DECEMBER 2014
ISSUE 4 ■ VOLUME 10

water asset management INTERNATIONAL

PAPERS

IWA PUBLISHING

water21 magazine of the International Water Association

Report warns of major renewal requirement for infrastructure

A report written for Local Government New Zealand to provide a national picture of the country's water, wastewater and stormwater infrastructure has revealed that around 25% of the assets are over 50 years old and up to 20% either need to be renewed or are unserviceable.

The report was commissioned from Castalia Strategic Advisors after the central government's 2011 National Infrastructure Plan found a lack of information about New Zealand's infrastructure. Funding for water assets is the responsibility of local government.

The country's infrastructure was found to be sound overall and performing to requirements, according to the paper, 'Exploring the issues facing New Zealand's water, wastewater and stormwater sector', part of a wider 3 Waters project. The wastewater network has a replacement value of NZ$15.8 billion (US$12.5 billion), potable water assets a value of NZ$11.3 billion (US$9 billion) and stormwater assets a value of NZ$8.6 billion (US$6.8 billion).

The report identified three focus areas for further investigation: investing to replace and renew existing assets; investing to meet rising standards and increasing expectations; and providing end-users with the right mix of incentives to use water infrastructure and services efficiently.

At a media briefing, Local Government New Zealand chief executive Malcolm Alexander said: 'One of the points from the report is the infrastructure is actually in pretty good shape. We know that this renewal curve is coming, so how are we going to manage it and how are we going to finance it, but we're not falling off the cliff. This is not a crisis issue.'

Local Government New Zealand is now consulting with councils and stakeholders on the issues and the appropriate mix of solutions, and the response will feed into development of a White Paper, which is due next March. ●

Philippines rural development initiative supports infrastructure projects

The new Philippine rural development initiative, launched recently, is set to implement rural infrastructure projects worth PhP1.12 billion ($25 million).

The strategy, being implemented nationally by the Department of Agriculture, is being supported with World Bank funding.

The projects will include communal irrigation, potable water systems, fish landings and sanctuaries and green houses.

Under its new country partnership strategy, the World Bank has pledged to support government projects in a number of areas including climate change, environment and disaster risk management.

This will include working to increase physical, financial and institutional resilience to natural disasters and climate change impacts, and improving natural resource management and sustainable development. ●

ADB approves loans for water, wastewater and flooding works

The Asian Development Bank (ADB) has approved two loans worth half a billion dollars to help the government of India's largest state, Rajasthan, to better manage essential urban services and finance water and wastewater upgrades.

A $250 million policy loan will help finance the creation of a corporate-style state body to oversee urban services development and an independent utility in the state capital, Jaipur, to oversee water and wastewater operations.Water and wastewater operations will also be delegated from the state government to municipal bodies, and water tariffs and property taxes will be rationalised to help insure a fair and sustainable revenue stream to finance urban services and improvements.

A $250 million project loan will support water system improvements in the five cities of Hanumangarh, Jhunjhunu, Pali, Sri Ganganagar and Tonk, which currently have low piped water coverage and high water losses.

In addition, in those five cities and Bhilwara, wastewater pipelines and treatment plants will be upgraded and expanded, wastewater recycling schemes will be put in place and sludge used to generate electricity.

The programme is expected to be completed by the end of 2019, when water supply in the cities will expand from just two hours a day to 24 hours a day. ●

water asset management INTERNATIONAL

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Water Asset Management International is an international newsletter on asset management in water and wastewater utilities. The focus of the newsletter is on the strategic aspects of this developing field, providing utilities with international perspectives on infrastructure planning and maintenance as they seek to deliver cost-effective services to their customers.

Instructions for authors are available at: www.iwaponline.com/wami/default.htm

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Water Asset Management International is published four times a year (March, June, April, December) by IWA Publishing. Statements made do not represent the views of the International Water Association or its Governing Board.

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SUBSCRIPTIONS

Water Asset Management International is available as either a print or an online subscription.

2014 price (4 issues):
£282 / €426 / $562
(IWA members: £217 / €326 / $413)

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Or visit: www.iwaponline.com/wami/subscriptions.htm

Design & print
Designer: David Parry
Printed by Hobbs The Printers, UK

ISSN (print): 1814-5434
ISSN (online): 1814-5442

Multi-stakeholder Cloud-based infrastructure service goes live

A new online Cloud-based project development tools for project sponsors, the International Infrastructure Support System (IISS), has been launched with support from major global development banks and key private sector entities to attract and increase infrastructure investment.

The system, which was developed in its early stages by the Asian Development Bank and implemented by the Sustainable Infrastructure Foundation (SIF), is an online, secure, scalable multi-user preparation platform and service developed with support from Capgemini.

IISS has been successfully tested, with analysis and support from PwC, and pilot projects are now being undertaken to test its robustness in Latin America, Africa, Central Europe and Asia.

The projects are being undertaken by SIF with the appropriate regional development banks and the assistance of the World Economic Forum (WEF).

Christophe Dossarps, the CEO of SIF, said: 'Consistency and consensus are key for infrastructure investments from their concept and preparation to their investment by private investors. IISS is a 21st century solution to provide such a framework for infrastructure project preparation and ultimately to support sustainable infrastructure delivery.' ●

EBRD and SECO to fund wastewater improvements in Tajikistan

The European Bank for Reconstruction and Development (EBRD) and the Swiss State Secretariat for Economic Affairs (SECO) have joined forces to enable Khujand, the main city of northern Tajikistan, to modernise its wastewater network and reconstruct an old wastewater treatment plant that had fallen into disuse after the collapse of the Soviet Union.

The cooperation follows two previous successful projects undertaken by the EBRD and SECO to improve the city's water supply. Khujand is the capital of the Sugd region, an ancient city that is home to 165,000 people. The city has a significant need to upgrade its crumbling municipal infrastructure, in particular to improve wastewater management.

The EBRD is providing a $3.5 million loan, and SECO is providing a capital grant of $5.4 million for the city's water and wastewater utility, the Khujand Water Company.

Some of the new financing will also be used to upgrade the water supply, providing running water for the first time to around 15,000 people in settlements near Khujand.

Richard Jones, EBRD head of office in Dushanbe, said: 'The planned modernisation programme will significantly reduce pollution and public health hazards.'

SECO country director Peter Mikula said: 'The cooperation between SECO, the EBRD and the city of Khujand dates back to 2004 and our first joint water project in the city. The projects have been highly successful and the project structure has served as a model for water projects elsewhere in the country and the region.' ●

World Bank provides infrastructure grant

The World Bank has agreed a new two-year assistance strategy for the Palestinian territories alongside a $62 million package of grants that will, among other projects, help finance the rebuilding of shattered infrastructure.

The grant funding will include $21 million towards water systems, building on existing operations including the water supply and sewage system improvement project. The remainder is to be spent on the electricity network.

Steen Lau Jorgensen, the World Bank's West Bank and Gaza country director, said: 'Gaza, which is one of the most densely populated places on earth, was already suffering from economic and social hardships before the most recent war and this has resulted in an unfolding human tragedy and physical destruction that requires immediate mitigation measures.'

He also said that it was very important for other donors to step up and provide critically needed support. ●

EPA announces water infrastructure and pollution reduction funding

The regional US EPA has announced over $183 million in funding for California to improve water infrastructure and reduce water pollution state-wide.

The initiative was announced at an event held to celebrate the results from $51 million in federal funding that was used to install water meters in the city of Fresno.

Fresno used a no-interest loan from the state to buy and install over 73,000 advanced water meters in residential homes that provide faster and more accurate meter readings and help homeowners to easily identify the amount of water they are using.

Since the meter installation was completed this year, water use in the city has dropped by 25%. The additional funding will be used for wider purposes – water quality projects to reduce water pollution, improve municipal drinking water and wastewater infrastructure, make water and energy projects more efficient and provide communities with technical assistance.

The state water board is also working with Fresno on another project, which it is estimated will cost around $250 million, which will be used to construct a new surface water treatment plant to augment the city's current groundwater-based supply. ●

International benchmarking – evolution of WSAA's Aquamark Tool

Benchmarking and continuous improvement programmes are fundamental tools within the water industry to achieve optimal asset management outcomes. The Water Services Association of Australia (WSAA) recognised this over a decade ago and with direction from key asset managers from its utility members it created the Aquamark benchmarking tool, which was first used in 2004. Russell Pascoe discusses the evolution of the tool and how it has been applied by the Water Corporation of Western Australia to drive improvement in the area of renewals planning.

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In 2003 the Water Services Association of Australia (WSAA), at the instigation of its utility members, commenced a project to create a comprehensive water industry asset management benchmarking tool. WSAA members determined that as the water industry was a capital intensive industry there were great potential gains if the industry could optimise its overall management of the whole asset lifecycle.

It was considered that creation of an ongoing benchmarking programme for the water industry supported by an appropriate benchmarking tool would provide significant benefits in the following areas:

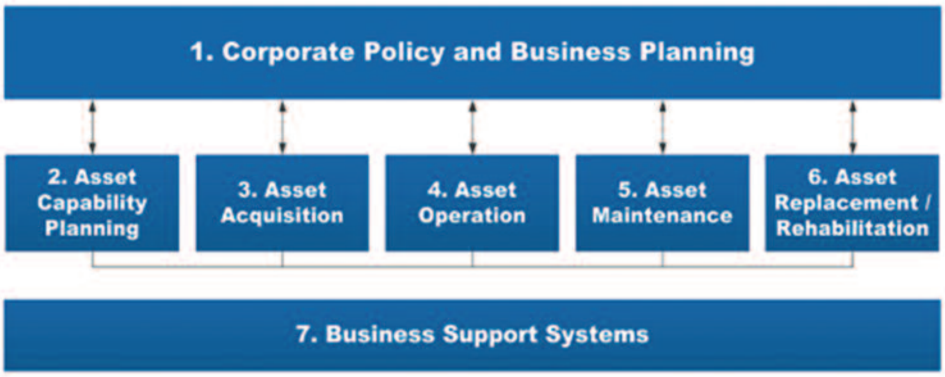
- Increased understanding of individual utility and overall industry performance
- Provision of networking opportunities – information sharing and less duplication of effort across utilities with common issues
- Could be used as a communications tool within utilities to increase asset management understanding across the business
- Help strategically align asset management effort with corporate business needs
- Provides a continuous improvement tool that could be used both for self-assessment and also audit purposes

The WSAA project led to the creation of a water industry-focused asset management benchmarking tool that was labelled Aquamark. The tool was established to cover the entire asset lifecycle and also to enable users to assess the robustness of the support tools and the integration of asset management functions to the prevailing business environment. Aquamark is a process benchmarking tool rather than an activity benchmarking tool. The tool assesses process maturity across seven elements. Within each of these elements there are many processes, sub-processes and measures that need to be considered. Figure 1 below outlines the seven high level functions that cover the asset lifecycle and the enabling policy / business planning and business support system regimes.

