What to do with ageing pipes: Pipe Whispering

October 2019

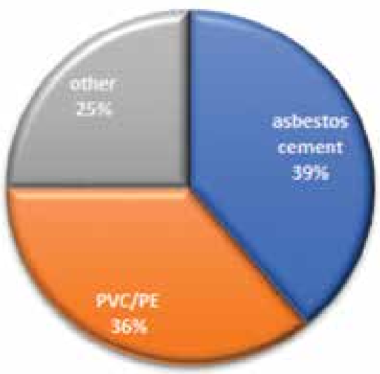
A large proportion of Queensland's water and sewerage infrastructure assets consists of pipes that are buried underground. Networks are dominated by two main material classes: asbestos cement (AC) and plastic (PVC and PE). AC pipes were commonly used for water and sewer mains until about 1990. After this time AC was phased out, with PVC and PE taking over. Installation of water and sewer mains peaked in the 1970s meaning that over half of them are more than half way through their expected life of 70 years.

As networks age, deterioration results in higher rates of breaks, bursts and leaks. These can be managed in one of four ways:

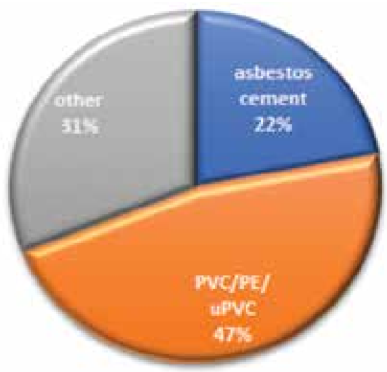
1. **Defer action:** some leaks may not be an immediate priority or economical to repair straight away.
2. **Pipe repair:** a break is repaired through targeted work.
3. **Replacement (renewal):** lengths of pipe are either excavated and removed, burst and replaced, or disconnected and duplicated in another place.
4. **Relining:** existing sewer pipes are lined internally avoiding expenses of excavation and trenching. Relining water pipes is rare as it is currently more difficult and costly because they are under pressure.

These actions can be combined with pressure management to extend water pipe lives and reduce leaks, but all decisions require a careful balance of net costs and benefits for the community.

WaterMains



Sewer Mains



Full Community Costs of Pipe Degradation

As well as the cost of repairing, relining or replacing degraded pipes, the cost of breaks for customers (e.g. service interruptions) and the broader community ('secondary costs') are critical to determining when to rehabilitate. Secondary costs can be difficult to estimate and include traffic and business disruption caused by breaks and the works to rehabilitate them, operational costs (e.g. water loss and pumping costs) but also potential for public health, environmental and reputational risks arising from leaks, breaks and overflows.

The mix of costs in each case impact decision-making about the optimal approach for pipe rehabilitation. For example, costs of renewal are commonly so high that deferral is preferred despite repeated repair work (so long as secondary costs and risks are low).

In contrast, avoidance of future costs may also justify a pipe being opportunistically renewed before it is absolutely required (e.g. when a broken pipe is renewed, adjacent networks may also be replaced despite being in relatively good condition in order to reduce future disruptions).

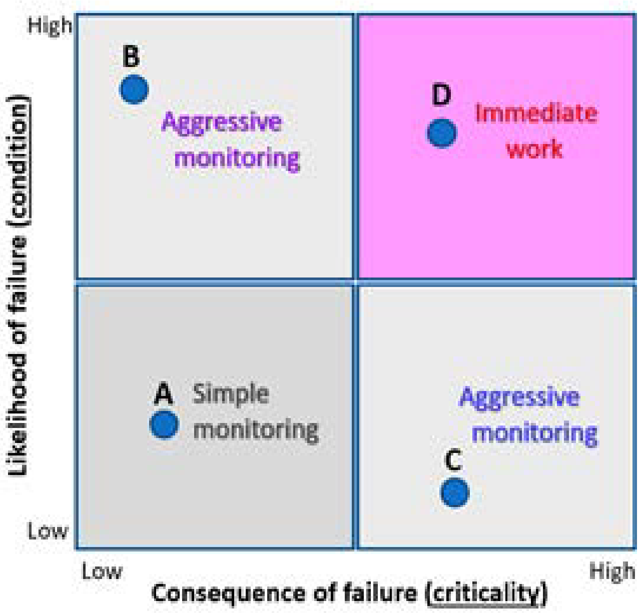
Balancing repairs and renewal

It is usually not optimal to replace a pipe before or even after the first break. Some service providers use the dated '**three-strikes rule**': a length of pipe that has failed and been repaired twice will be renewed (or relined) when a third break occurs. This method has the advantage of simplicity but is reactive and requires accurate data on the number and location of breaks.

