Operations and Maintenance

The Next Paradigm

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Burst Main - Consequences

Synopsis

This paper discusses how the current process of maintaining and operating a large metropolitan water, sewer and recycled water network will become both outdated and not meet customer and government expectations of the future.

The combination of Operational Technology, systems, already operating within the water utility can develop the next shift in Operations and Maintenance. In addition how regulators play a critical role and can heavily influence the future direction of the Utility.

Background

For many years the cost of running the operations and maintenance for a large metropolitan water authority has been steadily increasing despite some level of improvements in the way these groups operate. One of the key determinants of these processes is doing the same thing but try to do them more cheaply, by contracting out, setting efficiency targets or considering the use of new materials.

The nature of the activity such as a burst water main or blocked sewer, in order to meet the government requirements and the community expectations requires constant availability of maintenance staff for 24 hours per day and 7 days per week.

With legislative changes, covering government compliance standards, workplace health and safety, traffic management considerations, traffic conditions and general community expectations many of these costs have greatly outweighed any cost reduction processes that have been put in place.

The repair for example of a burst water main or even clearing a sewer blockage, remains relatively cheap and easy, however the additional pressures from the legislative and community expectations has increased the full cost of the repair by several fold.

The water industry is well renowned for its development of GIS systems for its entire underground pipe network, SCADA systems primarily based around sewer pump stations, the quality of the water it produces and maintains and the waste treatment plants it operates. However there needs to be a major shift in the thinking behind the operations and maintenance process, hence the opportunity to take a paradigm shift.

Current Practice

In a typical large Metropolitan city with a population of around 4 to 5 million the cost of having an Operations and Maintenance activity is around $200m per annum which will equate to around $40 to $50 per person, based on a four member family. This is between $160 and $200 per annum or around 15% of the total water bill. Much of the maintenance activity(80%) is of a reactive nature.

In order to make substantial reductions (50% or more) in this level of maintenance there is a need to consider what can be done to reconfigure this process to give an overall long term benefit to the community.

In the first instance the customers, or the general public, notify the water utility of problems in the network. For example if a burst water main has occurred then the customer will call a water and sewer utility call centre (manned 24/7) to advise of this burst main. Following confirmation, a site check by the utility a repair will commence. This process significantly heightens during seasons of high water demand especially when drought or high summer temperatures are occurring.

The repair is undertaken but the impact on the community can be enormous depending on where the event occurs.

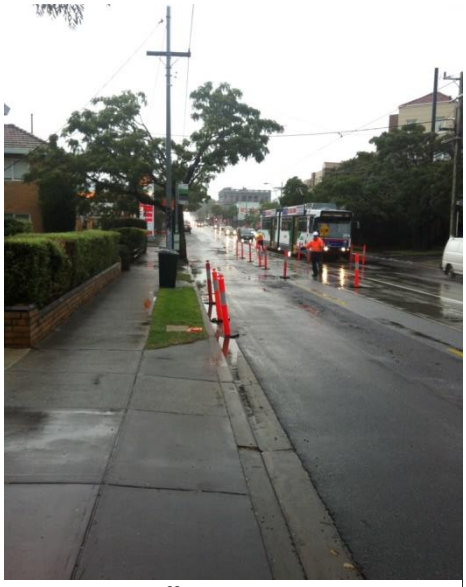
There might be:

- Road closures during peak hour or in some cases both morning and evening peak times
- Major damage to other infrastructure including roads and property
- Impact on the general public
- Impact on schools, child care centres and hospitals
- Major impact on shops, cafes, and other commercial premises
- Potential impact on the environment, stormwater network, waterways and parklands
- Impact on freeways, rail and tram networks

As well as the impact with the public many of these cases and these type of conditions put operational staff in potential high risk environments.