The first use of Aquamark was in 2004 and was solely for the use of WSAA members. Benchmarking was to be repeated for on a four yearly cycle – this timeframe based on:

- The process takes considerable time and cost (approximately A$50k plus in-kind effort) to run and participants were not likely to wish for more frequent rounds
- Each participant receives both an industry report and a specific utility report, which outline improvement opportunities and participants would need sufficient time to progress initiatives related to the improvement recommendations

Figure 1
Key asset management functions addressed within Aquamark



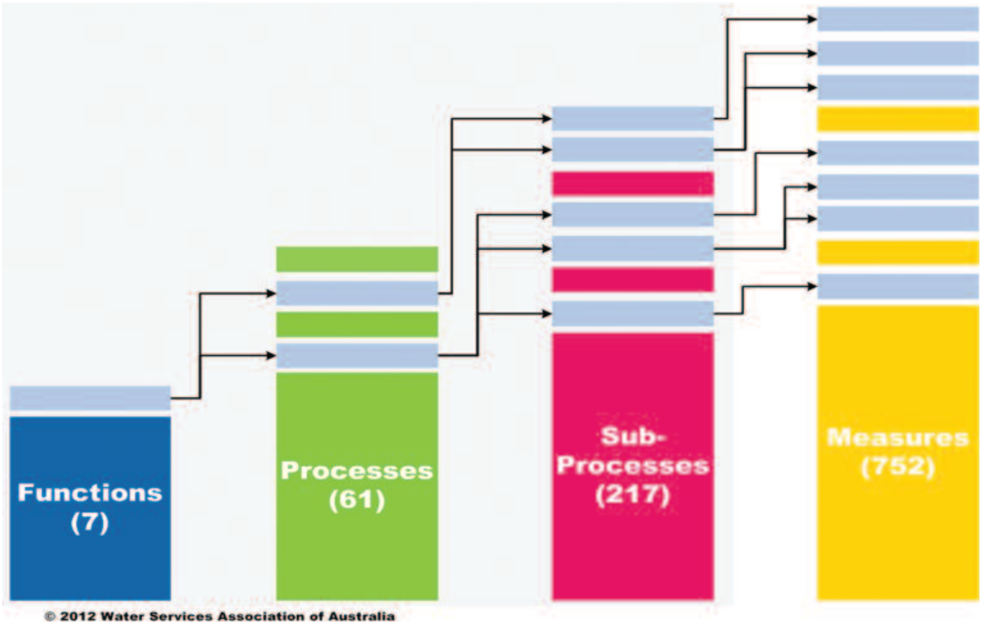


Figure 2
Overview of Aquamark tool structure

A key component of the Aquamark process is the requirement for confidentiality. Each participant sees the summary results, but they do not know what individual participants scored. Individual participant results can only be made known with express approval of the utility.

Leading up to the planned 2008 programme, WSAA members decided that there was greater learning to be had from the programme if the participation could be expanded to cover other jurisdictions such as the UK / Europe, North America and Asia. WSAA therefore ran the 2008 programme as a joint exercise with the International Water Association (IWA) and participation was broadened beyond Australia and New Zealand – predominantly expanding into North America. The most recent programme was run in 2012 and while total participation was slightly reduced – impacted by the global financial situation – it still included participants beyond the Australian and New Zealand utilities.

Benchmarking methodology

The overall Aquamark process has a number of steps and is much more than just completion of the benchmarking tool. The key steps are as follows:

- WSAA/IWA call for Expressions of Interest (EOIs) from the market for a consultant to co-ordinate the programme, produce the reports and to run the EOI for participation.
- Each participant must send nominated representatives to a workshop to be given an overview of the Aquamark tool and relevant training on how to use it and upload information into it – is also an option for participants to have the training done locally at their offices if they wish to train more people. (In 2012 Water Corporation took up this option and had around 20 people trained so that each of the various asset streams had relevant experts familiar with the tool)
- Each utility is requested to undertake a survey to outline what they consider to be the key drivers for their business at that particular point in time or the near future. A pre-determined selection of drivers is provided and the participants are required to weight the relative importance. It is recommended, and generally adhered to, that input into the survey is coordinated and completed by a good cross-section of the utilities' senior management.
- Participants are then provided with the Aquamark tool and given approximately 6-8 weeks to undertake a self-assessment against the specific measures within each of the seven high level functions. This will ideally involve many staff from across the business providing information on the various asset lifecycle elements as subject matter experts.
- The self-assessment details are provided back to the consultant co-ordinating the process and the information is then assessed in preparation for a validation exercise.
- The consultant then undertakes an on-site visit to each participant. This involves an inception meeting with senior management where the consultant outlines any first impressions from the self assessment data and explains the validation process. The validation is not normally across every measure (but the coverage can be expanded if repeated discrepancies are found), but rather a selection based on the data the utility has provided. The consultant requires the utility to outline why they have assessed measures as they have and to show evidence to enable the validation.
- The validation process can see measure scores both increased or decreased depending on what the consultant has evidenced and also with the consultant looking to 'normalise' the scoring between participants so there is consistency across the participants as to what constitutes a high or low score.
- At the end of this validation exercise the consultant provides a close out report to senior management and outlines any changes made to the report and where the utility results indicate strengths or areas of improvement.
- As part of the review of self assessments and the validation process the consultant compiles a list of 'best practices' across the seven functions. A first view of these are formed from the initial self assessment data review and the consultant uses this as a lead and looks to verify the rigour of potential best practices while on site.
- The consultant then prepares an overall industry report which highlights areas of collective improvement potential and individual utility reports for each participant that gives improvement recommendations specific to each utility.
- With assistance from the consultant WSAA conducts a Leading Practices Conference which all of the participants can attend. This involves the utilities who have developed the best practices presenting them and outlining how they got to that state, lessons learned along the way etc. – to give scope for other participants to fast-track their own development by absorbing these learnings.
- The Leading Practices Conference is followed by the compilation of the leading practices, identified through the process the whole programme, into a Leading Practices Compendium.
- The Leading Practices Conference has often been followed by participants then doing site visits to leading practice utilities to get more in depth information.
- Additionally WSAA will undertake to facilitate links between participants. Note the results for individual utilities are confidential so one participant cannot tell how others have gone. If they are seeking guidance / assistance in any particular area(s) WSAA can see which participants did well in those and with agreement can 'match make' to facilitate knowledge transfer.

In order to undertake the self assessment each participant needs to co-ordinate relevant subject matter experts within their utility to assess each of the measures within the seven high level functions. Figure 2 shows how the tool moves from the seven high level functions through an increasing number of processes and sub-processes ultimately to over 750 specific measures that are assessed. When using the tool the assessor has to answer questions related to the measures with the responses then being able to be rolled up to get scores across sub-processes, processes and the high level functions. This means that improvement projects can be targeted to any level – addressing a high level function such as maintenance, a process such planning maintenance or a sub-process such as planning preventative maintenance. This capability allows participants to target improvement efforts in a way that delivers the best return on investment for the organisation.

In reaching a view on the self assessment score for each measure the utility has to consider four elements. Two of these elements relate to capability and two relate to execution. The detail is as follows:

Capability:
- Process development (40% weighting)
- Process documentation (10% weighting)

Execution:
- Process coverage and frequency (30% weighting)
- Process effectiveness (20% weighting)

To achieve a high score on any measure it is important that the utility can demonstrate that the process is actually occurring on the ground – staff understand it and adhere to the rules. Having really sound process development and documentation will not result in a high score if there is no evidence of implementation. The coverage aspect can be both geographical (is it in place across all operating areas or only some) as well as across different asset types. For instance you may have sound renewals processes for water mains, but not for valves and hydrants so you need to make judgements about the coverage of each aspect.

Results and discussion of the 2012 WSAA / IWA programme

Thirty seven water utilities participated in this project from Australia, Canada, New Zealand, Philippines and the United States of America, providing an opportunity for international asset management process comparison and learning. Details of participants are shown in Table 1.

As previously indicated the project required identification of current key industry drivers. The business drivers evident from the project were overwhelmingly aligned to affordability, value for money, debt reduction, and regulation of revenues and prices. The themes for the Industry Report and Leading Practices Conference were then set around those asset management processes, practices and systems that best respond to these drivers.

The highest priority business drivers across the two participant groups of Australia / New Zealand (29 utilities) and North America (seven utilities) are summarised in Table 2 (recognising that the North America participant group was small and thus not representative of the region as a whole).

These business drivers showed a shift in the operating environment for water utilities globally. In 2008, participants were generally characterised by demand growth and service improvement, supporting increasing asset acquisition and capital delivery, but constrained by skills and resource shortfalls caused by competing demands and an ageing workforce. In 2012, a constrained economic environment and regional influences (such as major water security investment in Australia increasing debt and water prices) has meant that community and government financial constraints have shifted the predominant drivers towards community affordability, capital expenditure / debt reduction and ensuring regulatory compliance.