Some Service Providers adopt a **target level** of breaks (per 100 km of pipe) to guide rehabilitation programs. This target determines the effort placed on renewals, relining and repair in order to maintain breaks below an average target that has been determined for each community. This method is often reactive and average numbers can mask the true costs of maintaining service levels and make lower-cost solutions difficult to implement.

In small communities, replacement or relining is often **opportunistic** (untargeted) being driven by grant availability or opportunities to extend a scope of works (e.g. to make use of a transient workforce). This practice can maximise economies-of-scale needed to make such work viable in small towns. However, the approach may inflate long-term costs because it results in some pipes being replaced or relined unnecessarily.

Unfortunately, these mechanisms mean that data may not be collected on failure modes and rates, optimal renewal and repair processes nor the costs associated with different types of pipe. This sort of information would be invaluable for optimising future repairs and renewals both locally and elsewhere in the State.



Pipe Condition and Criticality

Network maintenance and renewal is optimised by targeting pipes in most need of rehabilitation. However, assessing the condition of pipes is challenging and age is not always a good indicator of degradation.

Old pipes may remain in good condition (e.g. when water is not aggressive and forgiving ground conditions such as non-reactive soils with no external loads). Equally, new pipes may degrade quickly if laid poorly or subject to aggressive conditions.

Furthermore, it is likely that some old pipe types varied in quality due to inconsistent manufacturing processes. This means that some pipes have a useful life that is much longer or shorter than the normal 70-year average.

The best-practice approach for determining investment in repair versus replacement is to base the decision on a risk assessment based on their likelihood of failure (condition) and the consequence of the pipe failing (criticality). Investment in management of pipes is influenced by their position in the matrix of criticality versus condition.

Criticality

Risk-based analysis should take full costs associated with renewing assets into account to some extent through analysis of criticality.

High criticality pipes, such as those servicing hospitals or large portions of the population, may be replaced before their condition warrants renewal because of the high secondary costs to the community or the environment.

'Running to failure' and the three strikes rule cannot be applied for critical pipes where breaks are to be avoided at all costs but may be acceptable for low criticality pipes if customer service levels can still be met.

Condition and Criticality monitoring is the key

To avoid the inflated costs of renewing pipes before it is necessary, service providers need to develop an understanding of the risk status of their networks.

New technologies for monitoring pipe condition such as automated analysis of CCTV footage, statistical analysis of breaks, pressure and complaints, sensors for detecting leaks and different forms of scanning for pre-leak failures can inform repair and renewal decision-making.

However, condition assessment and adoption of emerging technologies is subject to increased costs and is limited by technical capacity and no single system can provide 100% confidence in degradation rates.

Investment in the Queensland's ageing infrastructure needs to be targeted to help service providers to best manage the risks associated with their ageing networks by responding with the most cost-effective investment strategy.

This approach can be difficult for individual service providers particularly small and remote councils in regional Queensland. Regional collaboration to support targeted investment in the steady renewal of Queensland's network assets can mitigate the impacts of the emerging renewals deficit and is a subject of other papers in this series**.

Service providers in Alliances formed under the Queensland Water regional Alliances (QWRAP) initiative are working on common mechanisms to improve network investment.

Councils considering optimal repair and renewal strategies can find out more about these approaches by contacting **enquiry@qldwater.com.au**.

**This information sheet is part of a series aimed at preparing regional councils for changing investment needs of network assets. They are available along with two detailed reviews at https://www.qldwater.com.au/QWRAP.