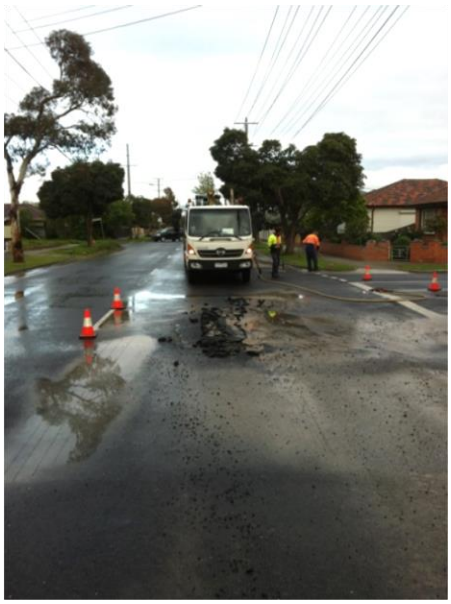
Water main burst

Road to be reinstated

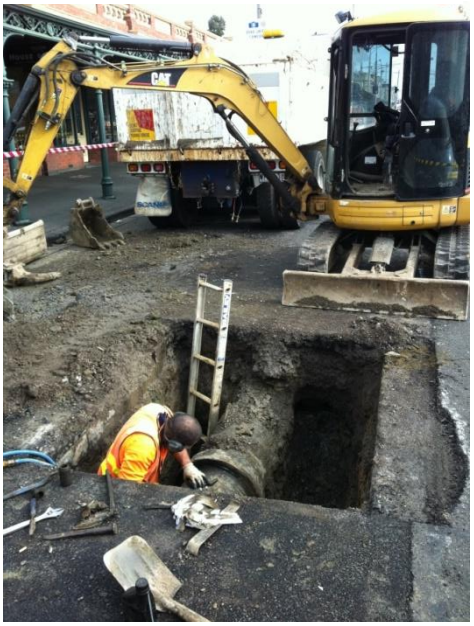


Traffic Management

Burst in Park



Burst in roadway



Repair on major road

Burst on major retail strip

Faults in the sewer network similarly impact on the public but with potential significant public health concerns as well as environmental considerations, in the case of large sewer spills. A significant clean up and extended site monitoring can greatly increase the cost of repair.

Sewer clean up after major spill

These practices are common with most metropolitan water utilities but it is not a great outcome for the community and while this reliance on the customer or general public to advise of a network problem it is surely not a great practice and needs to be challenged.

There are still cases such as where a third party contractor impacts the water or sewer pipelines but these will not be completely eliminated, but how to handle these circumstances with better and faster information could further enhance operational efficiencies.

Government Regulators

Water utilities are focussed on achieving the regulator's targets that have been refined over many years of operation. Rarely are these targets challenged but they become a standard process. If they are not challenged the water industry will not develop as it should. There are also many regulations that cover public health which might be challenged but will not be considered within this paper.

Some of these key targets relate to response times and how quickly the utility company assesses issues raised from the public and then how quickly the initial water or sewer services are restored. These targets are based around means and averages over set periods. Although some can be met easily there are some that may not meet the target. Repair work is mostly complex and can significantly impact on the community through extended traffic control and potentially hazardous conditions.

As these targets have been developed over time there is ongoing pressure to improve the target which may not lead to any better service, but in the case of a complex repair task, just increase cost for the utility. There is still a number of resources required to meet these increased demands of the regulator. The cost of these services may then become almost irrelevant as meeting the target is deemed the most important element of the service.

In addition the process used by many of the utility companies on asset management and planning is based around a risk model. Although this will be tackled in an future paper, it is worth understanding that if that risk model puts the consequential risk element, which include the Regulator targets at a very high level then a replacement of the pipework in a specific section of the network might occur to eliminate that consequential risk. There may be a more effective asset management assessment of that pipework which might result in a different outcome.

Figure 1 illustrates how the current utility process operates :

