive accuracy in 2023. The top 5% of pipes by LoF accounted for 71% of past failures, far outperforming age or burst-based models. With stakeholder input, the CoF model was tailored to reflect ETRA's context and priorities.

From all scenarios achieved with P&P, an optimized plan removed 6% of network risk, while a manually developed plan only 1% on a similar range of investment (€5M). The most optimal plans on a €10M range were refined and used as input to build final replacement projects.

This data-driven, risk-based approach enhances resilience, optimizes investment, and establishes a scalable methodology for future phases.



Scenarios of plans built and compared in the platform