The business driver results were used extensively in this project to:
- Identify those Aquamark processes that are most important to their delivery
- Assist with determination of industry wide and individual utility priority improvement initiatives
- Develop appropriate themes for the Leading Practices Conference and select appropriate leading practices that are relevant and beneficial to the participating utilities

The process benchmarking comparison for the overall participant group at the Aquamark Function level is shown in Figure 3. This chart indicates that the most advanced Functions are in Asset Capability Forward Planning, Asset Acquisition and Business Support Systems. This demonstrates the recent focus of utilities on growth and water security planning and acquisition, and is well aligned with the priority business drivers for 2008.

The less advanced functions were asset maintenance and asset replacement / rehabilitation, especially in the longer-term strategic / analytical processes reliant on good asset residual life and condition data and decision tools. The score for business support systems (information systems and data) is relatively high with participating utilities generally indicating information systems were adequate, although many had a focus on improvement of older legacy information systems. Many utilities were not getting full value from existing systems and data, with aspects such as data quality / validity and systems interconnectivity being consistent shortfalls.

The range of participant results from lowest to highest is large (50 to 70%)

Table 1 **Project participants**

Australia	Australia	North America	New Zealand
ACTEW Corporation	Power Water Corporation	USA	NEW ZEALAND
Barwon Water	Queensland Urban Utilities	Anchorage Water and Wastewater Utility	Dunedin City Council
Ben Lomond Water	Seqwater	City of Columbus Department of Public Utilities	Watercare Services Limited
Central Highlands Water	South Australian Water Corporation	City of Portland Water Bureau	
City West Water	South East Water	Greater Cincinnati Water Works	PHILIPPINES
Coliban Water	Southern Water	Metropolitan Sewer District of Greater Cincinnati	Manila Water
Cradle Mountain Water	Sydney Catchment Authority	Tohopekaliga Water Authority	
Gippsland Water	Sydney Water Corporation		
Gladstone Area Water Board	Unitywater	CANADA	
Goulburn Valley Water	Wannon Water	Regional Municipality of Peel	
Hunter Water Corporation	Water Corporation of Western Australia		
LinkWater	Western Water		
Melbourne Water Corporation	Yarra Valley Water		
North East Water			

Region	Priority 1	Priority 2	Priority 3	Priority 4	Priority 5
Australia / New Zealand	Affordability constraints	Value for money	Capital expenditure / debt reduction	Economic regulation of revenues / prices	Regulation compliance
North America	Regulation compliance	Affordability constraints	Ageing workforce / skills / experience retention	Capital expenditure / debt reduction	Ageing Infrastructure

Table 2
Priority Business Drivers (The Philippines excluded to preserve confidentiality)

for all functions except business support systems. This indicated the wide range of maturity in the evolution of asset management practices of the participating utilities – from formative (relatively new to asset management practice) to advanced (very mature in asset management practice).

One of the objectives of WSAA as it evolved the Aquamark tool over the last decade has been to maintain the capacity for repeat participants to monitor not just their performance against other utilities but also to a time series of results for themselves. Figure 4 shows the comparative results of the 22 utilities who took part in both the 2008 and 2012 programmes.

This comparison must be undertaken with some caution, as the Aquamark framework has undergone revision, and some repeat participants have either taken different approaches to scoring, or have undergone organisational change, since 2008.

For aggregate median scores there has been little change across all functions, but considering average scores across the repeat participants, improvement was noted in all functions, ranging from 2% for asset maintenance, to 6% for each function of asset capability forward planning, asset replacement and rehabilitation, and business support systems.

The most positive result is the change in the lowest-scoring repeat participant in each function, where scores increased across all functions by between 11% and 22%. This shows that utilities with the least developed asset management processes in 2008 appeared to improve significantly across all functions. The most significant improvements since 2008 occurred in processes related to demand growth and capital programmes, along with improved renewals planning – reflecting some of the key business driver priorities of 2008. Further, the improvements in the lowest scoring repeat participants were broadly in the strategic planning and decision making aspects of asset management and the inputs to those processes (such as risk management, financial management and life cycle best value decision making).

Clearly for repeat participants between 2008 and 2012, greater improvement from the Aquamark process was achieved by formative and developing utilities rather than those more advanced in asset management. This would seem to make sense given these utilities had a greater opportunity for improvement – and that more significant early gains (the low hanging fruit) can be made at lower cost.

For the more advanced asset management utilities there were only small gains made in the Aquamark scores. Analysis of the raw data showed that this was often due to:

- Increased asset management understanding, reflected in being able to better identify gaps in process development, or more particularly in coverage and frequency of process application, and overall effectiveness of processes resulting in a firmer approach to scoring process capability (in some instances – e.g., Water Corporation's assessment of its renewals function – scores actually decreased) rather than any real reduction in process capability
- Recognition that the improvement was for smaller but sometimes critical asset groups, which required significant investment of time and resources, but did not impact significantly on the overall asset base and consequently did not affect scores

Drawing from the priority business drivers for the overall participant group the following leading practice themes were developed:

- Foundations for sustainable asset management – sustaining business services and financial viability in the long-term, through appropriate asset management frameworks, governance, alignment with corporate objectives and performance management
- Tools, decision making and documentation – focusing on life cycle decision making processes and documenting decisions, strategies and plans
- Prudent asset investment – project justification and its application to growth, renewals and service improvement planning
- Efficient service delivery – service delivery strategies and the benefits of application of asset management principles in the asset acquisition phase
- Doing more with less operationally – managing service levels and risk at lowest cost, developing operating and maintenance strategies, use of smart systems and productivity improvement, and the value of configuration management
- Organisational asset management capability – staff skills and competencies, supported by proactive review and improvement planning for asset management business processes, information systems and data

These themes were the basis for the three-day Leading Practices Conference held in Sydney in November 2012. To address these themes a series of leading practices were presented which covered a broad range of topics that included:

- Experiences in implementing asset management systems / frameworks

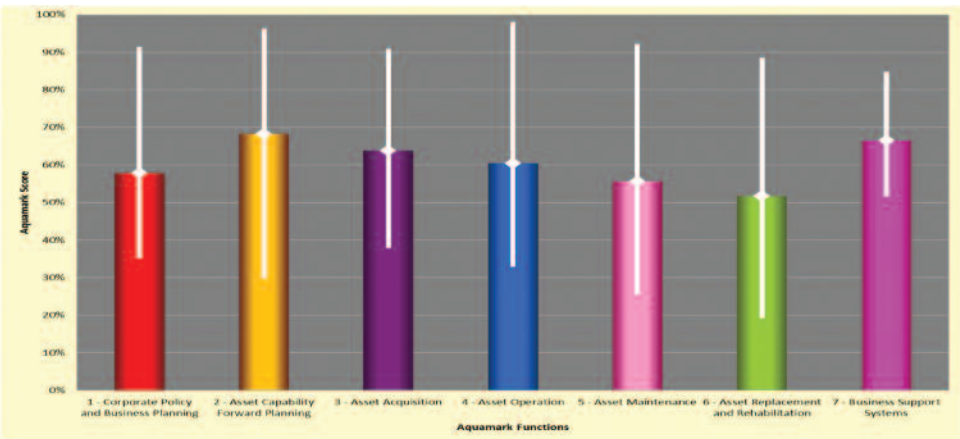


Figure 3
Overall benchmarking group Aquamark results at a function level

- Asset management improvement planning
- Asset management skills and competency requirements and how to meet them
- Creation of effective and usable asset management plans
- Approaches to investment decision making
- Renewals forecasting and planning
- Maintenance strategy development and optimisation

Water Corporation – use of Aquamark results

Water Corporation has participated in each of the WSAA benchmarking programmes since 2004. Since the 2008 programme Water Corporation has also undertaken an annual assessment of improvement initiatives from Aquamark programmes and carried out a reassessment of the scoring in those areas where actions / improvements have been focused. This is done by creating and monitoring an asset management continuous improvement programme, developed from outcomes of the Aquamark tool, as well as from regulatory and internal audit reviews.

Based on the 2012 programme results, Water Corporation's lowest high level function scores related to asset replacement and rehabilitation and asset operations. It was also of note that in comparative terms (refer Figure 5) Water Corporation had actually assessed itself more critically in the area of asset replacement and rehabilitation. In effect as the organisation began to focus more on this area it had a better appreciation of what it did not know or have in place. With much of the water security need having been addressed, or well in progress, the organisation needed to start and shift improvement efforts into the operations and replacement areas. This was reinforced by projections showing that there would need to be a significant trend increase in replacement / rehabilitation over the next 20 years – a nearly threefold increase in the annual expenditure in this area from around $80 million/annum to over $200 million/annum.

Within Water Corporation the asset operations weaknesses were already starting to be addressed through a couple of major corporate initiatives. Within the Perth metropolitan area the operations delivery functions have been amended through the creation of two new Alliance arrangements (Perth Region Alliance and the Aroona Alliance) covering the network conveyance assets and bulk water / wastewater treatment assets respectively. In the country regions the Water Corporation has been running an improvement programme called Building Better Business to improve operations and maintenance processes in the country areas.

