Use Empirical Data to Manage Water Infrastructure

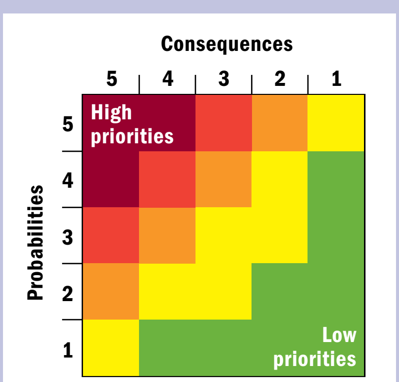
By having greater awareness and control of their infrastructure, utilities can drastically reduce the consequences of failure. **BY CLIFF JONES**

AS WATER UTILITIES struggle to maintain aging infrastructure, some alarming trends among large and small utilities are apparent.

- Many valves are unusable—e.g., a field crew can't locate, open, or close a valve within 10 minutes of reaching the valve's supposed location based on geographic information system or paper records. This means utility crews can't close the valve in the event of a main break downstream and have to search for upstream valves, shutting down larger areas and affecting more customers. If a utility has a lot of unusable valves, operators may have to attempt to close several valves before a line can be isolated. This additional work causes delay, additional disruption, and increased costs.
- Crucial fire hydrants are inoperable and can't provide adequate water flow in case of an emergency.
- Many valves are paved over, making it impossible for a utility to undertake quick, short-term remedial action to make a valve usable.
- Many distribution valves are found in the wrong position—shut and open. As a result, stagnant water in a line means customers aren't being served efficiently and additional pumping and chemical costs are incurred because it takes longer for water to reach the desired location.
- Transmission valves are often found shut. This usually refers to valves greater than 16 in. in diameter, which are the major arteries. As a result, significant additional costs are incurred for water treatment, energy, and inefficient operations.

Figure 1. Pipeline Risk Analysis

Managers can assess the probability and consequences of pipeline breaks to prioritize maintenance.



These situations can be challenging, but a greater concern is that these trends are fairly consistent throughout the United States. In areas with modern infrastructure such as the western United States, less than 40 percent of valves are unusable. In areas where infrastructure is older, more than 50 percent of a utility's valves may be unusable.

So why is having so many unusable valves a concern? According to AWWA and the US Environmental Protection Agency, there are, on average, 27 main breaks per year per 100 miles of pipe. That's a lot of breaks that must be isolated. Although most pipelines that fail are small diameter, many are large, and the larger the pipe, the higher the risk for damage. A 2007 Water Research Foundation study found the cost of large-diameter breaks averages $500,000. Realistically, however, main break costs vary from $6,000 to as much as $8.5 million.

For large-diameter breaks, flooding damage accounts for most costs, but other costs include water loss, pipeline excavation and repair, and repair of bedding material and surrounding areas. Water loss can include wasted chemicals and pumping costs until the break is repaired. Indirect costs to a water utility or municipality include collateral damage, customer complaints, traffic disruptions, unfavorable publicity, and political fallout.

These direct and indirect costs mount as a main break continues. Indeed, some large breaks have minimal costs, which is especially true when water is shut down quickly. If a utility can't locate or operate several valves, it takes longer to shut down the break and costs increase. So how can utilities address

An effective asset-management approach should minimize the negative consequences of inoperable valves and hydrants.

PHOTOGRAPH: ONTARIO CLEAN WATER AGENCY

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this situation and overcome operational inefficiencies?

ASSET MANAGEMENT

Asset management can be defined as a way to monitor and maintain valuable assets. Classic asset-management processes require utilities, directly or through consultants, to create a matrix to prioritize risk probabilities and consequences (Figure 1).

Criticality rating is based on consequence of failure. Condition rating or probability of failure is calculated from factors such as pipe age, material, break history, and complaint history (e.g., pressure loss, water quality, and discoloration). What will it cost and what's the impact of a pipe failure? The rating is usually based on factors such as these:

- Who are the pipe's critical users (hospitals, schools)?
- Who are its significant users (major industry users, government employees)?
- Where's the pipe located (along a railway or freeway, on a water crossing)?
- What size is the pipe?

When the matrix is applied, utilities usually replace high-priority pipelines or conduct a condition assessment of those pipelines to quantify the pipe's actual condition rather than basing a decision on a desktop study. However, replacing pipelines to reduce the odds of failure is a slow process. If a utility replaces 2 percent of its oldest and most at-risk infrastructure each year, it will take 50 years to replace all of its current pipelines, and the pipelines will continue to break.

However, by understanding the condition of valves and hydrants, utilities can significantly reduce consequences of failure and thereby reduce high-priority repairs. An asset-management approach should consider the condition of control points (valves) and the effect that improved system control could have on pipeline life expectancy and the consequence of failure.

A BETTER APPROACH

Many utilities and consultants use a 10-step asset-management process (Figure 2). First, the process determines an asset's current state. The utility then sets a desired level of service (box 4) and determines which assets are critical to sustain performance. This step helps determine appropriate maintenance or repair strategies as well as each asset's cost and risk tolerance. Finally, the utility can request funds to support the strategy and develop an asset-management plan for each component. Utilities complete the cycle by returning to the beginning of the process.

This plan only works if it's based on accurate asset location and condition data to ensure that assumptions made about the condition, residual life, and consequence of failure are valid. It's vital to compile accurate field data, particularly regarding boxes 1, 2, 5, and 6. Too often, asset-management studies are based on limited or no field data or, at best, on a statistical analysis based on occasional soil samples and pipeline couponing.

By having more than 90 percent of its valves in usable condition, a utility can drastically reduce consequences of failure. If utilities invest in valve management programs, they can obtain financial returns and operational efficiencies that justify ongoing system-control expenditures.

Figure 2. A 10-Step Process for Asset Management

Field studies make an asset-management program more relevant and manageable.