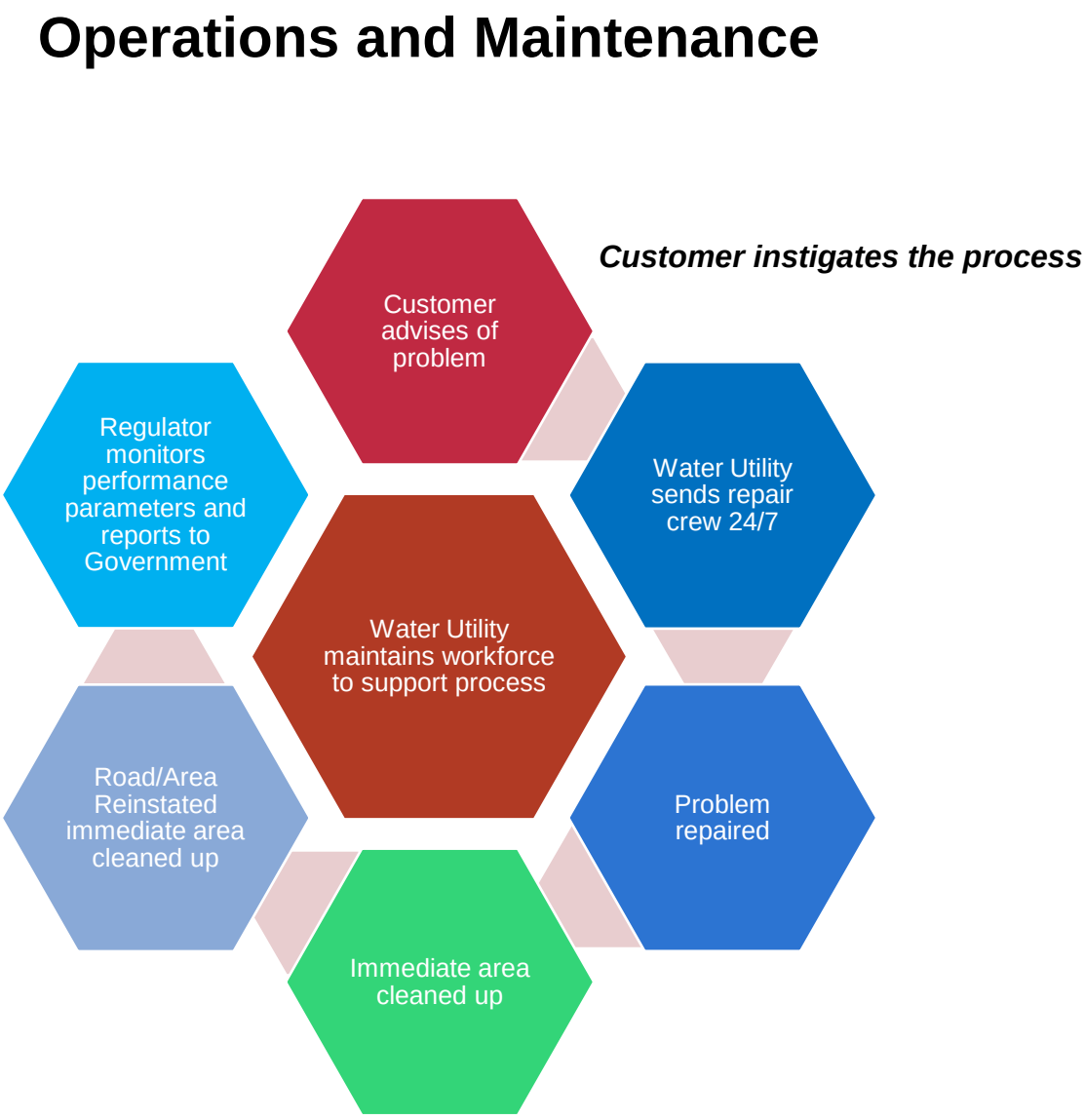


Figure 1 The Current Process

The Next Paradigm

Operational Technology

There has long been an emphasis on Information Technology as it drives the processes with which many of our computer technology are now based. However the next phase of this approach is to apply that knowledge and development through greater understanding of what really impacts on a business and what technology can be harnessed to give the best outcomes for that business and where the community is involved, as in the case of the water utility, what is best for the community.

Operational Technology is an enabler to support the development of better systems, equipment, information and data to make early informed decisions and combining this with intelligent networks that supply effective and current information and data to support the next major shift in operations and maintenance.

How does this apply to the water industry and more specifically to the operations and maintenance activity?

The primary focus for the water industry is to receive early information about their sewer, water and recycled water networks and thereby make decisions based around that information. As these systems develop the need to have the public or customers advising of problems within the network should not only be eliminated but will allow the development of very different response strategies for its maintenance operation.

Some of these strategies could include:

- Manage a work force to respond during specific hours – this could lead to having maintenance crews available outside of critical travel times for the public thus reducing the overall cost and impact on the general public.
- The early warning systems enable less consequential damage and any damage can be limited or even eliminated. This will greatly reduce repair and reinstatement times
- Planned maintenance activities to be linked more easily and more fully to these responsive maintenance activities
- Eliminating environmental issues
- Effective planning in relation to commercial businesses to limit any impact on their activity

- Better supply management especially in relation to schools, child care centres and hospitals so as to eliminate any impact
- Reduce the impact of poor publicity for the water utility.