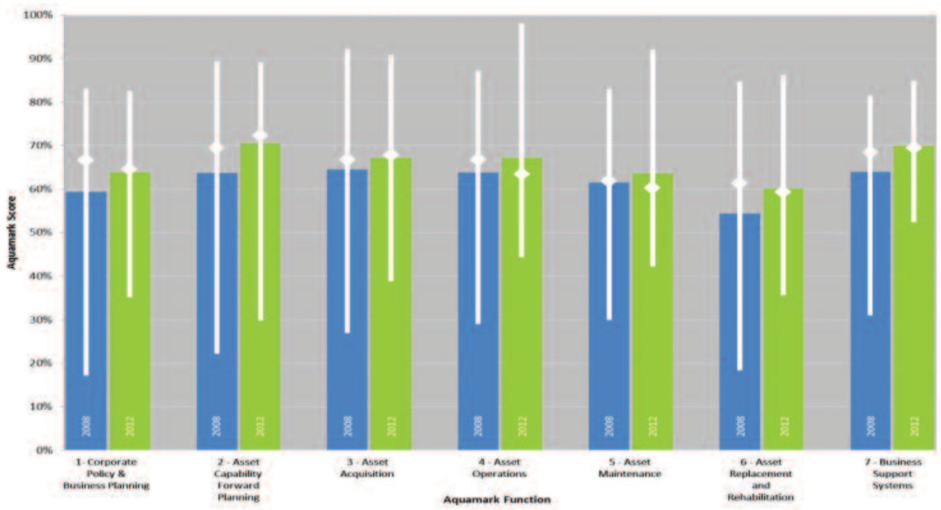


Figure 4
Comparative results of utilities that were in both 2008 and 2012 programmes

This left the asset replacement and rehabilitation function as the remaining area requiring improvement focus. Under the high level functional score the breakdown of process scores for this function are show in Figure 6. This figure highlights that governance, asset risk and replacement options and identification of end of economic life were the most significant gaps

In more detail the areas for improvement included:

- Need for full process documentation and clearer assignment of accountabilities
- Addressing data issues – completeness, accuracy, accessibility
- Lack of decision support tools for some asset types (e.g., electrical, mechanical assets)
- Asset risk and condition processes existed but were difficult to use and inconsistently applied
- Links between growth planning and renewals planning were not strong
- Quality of business cases for replacement / rehabilitation work needed to be improved
- Projections of future funding needs had to become more robust

As a result of the 2012 Aquamark outcomes and a follow-up regulatory review Water Corporation established a dedicated renewals planning section within its asset management branch. This new team documented an improvement programme to start and close the gaps that had been identified. This included the development of new tools, looking at the data issues, building an end to end process and raising the corporate awareness of the need to better manage replacement and rehabilitation programmes into the future. The work has progressed well but will be ongoing for several years as strategies and tools continue to be developed and then implemented. Table 3 shows a brief summary of some of the key actions that have been initiated and an assessment of their current status.

Conclusions

The intent of the WSAA / IWA Aquamark process is to identify and share leading practices, thereby improving the level of practice and

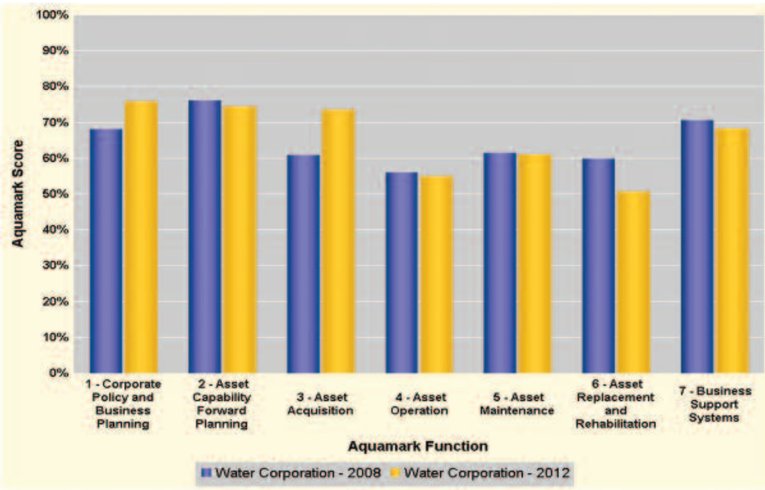


Figure 5
Comparative Water Corporation results 2008 v's 2012

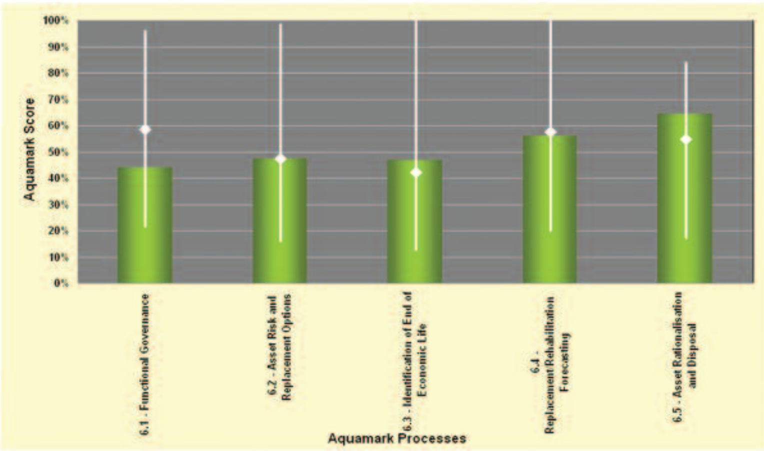


Figure 6
Process scores for asset replacement and rehabilitation function

maturity of the whole participant group. There has been a deliberate attempt by WSAA to expand the participant base in this programme both to increase the sources of potential leading practices that can be identified and shared and also to share the learnings across a wider group. The results through three cycles of Aquamark show clearly that the process is helping participants generate improvements across the spectrum of the asset lifecycle. The way the programme is tailored to identify and address the relevant business drivers has proved to be beneficial as results have shown gains being made in areas of business concern. This was clearly shown in the improved asset planning and asset acquisition scores from 2008 to 2012 when the industry in Australia was going through a significant investment in water security and growth. It can also be seen in the specific Water Corporation focus on improving its renewals processes post the 2012 as it moves from an era of new capital investment to one of dealing with ageing assets.

This collaborative programme appears to be highly effective and engaging, especially for utilities in the formative and developing stages of asset management maturity. Participants demonstrated a strong willingness to share their experiences – both good and bad so that the collective group could learn from them. Improvement opportunities for the industry have been selected and prioritised that:

- Align with the important business drivers across the participant group
- Are key improvements identified through the Aquamark benchmarking analysis
- Provide global opportunities for collaboration

This programme provides a substantial body of knowledge for building improvements in asset management. Irrespective of the history and context of each utility in terms of region, function, size, ownership, or form of regulation, participants were keen to improve their asset management processes and, by inference, their performance for customers, shareholders, staff and other stakeholders.

Moving forward, WSAA is now looking to see what further evolution is needed. Some key considerations already identified for the future of Aquamark include:

- Aquamark needs to be aligned with the new ISO 55001 Asset Management Standard. An assessment has already been done that shows Aquamark has a strong alignment with PAS55 but WSAA believes it should be unequivocally seen as consistent with the new ISO standard.
- Based on the WSAA experience on the Australian 'mirror' committee for the development of the new ISO standard it is of the view that there is much to be learned from other industries that could be applied to water industry asset management. It is therefore considering reviewing Aquamark terminology to ensure it is generic enough to be used by other industries / locations.
- Given the results form 2012 show greater benefits being achieved by utilities that are less mature as asset managers WSAA is also looking at how more advanced utilities can continue to get value from the process – for overall industry improvement it is essential that such utilities continue to participate but clearly they need to get benefits as well. Possible expansion of the tool to entice other industry sectors to participate may well help this objective.
- The benefit of ensuring a high number of participants with different experiences is clear so WSAA is reviewing how it can make Aquamark, or its future derivative, attractive to other water industry participants who have not yet engaged.
- The actual software itself also needs to be updated to take on board suggestions from existing participants around aspects such as ease of data entry and minimisation of duplication within the question framework.

Table 3
Summary of key actions that have been initiated

Initiative to address gap	Current status
Link business objectives to renewals processes and review KPIs	Current R&D project to develop performance framework
Review renewals data requirements	B&V project – cost benefit analysis of data
Review and identify tools and system improvements	Research project with CSIRO, trials of Decision Support Tools e.g., SALVO, WiLCO
Review and refine asset lives	Ongoing, specific project on AC pipes
Identify needs for maintenance staff involvement	Development of project for M&E assets
SALVO approach – input required	Refine risk assessment application
Asset risk assessment application redeveloped	Develop condition assessment programme
Water mains, sewers – complete	Sewer pressure mains, concrete structures – under development
Communication and training requirements for renewals planning	Roadshows and ongoing stakeholder meetings

WSAA would be keen for others to participate in such a review process with the objective of creating a benchmarking /continuous improvement assessment tool with a robust support process around it that had widespread appeal and take up. ●

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Water and sewerage condition assessment and asset performance guidelines

The Practice Note 'Condition and Performance Assessment Guidelines for Water Supply and Sewerage' was developed by the Institute of Public Works Engineering Australasia to draw together most appropriate contemporary practice to encourage risk-based consistency of data collection and outputs. Peter Way, Aneurin Hughes and Craig Winslade discuss the guidelines and how they can be used by water supply and sewerage utilities to assist in long-term asset management.

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The Institute of Public Works Engineering Australasia (IPWEA) is a member-based 'not for profit' organisation that produces various tools and resources to promote best practice in sustainable public works services delivery. Much of this work is centred on infrastructure asset management. Over recent years this has included documentation and training to provide practical guidance on condition assessment for a range of municipal infrastructure assets. Following a very positive response from industry on IPWEA's condition assessment guidelines on Stormwater, (IPWEA, 2011) Buildings (IPWEA, 2009) and other infrastructure, it was considered an appropriate time to develop guidance material on the condition assessment of water supply and sewerage (WS&S) assets.

This paper outlines the approach taken in developing Practice Note 7 'Condition Assessment and Asset Performance Guidelines for Water Supply and Sewerage' (IPWEA, 2013).

Monitoring service and asset performance / condition is an essential function for a water supply and sewerage utility to meet its objectives of achieving its customer service targets in the short-, medium- and long-term.

Condition assessments are technical inspections carried out by competent assessors to evaluate the physical state of water supply and sewerage components and their ability to deliver the services required.

Condition and performance assessment generally comprises and results in:

- Physical inspection of water supply and sewerage systems to assess the actual condition and performance of the assets in comparison with the asset owner's desired standard of service
- Identification of both short-term maintenance works and longer-term renewals or refurbishments, required to bring the condition of the water supply and sewerage system up to, or maintain it, at an agreed condition standard to provide the required level of service
- Ranking of these maintenance works and longer-term renewals in order of priority based on a risk management framework
- Determination of actions by suitably qualified / experienced personnel to mitigate any immediate risk until remedial works (or other actions) can be taken to address problems

Condition assessment is but one aspect of water supply and sewerage management. It is vitally important to have a good knowledge and understanding of the condition of the assets to then develop appropriate strategies and actions for maintenance, major replacements, refurbishments and possible future investment on new works.

