

Risk-based approach to asset management

In partnership with and implemented by Sydney Water Corporation (SWC) – a major water utility in Australia – Sinclair Knight Merz (SKM) developed a robust, sustainable, “world-leading” risk-based asset management strategy for defined critical water mains (CWMs). Importantly, the strategy and the implementation plan can transparently demonstrate to SWC’s Board and the economic regulator that the expenditure programs for the management of specific individual assets within this asset class are prudent, reasonable, justifiable, economically efficient and robust. This is achieved through a clear strategy that uses leading-edge economic management and decision-making tools that link outcomes and expenditure programs with defined performance objectives.

The key challenge was to develop a proactive system to manage over 21,000 kilometres of pipes and over 405,000 valves throughout greater Sydney, where the failure of one pipe can potentially cause significant public health and safety risks, major economic loss and significant inconvenience to the community.



CWMs (up to two metres in diameter) are defined in terms of their impacts when failure occurs and specified criteria, including:

- Size (any main greater than 300 millimetres or in key business districts/hubs ≥ 150 millimetres)
- Proximity to railways, major roads, highways/freeways
- Located in landslip areas
- Servicing critical customers (eg hospitals, large industrial water users)
- Areas with a single supply.

CWM’s have significant consequences when they fail, impacting the local community and often bringing traffic to a standstill. Assessing their condition is difficult as they are under pressure and have limited access points, and techniques available for condition assessment are limited and relatively expensive.

The strategy developed collaboratively by SKM and SWC is based on an asset management decision tool that can quantitatively assess pipeline failure risk (probability, consequence of failure) for individual CWMs – at main, shutdown block or asset element level. The economic consequence cost of failure assesses all relevant environmental, social and financial factors. This strategy and the asset management tool have been developed to enable timely and targeted intervention to “prevent failure”.

The key sub-project involved developing an asset management decision-making tool (economic tool, decision framework and rules). This tool enables both timely intervention and appropriate action by SWC to “prevent failure” and specification of an appropriate mix of works programs that will satisfactorily mitigate SWC’s risk for the least life-cycle cost. The tool can also be used by SWC to prioritise capital expenditure on CWMs and help develop business cases for individual CWM assets / projects.

Other important supporting sub-projects to determine the cost-effectiveness and effective mix of response initiatives and expenditure programs within this project included:

- High consequence assets definition (asset segmentation of CWM assets along or across rail, roads and waterways)
- Condition assessments (targeted individual asset inspection programs)
- Rehabilitation and renewals (pressurised pipes, valves, tunnels, support structures)
- Shutdown operation manuals (and contingency plans) in modifying risk profile
- Valve identification and management (for all types of CWM valves)
- Mechanical failure minimisation initiatives
- Information management improvements (supporting economic tool, decision-making)

Delivered on time and budget, the project’s key achievements included:

- A targeted asset management strategy for SWC’s CWMs that integrates all relevant works programs.
- Establishing an understanding of SWC’s economic business risk presented by these CWMs.
- Developing several tools and decision-making frameworks that SWC can use to implement these strategies. In particular, a decision-making tool that identifies individual CWM assets at risk and identifying appropriate remedial treatments.
- Developing a process for the asset management decision-making tool to transparently demonstrate to regulators (eg Independent Pricing and Regulatory Tribunal [IPART]) that there is a robust and economically efficient process for developing prudent, reasonable and justifiable CWM expenditure programs that are linked with a clear strategy and defined performance objectives.
- A clear direction for further long-term improvements in their strategic asset management.

This project is significant/valuable as it drives spending which is subject to significant scrutiny by the economic regulator (IPART)

Who does this affect?

Owners of critical assets, in particular, pressurised water pipeline assets, that have the potential to significantly impact on communities in the event of failure.

What do I need to do?

Understand the benefits associated with implementing an asset management tool that transparently provides a robust and economically efficient process to justify expenditure programs.

About the authors

David Lynch is a Principal of Sinclair Knight Merz with extensive experience in strategic and business planning for water utilities.

Michael Bendeli is an Associate of Sinclair Knight Merz with significant experience in asset management for water utilities.

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this tool
allows for the
prioritisation of
individual assets
for inspection

when seeking to justify SWC's expenditure programs and pricing submissions.

Commercially available economic tools for water mains take a top-down approach based on broad conditions and statistical modelling of pipes at a cohort level. While this approach does provide an estimation of renewal expenditure, it does not provide any details of which CWMs are to be targeted for replacement or renewal. This project developed a sophisticated, bottom-up economic tool using specific asset, condition and location data (linked with GIS data) to quantitatively determine the probability of failure and economic consequence cost of failure of each individual asset (main, shutdown block, element level).

SKM/SWC adopted a comprehensive approach to risk management for the defined set of CWMs – from hydraulic modelling of breaks, to improvements in the processes of managing mechanical failures, and full-economic (triple bottom line, full quantitative assessment) and risk management of the potable water network at an individual asset level (as well as shutdown block and main levels).

This project not only performed risk assessment of the potable water network, but considered cost benefit considerations for the selection of risk mitigation measures to establish the most appropriate and cost-effective response as a function of the CWM asset risk. This is identified as “best practice” and yet is missing for much of asset management in the urban water management sector [as identified in the recent National Water Commission Report (Australia), 2011].

The asset management decision-making tool:

- Identifies the risk of individual asset elements (GIS level) which can be aggregated to shutdown block and main level.
- Considers a wide range of social, community and environmental factors in quantitatively assessing the consequence cost of failure (and therefore of asset risk) on a triple bottom line (monetised) basis and within a least life-cycle cost framework.
- Uses its outputs to develop a cost-effective and efficient mix of operating (inspections), capital (renewals, replacements) and policy (eg developer approval processes) responses and works programs to mitigate failure risk.



Compared with other asset management tools, this tool allows for the prioritisation of individual assets for inspection (condition assessment) or treatment (eg renewal) based on a quantitative assessment of risk (likelihood of failure and consequence of failure). No such decision tools are commercially available – all focus on cohorts of assets (of similar material type, diameter, etc) rather than individual assets. This has provided an impetus for continuing practical research into improving quantitative assessment of probability and consequence of failure (inspection and condition assessment technologies) and risk.

The tool also defines the relevant and targeted information that needs to be collected for economically efficient and effective decision-making (eg from contractors undertaking pipe condition assessment of CWM assets). There is also opportunity using an adaptive management approach to improve and enhance the framework and tools provided as they are applied and more information becomes available (by SWC without further consultancy input).

Community, environmental and social perspective considerations are considered in the economic model / asset management tool in assessing the consequences (triple bottom line in monetised terms) and the risk of failure of CWM assets. Community and environmental benefits include:

- CWMs (with the most significant potential customer and community impact on failure) at greatest risk are identified for targeted remedial action early ahead of actual failure.
- Shutdown and contingency plans are designed to minimise the impacts if failure does occur.
- These and various other initiatives (eg valve management) are designed to reduce the likelihood of failure and the frequency and extent of the impacts.
- Minimising direct (water supply disruption, property damage, water loss), indirect (traffic, impacts on other services, increased security of supply to community services and “critical customers”) and environment (waterway, less landslip and soil erosion) impacts.

The overall project benefits are improved failure performance of CWMs and lower costs with cost-effective and effective works programs directly linked with SWC's acceptable risk profile. This work also foresaw and addressed issues raised by IPART after the project started.

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