For there to be a change in the basic assumptions of the operations and maintenance process which will significantly reduce reactive maintenance, a process can be developed which will allow these strategies to be effectively implemented which will reduce costs, develop mechanisms for real continuous improvement.

Role of Technology

The role that technology plays in being able to develop the paradigm shift is already available in many parts of the utility organisations through its **SCADA** (Supervisory Control and Data Acquisition) operating system . SCADA is a system operating with coded signals over communication channels so as to provide control of remote equipment and is heavily utilised within the Utility business as part of the mechanical and electrical networks. This section of the utility relates to the pumping stations and some of the operational plants around a water and sewer utility. It is, however, fragmented through only small sections of these organisations.

The structure of many of these pumping stations and the lower security levels in earlier SCADA systems led to major installations of monitoring equipment such as larger cabinets requiring electrical power to run to these sites, radio networks for security, requiring line of site communications and high operating and management costs. A typical very small cabinet without any controls, could cost up to $50,000. Many of these cabinets also can be subject to vandalism, graffiti and potentially criminal damage.

In order for the SCADA systems to become the major tool in enabling the operational technology to be effective it needs to be easily secure and well connected. The newer SCADA technologies allow very secure networks to exist and will become ideal for the broader water, sewer and recycled water networks.

Whilst SCADA becomes the backbone,the critical information within the operational networks becomes the various sensors and information devices that are positioned around the networks. Developments in different measuring technologies and the use of mobile phone communication devices will allow a myriad of devices to be connected within the secure SCADA environment at significantly lower installation costs. Most of

the devices require very little power requirements, so the major installation might only be around $2000 or even in some cases less. In addition, because of the improved communication profile (via the mobile network) many components can be placed underground reducing the chance of vandalism or even criminal damage. With significantly improved communications, knowledge of any incident will be quickly and effectively monitored.

With future development it would be expected that the installation and components costs will reduce significantly and allow the enabling of many thousands of devices within the network.

As new infrastructure comes on line it would be a natural extension to include all the measuring devices needed to support the water, sewer and recycled water networks within the building of the new infrastructure.

Water Network

This new operational technology will enable the paradigm shift to occur, specifically through the widespread deployment of devices critical to the information needed within the water network. Primarily the investigation and maintenance activity within these networks, centres around burst mains, leaking mains, pressure variants, water quality and valve and hydrant activity.

Within each of these elements having the information on line and available will enable the engineering sectors of the business to analyse, and fully understand the activity within the water network. There will need to be a focus on data and information and how that is analysed but an effective control centre will be able to identify trends and develop skills to make changes in the network or even shut a network to make a repair before the major damage can occur.

The better system knowledge will further enable the ability to change work practices and times to ensure the impact on traffic flows, reductions in consequential damage and general community impact and will ensure the water supplied throughout the network is to specification and with minimal interruption to the consumer.

The reduction in impact on traffic flows, the consequential damage that might occur as a result of a water main burst are all community impacts without considering the loss of available water to the community.

In addition the ability to measure any water loss that is occurring in the network will reduce the level of non-revenue water.

Full repair of pipework and roadway can occur immediately as there has been little or no damage from excess water.

Better knowledge of the system is based around the following:

- Fully fledged Secure SCADA network
- Massive increase in measuring devices positioned around the network
- Massive increase in instrumentation covering these types of components:
    - Pressure, flows, temperatures, chlorine levels
    - Electronically controlled valves to manage the network and redirect flows where feasible
- Data management and interpretation systems
- Full visibility network

The system can then expect to allow:

- Engineers to be able to view and analyse water main activity at all times
- Visibility and prediction of losses in the system
- Fix the system problems prior to them becoming visible to the community
- Understand and respond rapidly to water quality issues

Sewer System

The primary sewer system in most of the large metropolitan networks is a gravity system that transfers the sewer from the household or business and flows into larger sewers to be treated at major sewer treatment facilities.