Scope and purpose of the guidelines

The intention of these guidelines is to provide practitioners with the necessary principles and procedures to enable the effective and efficient condition and performance assessments of water supply and sewerage infrastructure. The main outcome being sought is that utilities have their 'finger on the pulse' in relation to the condition of their asset base and are then able to make informed decisions on main-

Description	Consequence of Failure Rating
These are WS&S system assets where failure is the most disruptive and expensive to the community or the organisation. In some instances the result could be loss of life or major and/or long-term impact on customer service. The costs would include direct costs (repair costs) and disruption costs (e.g. business temporary closure, evacuation of premises, traffic delays). Where significant environmental damage results then a WS&S utility could be liable to severe penalties. These facilities and their assets should be subject to an appropriate risk assessment with controls established in the form of maintenance and performance monitoring plans to ensure that an acceptable risk level is maintained. The following are examples of very high consequence of failure assets: • Water sources (where the source is the only source) • Dams which are determined to be high risk by the Dam Safety Regulator • Water treatment plants (where there is no alternative plant to provide a back-up supply) and waste water treatment facilities • Major water supply reservoirs particularly where there is no duplicate or alternative supply to a zone or community • Major pump stations • Major trunk mains (water and sewerage) and associated valves • Very deep sewers (say greater than 5 metres deep) • Larger diameter sewerage rising mains • WS&S systems serving critical customers or major facilities (e.g. hospitals, schools, major industrial customers, commercial precinct etc.) • WS&S mains serving a CBD precinct • WS&S mains that traverse major transport corridors or waterways • Single feed systems – a single main feeding a community where there is no alternative supply or inadequate reservoir capacity • WS&S mains located under buildings or structures • Sewerage assets in highly sensitive environmental areas • SCADA system where control functions are performed and redundancy does not exist • Power supply to critical facilities (see above) where no redundancy exists	Very high (rating 5)
These are WS&S system assets where failure is disruptive and expensive to the community or organisation but the impacts may not be as great as for rating 5. In some instances the result could be permanent disability or major and/or long-term impact on customer service. The costs would include direct costs (repair costs) and disruption costs (e.g., business temporary closure, evacuation of premises, traffic delays). Where significant environmental damage results then a WS&S utility could be liable to severe penalties. These facilities and their assets should be subject to an appropriate risk assessment with controls established in the form of maintenance and performance monitoring plans to ensure that an acceptable risk level is maintained. The following are examples of high consequence of failure assets: • Water sources (particularly where alternative sources may have poorer water quality or would be very expensive to operate) • Dams which are determined to be low- to medium-risk by the Dam Safety Regulator • Water treatment plants (where there is an alternative plant to provide a back-up supply) and small waste water treatment facilities where environmental or public health impacts may not be significant (e.g., discharging to wetlands or extensive lagoon system) provided a response can be implemented within a few days • Major water supply reservoirs where an alternative supply to a zone or community can be provided for a reasonable period	High (rating 4)

Table 1
Indicative listing of consequence of failure ratings (continued over page)

tenance and renewals requirements to maintain the desired levels of service. In order to achieve this outcome, a utility will need to:

- Review and update the register of water supply and sewerage assets and classify these assets into their appropriate component levels
- Undertake analysis of the operational and maintenance data to assess asset performance / condition
- Undertake condition assessment as part of routine operation and maintenance activities and when opportunities arise
- Undertake a formalised inspection / condition assessment programme based on risk profile and sampling to rate each component inspected and enable an estimate of remaining useful life
- Undertake more detailed assessment of critical assets, or undertake further investigations to determine the extent of asset deterioration identified during data analysis or inspections
- Undertake risk analysis based on condition to predict the timing of future renewals and replacements of water supply and sewerage components and / or appropriate maintenance activity and frequency
- Develop reports on the performance, condition and risk profile of the asset base
- Inform the valuation process through providing real information on the remaining life of the assets and their rate of deterioration
- Develop a prioritised renewals capital investment programme and maintenance programme and financial planning for the funding and implementation of the programmes
- Support the strategic asset management for the water supply and sewerage systems as outlined in the asset management plans

Risk and consequence of failure

The guidelines follow the risk management principles as generally outlined in AS/NZ ISO Standard 31000 and in documents such as the International Infrastructure Management Manual (IIMM, 2011). This involves the steps of risk identification, risk analysis, risk treatment and a risk mitigation plan.

As part of the risk assessment process it is important to understand how water supply and sewerage systems, and components of those systems, may fail in their ability to deliver the service required of them. Such failure can range from a fairly minor impact on service levels through to major failure, resulting in potentially catastrophic impacts on the users of the services, the broader community or the environment. These adverse impacts can include:

- Major loss of life and property through failure of a major dam
- Loss of supply of water and / or reduction of pressure to affected properties
- Inability to meet firefighting flow demands
- Flooding of property or roads, pathways or other public space due to main breaks
- Failure to meet water quality standards due to contamination or treatment failure
- Failure of sewage treatment resulting in discharges not meeting environmental standards
- Pipe blockages or breaks or pump failures resulting in sewerage overflows, creating hazards to the public and adverse environmental impacts
- Property, infrastructure and environmental damage including erosion, scour or pollution

• Major pump stations where an alternative supply to a zone or community can be provided for a reasonable period • Significant trunk mains (water and sewerage) and associated valves • Deep sewers • Medium diameter sewerage rising mains (relative to the asset inventory) • WS&S systems serving critical customers or major facilities (which can access an alternative supply for a period or have on-site storage) • WS&S mains serving a high density urban area • WS&S mains that traverse significant transport corridors or waterways • Single feed systems – a single main feeding a community where an alternative supply is available for a reasonable period (say 1-2 days) • WS&S mains located under minor buildings or structures • Sewerage assets in sensitive environmental areas • SCADA system where control functions are performed and only partial redundancy exists	
These are WS&S system assets where failure is likely to be less disruptive but still of significance to the affected community or organisation. They are likely to require a lower priority level and frequency of inspection and maintenance. However as the asset ages or deteriorates then the likelihood (and hence risk) of failure will increase which may then require a change in the monitoring of performance and condition. The following are examples of such: • Alternative/ stand-by water sources • Smaller diameter trunk mains (water and sewerage) relative to the asset inventory • Smaller diameter sewerage rising mains • Most of the remaining pump stations and reservoirs • Power supply to the remaining pump stations and alternative /stand-by water sources • WS&S mains that are beneath sub-arterial roads • WS&S mains located in high density urban development precincts • SCADA system where data collection and control functions are performed and redundancy exists • Power supply systems to critical facilities where redundancy exists, or to less critical facilities	Medium (rating 3)
These are WS&S systems where failure is likely to be of low significance in terms of disruption to the affected community or organisation. They require even less frequent inspection however service level requirements should still drive proactive maintenance and remedial action. The failure of these assets should not be ignored. Multiple failures will eventually impact on customer service levels and lead to increased customer complaints. The following are examples of assets with a relative low consequence of failure: • WS&S mains providing services to residential and low density urban development • Smaller pump stations or reservoirs feeding to a few properties	Low (rating 2)
These are WS&S systems where failure is likely to be of very low significance in terms of disruption to the affected community or organisation. They require infrequent inspection, triggered by a complaint or evidence of a problem. The failure of these assets should not be ignored. Multiple failures will eventually impact on customer service levels and are likely to lead to increasing customer complaints The following are examples of assets with a relative low consequence of failure: • Small diameter WS&S mains (100mm or less) in a rural environment where there would be limited disruption • Very smaller pump stations or reservoirs feeding to a few properties where an alternative supply can be provided within a reasonable time	Very Low (rating 1)

Consequence of failure

For water supply and sewerage systems, the consequence of failure associated with these assets can vary, making some assets more critical than others. Critical assets are defined as those that have a high or serious consequence if they do not meet their level of service targets. The guidelines provide criteria that may be adopted by a utility in determining facility or asset consequence of failure. The information is indicative only and it is anticipated that each organisation will review and adapt the information provided to suit its own circumstances. The higher the consequence of failure score, the higher the priority and resources invested in condition and performance assessment, maintenance and renewals. Consequence of failure scores of 1 to 5 are assigned with 5 being deemed to be the most critical level. Table 1 gives an indicative listing of consequence of failure ratings.

Likelihood of failure

A 1 to 5 condition rating for an asset can be used as a surrogate for likelihood of failure. The guidelines propose that, at the outset, before a good base of data is able to be collected and assessed, there is a need to apply some coarser processes to assist in prioritising where the investigative effort is likely to be most productive. A number of surrogate indicators can be utilised to assist in this regard, such as age of the assets, known historical performance, material types, soil conditions, assets under traffic loading, proximity of trees, etc. The aim of this exercise is to develop an initial likelihood of failure grading from say 1 to 5, which can then be used in conjunction with the consequence of failure, to carry out the risk rating assessment that then allows priorities to be assigned for more detailed investigation. The likelihood of failure ratings can then be refined as subsequent condition assessments are carried out and the resultant data is incorporated into the risk management process. Whilst it is recognised that there has been much research done on modelling of various failure mechanisms for these types of assets, this guideline simply flags that this is something for each organisation to consider as a future exercise, as sufficient local condition data is gathered to enable meaningful modelling.

Rating system for condition assessment

The guidelines use the most commonly adopted condition rating system across many asset classes, being the basic 1 to 5 where Condition (0 is not rated) 1 is very good or as new and Condition 5 is very poor and approaching being unserviceable.

