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Tucson Water Finds The Right Pipes With Machine Learning

With VODA.ai predictions

55% of failures could have been prevented in just 1% of pipes

Tucson Water Finds The Right Pipes With Machine Learning

OBJECTIVE:

Find neighborhoods with the worst pipes ripe for failure, and focus resources there for proactive replacement.

THE CHALLENGE:

Find a science-based method for directing resources to the worst pipes and eliminate guesswork and gut instinct.

QUICK FACTS:

- 4,600 miles of pipeline
- 193,000 pipe segments
- 390 square mile service area
- Hundreds of booster stations and pressure control valves

For the 2021 fiscal year, the Tucson Water department had a goal of targeting short water mains for repair and replacement. Their strategy was to find neighborhoods with the largest concentration of high-risk pipes and proactively replace those in the worst condition.

Identifying these “hot spot” neighborhoods and specific pipe segments at the highest risk of failing within the next twelve months was their immediate challenge. With 4,600 miles of pipes (comprised of 193,000 pipe segments), knowing the likelihood of failure and the potential consequence of a failure was critical for allocating limited resources. Tucson Water turned to the VODA.ai platform powered by their daVinci ML™

machine learning engine.

Traditional methods for deciding which pipes to inspect, repair, and replace rely on pipe age or history of failures. Machine learning from VODA.ai is far more accurate in calculating aging infrastructure’s current and future health.

The Tucson Water team was interested in machine learning but skeptical of the usefulness of this new technology. The utility was already replacing 1% of their pipes annually using traditional methods to choose which lines to replace. Their leadership wanted to know if machine learning could do a better job, so they engaged VODA.ai to conduct a pilot in 2019. The VODA.ai team asked for details on all active pipes, including prior failure data — and asked Tucson to withhold the most recent year of failures. The idea was for daVinci ML™ to predict the health of all pipe segments that year and have the utility validate the accuracy of the predictions against what really happened.

The results of the pilot were impressive. Machine learning ranked each segment by likelihood of failure. In the top 1% of the highest risk segments, daVinci ML™ predicted 55% of all the failures that year. Since the utility was replacing 1% of the pipes annually, they could have avoided just over half the failures if they had these predictions sooner. Equally impressive: of the top 1% of breaks identified by daVinci ML™, 17% never failed before, making the “Prior Failure” model alone a poor predictor, at least for this year.

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The Pipe Age method found only 16% of the breaks within the top 5% of Tucson's high-risk pipes. Within the top 5% of the pipes at the highest risk of failure, the previous failure method found only 43% of the breaks compared to daVinci ML™ finding 77%.

Tucson Water now makes more informed decisions in managing its infrastructure using insights from machine learning. VODA.ai maps these results, highlighting each pipe segment by the level of risk. Each is labeled with its unique pipe ID.

Research shows water main breaks have increased 27% in the past six years to more than 800 per day in the U.S. In annual surveys, utilities rank water pipe replacements as their highest priority.

bridges, rainfall, contractor skill, and even seismic activity.

Machine learning can evaluate hundreds of variables, find patterns that led to prior failures, and assign probabilities of future health based on those patterns. Machine learning is unbiased and a cost-effective, versatile strategy to improve asset management and reduce costs and risks.

Tucson Water enjoyed exceptional results from the pilot. They have expanded the program with a multi-year subscription. It is now a Standard Operating Procedure (SOP) for the utility, employing a scientific approach to decision making with machine learning. VODA.ai is also integrating daVinci ML™ with Infor, Tucson Water's enterprise asset management system.



"The Tucson Water Department embarked on a short main replacement program. VODA.ai provided us with the insights needed to choose the right neighborhoods and the right pipes to target for assessment and replacement. Our decisions are informed by science, and VODA.ai's accuracy saves time and money for us."

— Scott Schladweiler, Chief Engineer at Tucson Water

Engineers need tools to help them make intelligent decisions about which pipes to inspect, monitor, repair, or replace — and just as important, which ones to leave alone. Digging up a line expected to fail but finding it healthy is a poor use of resources. Every utility is unique in its mosaic of pipe infrastructure and failure history. Each has different pipe materials, ages, sizes, soil, weather, proximity to roads, railroads,

We conduct many pilots for utilities exploring machine learning. It is gratifying to us and beneficial to utilities when science-based decision making becomes standard operating procedure.