Within the sewer network, at a number of points, once the sewer has reached a low point it is pumped from this lower level up to a higher level via pump stations and then gravity flows will recommence. These pump stations, as outlined earlier, are heavily monitored by existing SCADA systems, as they normally occur close to the lowest points in the terrain. They potentially become environmental disaster zones, hence they are already part of the SCADA management protocol.

The network has traditionally been unmonitored and relies on the public to advise if the network is not performing adequately .

The sewer operational and maintenance system is primarily centred around clearing of the sewer assets which might have an obstruction or tree roots blocking the progress of the gravity sewer.

Better knowledge of the network and what is happening within will lead to better performance and more information on trouble spots, a lot earlier than currently is the case.

Better knowledge of the sewer system is based around the following:

- Fully fledged Secure SCADA network
- Massive increase in measuring devices positioned around the network
- Massive increase in instrumentation covering these types of components:
    - Flow meters, temperatures, gases
    - New online measuring equipment that can be easily hooked to sewer mains
    - Sewer manhole sewer level measuring devices
    - Electronically controlled valves to manage the network
- Data management and interpretation system
- Full visibility network

The system can then expect to allow:

- Engineers to be able to view and analyse sewer main activity at all times
- See and predict problems in the system
- Fix the system problems prior to them causing external problems
- Being able to manage the waste stream and prepare the treatment plants for the changes in sewer condition prior to it reaching the plant
- Understanding the sewer surges from heavy rain conditions
- Minimise the problems of spills to the environment

Recycled Water / Storm Water

Similar conditions apply with both Recycled and Storm Water but again under different pressure points, with Recycled water having health and general community concerns and potentially over a long period of time, so on line measurement of the parameters of the recycled water activity will become crucial to water utilities.

Storm water may also have health related concerns, but during heavy storms or adverse weather conditions it can cause flooding. Being able focus potential flooding activity in the right area becomes a monitoring and management process. Stormwater can also be controlled and be planned to assist in the recycled activity enabling more stormwater to be captured for reuse when controlling the stormwater network.

The Control Centre

The control centre which is currently manned 24/7 to ensure the safety and security of the sewer and water networks, has a primary focus on responding to customer and general public advice on the issues within the network. This paradigm shift will truly become a control centre to effectively manage the water and sewer networks and assist in reducing the overall cost of operation.

Government Regulators

Implementation this new paradigm the regulatory body will need to redefine its approach to monitoring and policing the water industry. This will be a major opportunity for the regulators to monitor the development of technology within a water business and how effective that development becomes. By embracing this change in strategy the regulators will see a lowering of costs, much improved community outcomes, enhancement for the industry and a measure for other industries.

The regulatory framework must then become more of a proactive approach which supports even further development of the water industry.

Figure 2 outlines how the new Operations and Maintenance activity will enable greater overall improvement in this activity