The aim of the guidelines is to provide water supply and sewerage utilities with a simple and robust methodology for assessing asset condition. It provides a basic 'core approach', which represents the minimum level of condition asset detail all practitioners should be striving to achieve. It also contains an advanced approach for those utilities that have the resources and desire to achieve a more detailed level of assessment. The advanced approach uses a multi-criteria system targeted to the specific asset type as opposed to the basic generic ratings. In the advanced approach a utility will undertake deterioration modelling to assess future impacts of asset performance in response to levels of renewals expenditure. Having reliable, consistent condition / performance data over a reasonable timespan would be a prerequisite to modelling; this is the aim of the guideline.

Where well proven condition rating processes exist (e.g. WSA 05 – 2013 Conduit Inspection Reporting Code of Australia) these have been recommended in the guidelines.

Grade	Condition	Description	Estimated % asset useful life remaining
1	Very Good	Excellent physical condition. Observable deterioration is insignificant. No adverse service reports. In the absence of any other information the asset will be at Condition Grade 1 at an age of less than 20% of the design useful life.	100% to 80%
2	Good	Observation and/or testing indicates that the asset is meeting all service requirements. Sound physical condition; minor deterioration/minor defects observed. In the absence of any other information the asset will be at Condition Grade 2 at an age of between 20% and 50% of the design useful life.	80% to 50%
3	Fair or Moderate	Moderate deterioration evident; Minor components or isolated sections of the asset need replacement or repair now but not affecting short term structural integrity. In the absence of any other information the asset will be at Condition Grade 3 at an age of between 50% and 80% of the design useful life.	50% to 20%
4	Poor	Serious deterioration and significant defects evident affecting structural integrity. Asset is now moving into zone of failure. In the absence of any other information the asset will be at Condition Grade 4 at an age of between 80% and 95% of the design useful life	20% to 5%
5	Very Poor	Failed or failure imminent. Immediate need to replace most or all of asset. Asset is unable to support the target level of service though may still be providing some level of service.	5% to 0%

Table 2 **Generic condition grading and estimated % useful life remaining – civil assets**

To further assist practitioners in rating the various components' condition grades, a series of photographs are included in the appendices to the guidelines to indicate examples of condition grade from 1 to 5 for a variety of typical components.

The important point is that condition is being measured in an objective way to assist subsequent decision making about the level of service being provided by the water supply and sewerage assets. Condition degradation typically accelerates over time for water supply and sewerage components and accordingly, condition grades can be utilised through application of appropriate degradation models, to assess remaining useful life of these components. Table 1 gives an indicative generic condition grading and estimated % useful life remaining for typical civil assets.

Data sources

There is a wide range of data collected to manage a water supply and sewerage network. This data would include:

- Data for daily operational monitoring of a network including flows, customer complaints
- Data that is collected as part of a planned condition-based maintenance regime (e.g. pump vibration analysis)
- Data on maintenance resources or costs allocated to an asset (not an associated asset e.g., service connection defect allocated to a connecting main) particularly resources or costs assigned to reactive maintenance
- Water quality monitoring data at source, treatment and distribution
- Wastewater composition monitoring data (e.g., trade waste characterisation, hydrogen sulphide monitoring)
- Opportunistic condition assessment (e.g., assessing the condition of a burst water main)
- Detailed investigation (e.g., a specific investigation in response to failures or a pro-active assessment of a critical asset). This activity could include detailed structural assessments or laboratory analysis.
- A formalised asset inspection / condition assessment programme (e.g., a rolling programme of reservoir condition assessments, CCTV of pipe networks, etc.)

It is important that information from these various data sources is stored in a corporate information system so that it is readily accessible for assessing asset condition. The guidelines provide detail on establishing an information management strategy recognising the importance and cost of this aspect.

The approach

The guidelines recognise that a large amount of operation and maintenance data is already captured and encourages better use of this data for asset performance and condition assessment. The guidelines categorise the asset condition and performance assessment process at three levels, namely:

- Level 1: Routine operation and maintenance data assessment. Relevant data captured as part of the ongoing operation and maintenance process is analysed to gain an understanding of asset condition and performance.
- Level 2: Formalised asset inspection / condition assessment. This will include a planned and structured inspection of the asset portfolio, which should include a representative sample and a risk-based sample of the portfolio. This may also form a component of the asset valuation process.
- Level 3: Detailed investigation. This will include any detailed investigations following identification of assets of concern resulting from the Level 2 assessment (where further investigations are warranted) or proactive detailed investigation of critical assets (e.g., trunk water mains).

The guidelines provide a listing of methods available for the condition and performance assessment of the various types of water supply and sewerage assets at Levels 1, 2 and 3.

A utility would typically take the following approach in determining an optimal condition / performance assessment strategy of is asset portfolio:

- Determine the objectives of asset condition / performance and the desired outcomes
- Collate and analyse the available data
- Identify the knowledge gaps
- Determine how the knowledge gaps can be addressed. This may include: collecting tacit knowledge from operational staff through workshops; undertaking desktop assessments and initially basing condition on the asset age or other criteria where no other information is available; improving, or making better use of existing operation and maintenance data capture (Level 1 assessment); undertaking Level 2 assessments as

part of the valuation process or as a specific annual programme; and / or undertaking Level 3 assessments where a need is identified and a cost-effective and technically feasible approach is available.

The inspection process

A plan of action for inspection of the assets involves deciding on particular service areas or parts of service areas and the extent of survey inspection to be carried out in that area. Will it be the whole network for that area, discrete parts, or a sample? The risk management principles outlined previously are utilised to assist this decision making.

In deciding on the level of inspection sophistication to apply, various factors need to be weighed up, as follows:

- What resources are available in terms of skills of existing staff or external specialist firms?
- What level of condition data is needed to improve decision making for the particular assets, that is, will visual inspections provide the necessary level of detail?
- Possible use of technology such as CCTV, acoustic sensing, vibration analysis or thermography to provide meaningful condition data?
- How repeatable is the process to ensure consistency over time for subsequent inspections?
- Will the cost involved be warranted for the importance of the assets involved?

The guidelines spell out in detail the various steps involved in a typical inspection process beginning with preparing a pre-inspection survey pack, the role of the Inspector, setting inspection frequencies, occupational health and safety issues, the condition survey data to be collected including confidence grades, and finally any works orders that might be generated to deal with urgent issues.

Actions arising from condition and performance assessment

The guidelines provide advice on analysis of data arising from the asset condition and performance assessment process, and financial planning to address the required interventions identified from the assessments. These will range from short-term maintenance needs that require 'urgent' attention to longer-term renewal expenditure. Another Practice Note on Long Term Financial Planning (IPWEA, 2010) which is freely available as a download, is also of assistance and cross referenced in PN7.

Improvement planning

The guidelines promote a process of continuous improvement. This is typically achieved as more of the water supply and sewerage system portfolio proceeds through the condition assessment and performance measurement process. In this way, greater knowledge of the way in which the assets are performing will be developed and all stakeholders will gain a better appreciation of how the adoption of a robust asset management process can deliver better outcomes in terms of matching intervention and actions to the desired levels of service that is sought from the particular water supply and sewerage asset.

The improvement plan must also be consistent with the organisation's overall corporate strategic plan and be realistic in terms of the resources available and the timeline expected for measurable results.

Toolkit for renewals forecasting

A simple spreadsheet based tool is provided as part of the guidelines to assist users to develop a 20-year condition and consequence of failure renewals forecast and this allows selection of the priority and timing of renewals based on the condition and risk profile of the assets. The tool includes some generic deterioration curves which can also be adjusted by the utility. These deterioration curves are based on assumed asset useful life, which in practice may significantly alter due to a range of environmental factors, materials differences and construction techniques. Whilst providing a useful starting point for developing a renewals plan, it needs to be recognised that limitations apply such as those mentioned above and assumed interventions by replacing like for like assets.

Conclusion

The guidelines (Practice Note 7) for water supply and sewerage condition and performance assessment fill an important gap in assisting practitioners to carry out regular inspection surveys of water supply and sewerage assets using a risk-based approach that encourages an initial focus on the more critical assets. The guidelines provide a straightforward process to determine condition grading and performance assessment on a uniform, nationally-consistent basis that can then be analysed to develop further information on short-term maintenance needs, pro-active maintenance planning and. most importantly, long-term asset renewal and replacement programmes. Financial related information such as valuation based on depreciated replacement cost and remaining useful life, are all outputs achievable as well. The guidelines provide a listing of methods available for the condition and performance assessment of the various types of water supply and sewerage assets at Levels 1, 2 and 3. ●

Acknowledgements

As part of the peer review process followed for development of all the Practice Notes, the authors wish to thank the many individuals that are acknowledged in the Practice Note for their input and the wealth of information freely provided.

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Getting started on developing an asset management plan: DWA's water asset management strategy

To support the use of infrastructure asset management in South African water services institutions, the Department of Water Affairs developed an Asset Management Strategy alongside a step by step guide on how to develop an asset management plan. Mark Bannister discusses the strategy and guideline document and how these will support the improvement of infrastructure assets in the country.

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Infrastructure asset management (IAM) is an integrated process of decision making, planning and control over the acquisition, use, safeguarding and disposal of assets to maximise their service delivery potential and benefits, and to minimise their related risks and costs over their life cycle. Thus, IAM includes the operation of infrastructure assets as well as planned maintenance and repair, refurbishment and renewal, and provision for replacement of the infrastructure.

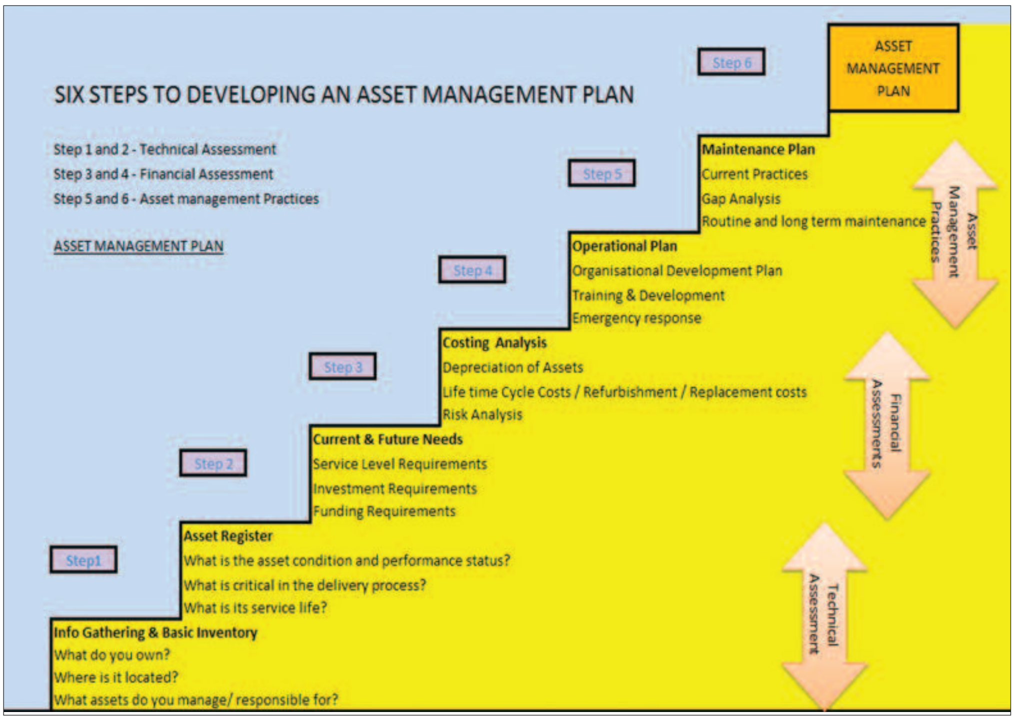
This definition indicates that IAM: takes an organisation-wide perspective and draws upon applicable principles and techniques in the management, engineering, accounting and social sciences (including human resources); has an outcomes focus (i.e. a focus on outcomes such as maximisation of service delivery potential, protection of the ability of the infrastructure network(s) to deliver services, cost effectiveness and efficiency); confers a custodianship role on the managers of infrastructure and their political leaders – i.e. that they are responsible for the lifelong sustainable operation of the infrastructure and for service delivery, not only to the current users of the infrastructure, but to future users as well; and finally must take into account both consumer expectations (including levels of service, and cost of the service) and the legislative environment (e.g., financial and environmental legislation, including any regulatory regime).

Infrastructure asset management in South Africa

South Africa has progressed well with legislating for IAM in the water services sector and many water services institutions (WSIs) deliver infrastructure services reliably, without unscheduled interruption and according to specification. These WSIs have skilled staff and the management of infrastructure assets and services is sufficiently budgeted for.

However, where WSIs are not prioritising IAM – where there may be insufficient political will and where skilled staff and budgets are not available – there has been failure of service provisioning which, in the worst cases, has resulted in total collapse of services. The total value of South Africa's water services infrastructure – water and wastewater treatment works, reticulation systems and treated water storage facilities – is estimated at

Figure 1
Six steps to developing an asset management plan



around R200 billion ($17.8 billion). Recent studies by various institutions have revealed that there is a critical deficiency in asset management systems and practices in most water services institutions, particularly municipalities. Thus, asset failure has unfortunately become commonplace, leading to service delivery failures and resulting health risks.

A key requirement of water services legislation is for WSIs to develop and apply IAM through their Water Services Development Plans (WSDPs) and water board business plans. To date these plans have focused more on the development of new infrastructure to address the basic services backlog, and less on the IAM requirements over the life of existing and new infrastructure.

The South Africa water services strategy

In response to these challenges, The Department of Water Affairs (DWA), in collaboration with the water sector at large, has developed an asset management strategy to capacitate water services institutions to improve the management of infrastructure assets. A further document entitled 'Asset management Plan – Getting Started' was also written as a step by step guide on how to develop an asset management plan (AMP) from first principles and aligned with the strategy.

The vision the strategy has for the sector is that proper life cycle management of water services assets are fully integrated into the water services business of all WSIs in South Africa.

The aim of this strategy is that DWA and its partners will empower and guide WSIs to practice sound IAM, aimed at ensuring optimal utility from public investments in water services infrastructure and the reliable and sustainable meeting of service delivery obligations.

The objectives of this strategy are to:

- Create a platform for coordination of principal stakeholders to support WSI IAM as a matter of national priority
- Address water services infrastructure failures in targeted WSIs in the short-term, and effect improvements that can be publicised in order to demonstrate the benefits of IAM
- Develop in the water services sector in the longer-term a culture of sustained improvement in the management of infrastructure

The following principles underpin this strategy:

Systems approach: IAM planning must look at the entire delivery chain (i.e. delivery of water services), identify the constraints within the system as a whole and then methodically address these, prioritising the most serious constraints.

IAM is an integral part of ongoing service delivery: as an integral part of service delivery, IAM is a continuous process, not a one-off project or an event. It is a process firstly in the sense that improvement must be planned and improvement must be progressive. It is a process secondly in the sense that improvement is not static – demands, performance objectives and technologies all change with time, and infrastructure is subject to wear and tear and to obsolescence. Finally, it is a process in the sense that infrastructure management and improvement in infrastructure management is, or should be, a day in, day out duty of the owners of that infrastructure.

Water services focus: this strategy addresses improvements in the practice of water services IAM, as opposed to the management of water resource infrastructure or other municipal infrastructure such as roads and stormwater, electricity, solid waste facilities or public amenities.

IAM focus: numerous challenges are encountered in IAM, such as the lack of technical expertise. This strategy recognises the broad array of challenges with which infrastructure managers are presented, but concerns itself with the formulation of priority actions to address IAM-specific issues.

Recognition that water services delivery is both a human right and commodity-based: water services infrastructure is utilised to treat, transport or store a commodity – i.e. water. The quality of water services is directly linked to the protection of water as a scarce resource, the quality of potable water and its impact on health and safety, and the quality of discharge into river systems.

Outcomes-based: each priority must be outcomes-based and measurable.

An appropriate mix of short-term successes and long-term sustainability: properly managed infrastructure assets have life spans that can be measured in decades and thus the full benefits of IAM are felt over successive generations. Whereas this strategy recognises that the full establishment of IAM practices has a medium- to long-term horizon, it also recognises that short-term successes are not only possible but are required to establish credibility, harness support and to improve failing service standards.

Promotion of an integrated, inter-disciplinary and inter-sectoral approach: IAM operates at the interface of several functional disciplines, some of which include accounting and finance, town and regional planning, and engineering. The role of communities and of political leadership is also important – the latter sometimes of overriding importance. This strategy promotes appropriate inter-disciplinary and inter-sectoral alignment, and thus an integrated approach to IAM.

Focus on the key challenges and prioritise: numerous challenges present themselves in the management of water services infrastructure. The strategy recognises that only a select group of challenges can be addressed at any one time and that the key challenges that impede the adoption and practice of sound IAM must receive priority attention.

Adoption of the Pareto (80/20) Principle: this principle states that a small proportion of the full effort required to achieve a particular result generally achieves close to the desired result and that further efforts are often subject to diminishing returns. This is sometimes stated as '80% of the full result from 20% of the full effort', or the 80/20 Principle (or rule). It is usually valid for IAM. (Extending this thinking, a 'scan' effort, to determine as quickly as possible where the most critical problems lie, followed by the first steps of what would be a longer improvement process, would often be worthwhile. This effort can, quickly and cheaply relative to a more thorough effort, both bring about some rapid incremental improvement and also ascertain the extent of a problem and how much further effort would be required.)

No one size solution fits all: while the general principles of IAM remain valid for all institutions, the priorities differ from institution to institution and also

Benefits of infrastructure asset management

Keeps infrastructure operational and delivering services
Improves revenue-earning potential through delivering chargeable services
Creates sustainable jobs
Saves costs in the long-term and often in the short-term as well
Ensures that more funds for new infrastructure are available in the future

change with time – as do the techniques, the technological and non-infrastructure options and other factors.

Start with the basics, and get them right: the approach must be incremental. Do not attempt to progress further until the basics are right. Address the weakest links in turn – and as each is improved and is no longer the weakest link, attend to the new weakest link. Where there is strength, support it, and build on it.

Political, management and operational focus: all levels must commit to IAM in order for it to be successful – from politicians who ensure political will, legislative compliance and community requirements, to planning by management, to implementation at the operations level.

Benefits, scope and process of IAM

It is internationally recognised that the application of IAM practices has numerous benefits for asset owners, the beneficiaries of infrastructure services and other stakeholders.

Effective management of infrastructure is central to public sector institutions that seek to provide an acceptable standard of services to the community. Infrastructure impacts on the quality of living environment and economic health.

Not only is there a requirement to be effective, but the manner in which the institutions discharge their responsibilities as public entities is also important. They must demonstrate good governance and consumer care, and the processes adopted must be efficient and sustainable. Councillors and officials are custodians on behalf of the public of infrastructure assets, the replacement value of which, even in a small municipality, can amount to several hundred million Rand, and in larger ones, to several billion Rand.

An integrated IAM process and programme will have a very significant positive impact. It will:

- Assist public sector infrastructure owners to improve decision making about their capital plan requirements
- Change cultures, with the aim of instilling an integration of information and decision making across all owners of public sector infrastructure (including through different spheres of government)
- Provide an environment for more productive relationship with government stakeholders and consumers
- Provide a cradle-to-grave picture of their IAM that will guide owners in their planning and sustainable implementation of IAM
- Focus institutions on providing services that will improve in quality over the short-, medium- and long-term
- Enable institutions to identify and maintain key assets, which will lead, among other things, to fewer instances of non-compliance with national standards (e.g., drinking water quality regulations)

The business model for IAM must focus on minimising the lifetime total costs of infrastructure assets, while still achieving service goals with respect to:

- Delivering those services, and meeting goals with respect to reliability
- Complying with statutory requirements with respect to, for example, quality and resource usage
- Buying new capital assets
- Operating current assets
- Maintaining current assets
- Refurbishing and renewing assets
- Replacing aged assets
- Disposing of non-functional assets
- Scope and process of IAM

IAM is not a once-off or external intervention. It must become integrated into the operations of the institution owing or managing the infrastructure.