The Future of Operations and Maintenance within the Water Industry

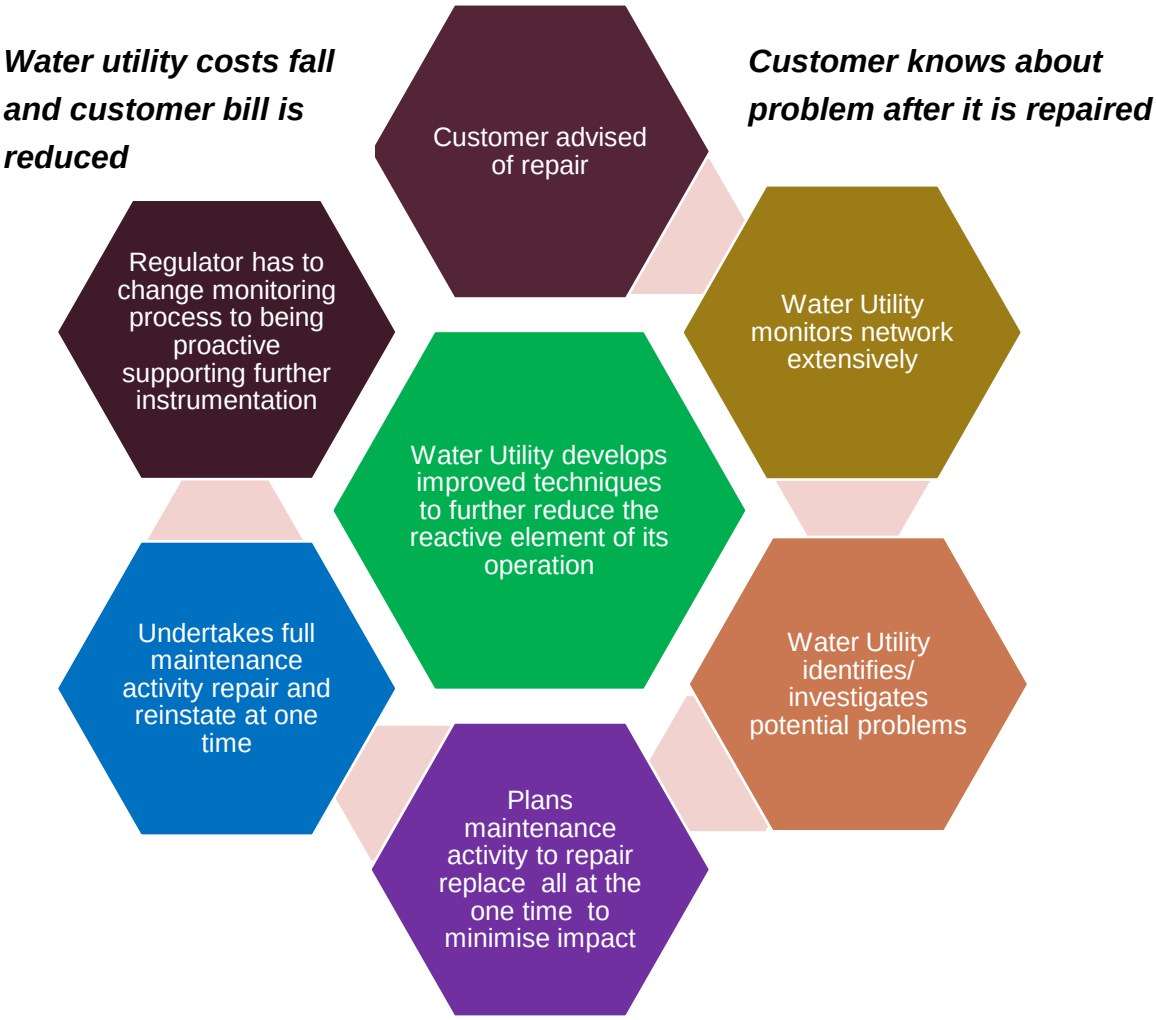


Figure 2 The Next Paradigm

Summary and Conclusions

The complete management of the water, sewer and recycled networks for any community is critical to the health and wellbeing of that community. This can relate to the smallest community up to the large metropolitan cities around the world.

In order to effectively manage these networks primarily in larger populations there is an ever increasing need to have knowledge, information and especially real time data.

For many years SCADA systems used within the water industry have been primarily focussed around activity at pump stations and treatment plants, both sewer and water, with the predominance being within the sewer network.

In order to reduce overall operating costs, improve customer service, improve safety, reduce the impact on the environment and improve reliability of the sewer water and recycled water networks there is a need to apply Operational Technology through the intensive development of the SCADA systems and applying this to the Operational and Maintenance activity within the utility.

By applying this technology there will be a quantum shift in the Operations and Maintenance process within the utility and will

- Greatly improve the positive interaction with consumers who no longer report problems in the networks
- Reduce the impact of consequential damage as a result of breaks in sewer and water mains
- Reduce the environmental impact from these activities
- Greatly reduce the impact of operations and maintenance on the travelling public
- Redirect regulatory focus to strategic development of the utility rather than a policing activity
- Reduce the potential safety risks in performing the maintenance activity
- Significantly reduce the cost of operation to its customers
- Truly manage the networks

The expected savings to a metropolitan city of 5 million people could be in the order of $50 million per annum or around a 25% saving from existing maintenance levels.

David Maple

David Maple is a Director of Maple & Associates and has been associated with the water industry for over 25 years. He has held a number of key roles within the manufacturing and the water industry and most recently as Network Operations Manager at a Water Utility. He is a Fellow of The Institution of Engineers and has broad knowledge of both Operations and Maintenance and technical innovations around SCADA, Strategy and Asset Planning for water, sewer and recycled water operations.