Furthermore, it must be a process that involves continuous improvement. However good or bad the IAM of an institution currently is the performance cycle must be upwards. For example, knowledge of assets might be minimal to start with, but improved asset O&M will lead to improved performance and more effective service delivery, and all the time knowledge of assets will be improving. If knowledge of assets is good to start with, then attention might focus on improving demand prediction, risk analysis, and identifying optimum technological solutions.

In brief, the scope and process of IAM constitutes:

- Assets can only be managed if they are known about. Thus, at the minimum, there must be knowledge of at least those assets most critical to service delivery – what they are, where they are, to what extent they are still working, and their capacity.
- The level of service of each infrastructure facility or component must be known, including its capacity, and relationship to demand – how much spare capacity is there?
- There must be knowledge of current demand and prediction of demand, and whether an asset is still required, needs its capacity supplemented, etc.
- Finance is of fundamental importance. Can the infrastructure owner afford to manage the assets, given the costs of operation and of maintenance, and of renewal and recapitalisation? If the costs cannot be afforded, what are the consequences? To what extent is finance dependent on revenue derived both directly and indirectly from provision of the service? And to what extent is the overall viability of the owning institution dependent on that revenue? Then – can the owner afford not to manage the assets, given the loss of revenue, loss of amenity, and other losses were the infrastructure to deteriorate and the service delivery to be hampered?
- Planning is also of fundamental importance. How will the infrastructure be managed and the service provided – bearing in mind that IAM involves people, processes, systems and finance? This needs to be set out in an IAM plan (which can be very simple to start with).

Improved service delivery leads to improved finances, then to better IAM planning (which is the current focus of implementation of the strategy), better knowledge of the assets, and so on, leading to improved service delivery – and the cycle of improvement continues.

Guide to implementation of the strategy

The Asset Management Plan – 'Getting Started' guideline document has been written to support the asset management strategy produced by DWA in 2012. It has been written to provide a starting point for those Water Service Authorities that have little or nothing in place, so that they may 'get off the starting block' in terms of becoming compliant. The guideline acknowledges that there are many excellent documents already written which will go into far more detail as an organisation progresses in line with the strategy. This guideline has been written in an informal way to drive home the basic requirements necessary, in particular the asset register, in order to get a utility started and succeed in setting up a basic AMP. The structure of the AMP will then be in place and the foundations will be set to take the process forward and to a level of detail that is necessary for the organisation.

An AMP is a critical management tool that introduces discipline and logical processes into the planning of an organisation's activities around the infrastructure that falls within their responsibility. And once again it is a legal requirement, just like a driving licence!

The advantages of a good AMP are numerous and these are highlighted in the 'Getting Started' guideline document, however it will include sustainability of the infrastructure that the organisation is responsible for, effective operation and maintenance of the equipment which will lead to a better quality of product (working towards or maintaining Blue and Green Drop status) with fewer breakdowns, continuity of service delivery as the needs of the consumers change over time, greater understanding of what is required to continue effective delivery, prioritising interventions, and across the board there will be massive cost saving because of efficiency, reduced leakage, productive staff, unnecessary replacement of equipment, good planning to ensure the most appropriate delivery of services, and so it goes on....

What are the key ingredients?

There are five key ingredients that are essential for developing an effective AMP. These are as follows:

The first ingredient is the scope of what the organisation is responsible for. In the case of a municipality – what is the area of jurisdiction, how many people are supplied, what level of services currently exists and what is planned for in the future? If the scope was a cake it would be the size of the cake, how many it will feed, now and tomorrow, and whether it is basic sponge cake or a glitzy cheesecake. To use the cliché of 'You can't manage what you don't know' may be a little tacky to apply, but at the same time, it is so true.

The most important ingredient in an AMP, around which everything else is subservient, is the asset register – it is the flour in the bread, the grape in the wine, it is the players in the soccer team. The asset register provides a logical approach to establishing the 'know' within the quote above – once you know what you have, then you can start applying management principles.

The next ingredient is money or finance!! What are the funding requirements to make this all happen? How much will it cost to maintain the infrastructure that is presently under the organisation's control? How much will it cost to expand infrastructure to new areas where consumers want a higher level of service? How much will it cost to replace existing infrastructure in the future and what plans are being made now to ensure that money is available at the time the replacement is needed and to ensure continuity of supply?

Next is the methodology or asset management practices– how do we bake this cake? This is the 'How' component rather than the 'What' – how do we operate the infrastructure we have? What structures do we need in place to ensure effective operation and maintenance continues in the future? What type of personnel do we need to employ to make this happen? Do we have the required moveable assets – the tools, the vehicles, the spare parts to make it happen?

The fifth key ingredient, with equal importance to the asset register and without which nothing else will happen, is people. Each and every stage of the development of an AMP is driven by people. Monitoring, reporting, reaction and accountability is all driven by people.

The guideline has identified six steps (Figure 1), which involve the ingredients detailed above and these steps must be ascended to achieve the goal of having an AMP in place. The six steps incorporate the technical assessment, the financial assessment and the asset.

Conclusion

In terms of the water services asset management strategy outputs, DWA will lead the actions within each output, taking responsibility for those within its power to do so, and working closely with other national government departments where responsibility for the envisaged action is statutorily with those departments. DWA will cooperate with all stakeholders, including national government departments, local government and other sector role players.

Guideline – 'Getting Started' has been developed with the intention of complimenting the water services asset management strategy. The guideline document is to be used by WSAs and WSIs to support those that have nothing or very little in terms of an asset register or an AMP, and to get them off the starting block in this regard. The guideline document has provided a step-by-step guide as to how municipalities can actually make it happen. Even if municipalities currently have nothing in place, if they follow the steps provided, it will give them the foundations on which to build upon. There has been a particular focus on the asset register since this is the most important component, without which an AMP cannot be developed. As mentioned earlier, there are many excellent documents in the sector.

The provision of an AMP is a legal requirement for every municipality in the country. DWA has identified DWA asset management champions in each province of South Africa and trained them to roll out the strategy and guideline document to the WSAs in their area of responsibility. The training they provide will inform the WSA of the strategy and present the guideline document so that they have the knowledge and tools to create, or develop further, their own AMP into a suitable product. However, the support that DWA provides, if indeed required, does not remove the obligation of the WSA to develop it themselves. It is their responsibility to deliver and DWA will guide and support the process as necessary. ●

Further reading

Australia and New Zealand: International Infrastructure Management Manual, Association of Local Government Engineering New Zealand and the Institute of Public Works Engineering of Australia, Version 3.0. Addresses asset management concepts and practices for numerous types of infrastructure assets and includes several brief case studies.

USA: Water Infrastructure Network (WIN) is a 'broad-based advocacy coalition of local elected officials, drinking water and wastewater service providers, state environmental and health administrators, engineers, and environmentalists for America's drinking water and wastewater infrastructure'. For more information, visit: www.win-water.org.

USA: US EPA Asset Management materials, WERF SIMPLE, IIMM, PAS 55, ISO 55000.

South Africa: Asset Management for the Water Services Sector in South Africa by D. Stephenson, B. Barta and N. Manson.

South Africa: Institute of Municipal Engineers South Africa (IMESA) - Infrastructure Asset Management Training Course. A Training course designed and implemented specifically for Municipalities as Water Service Authorities.

South Africa: Department of Water And Sanitation (2011), Water services infrastructure asset management strategy. Strategy as described in this paper.

South Africa: Department of Water And Sanitation (2012), Asset Management plan 'Getting Started'. Guideline as described in this paper.

This paper was presented at the Singapore International Water Week, held 1-5 June 2014 in Singapore.

Uniform failure registration: from data to knowledge

By consistently analysing registered failure data the condition of underground assets can be quantified with more confidence, providing a valuable source of information required for asset management. To increase the usability of their registered failure data, Dutch water companies in collaboration with KWR Watercycle Research Institute have developed a uniform standard with a central database. Marcel Kwakkel, Irene Vloerbergh, Peter van Thienen, Ralph Beuken, Bas Wols and Kim van Daal report on the useful insights which have already been gained.

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Water utilities and their operators aim to minimise leakage and breaks to ensure the continuous supply of drinking water to their customers, to minimise direct financial losses associated with leakage and to prevent secondary damage to nearby objects.

Asset management (AM) can benefit from the effort put in registration of failure data. Such a registration allows for the understanding of pipe behaviour over time under specific circumstances, thereby giving insight into the condition and ageing of assets. However, to be able to achieve such understanding, registered data has to meet the following criteria: suitability, reliability and sufficiency. Data suitability depends on the registered parameters, which should resemble the key parameters considered to have a large influence on the occurrence of failures. The assurance of reliable data gives confidence to the analysis made with the data. This is important as significant investments will be made based on these data. By incorporating quality assurance steps within the registration process, the accuracy and consistency of data will improve. Finally, to be able to draw statistically significant conclusions from the data, the amount of data has to be sufficient and the method of analysis has to be sound.

Based on a studies by Vloerbergh and Blokker (2007, 2010), seven out of ten Dutch water companies decided to design and implement a uniform failure registration system (USTORE). Due to large differences in registration between the companies, earlier registration efforts showed limited usability. Therefore, much effort was put in determining what parameters should be registered, and how accurately and consistently this should be done. Figure 1 shows the key parameters considered to have an influence on the occurrence of failures. Registration by multiple choice questionnaires by field workers leads to a uniform and consistent dataset.

Although generally considered favourable, low failure frequencies of the Dutch drinking water industry are a difficulty for data analysis. On average there is approximately only one incident per 19.5km of total network length per year, which increases the time required to obtain sufficient data. By joining forces, data acquisition is accelerated, thereby increasing the amount of detail or advancing the usefulness of data analysis to support AM decisions (replacement and investment strategies).

This paper starts with a description on the current status of USTORE. It provides details on the registration cycle and an overview of the database contents that serves as an input for data analysis. Next, a selection of derived

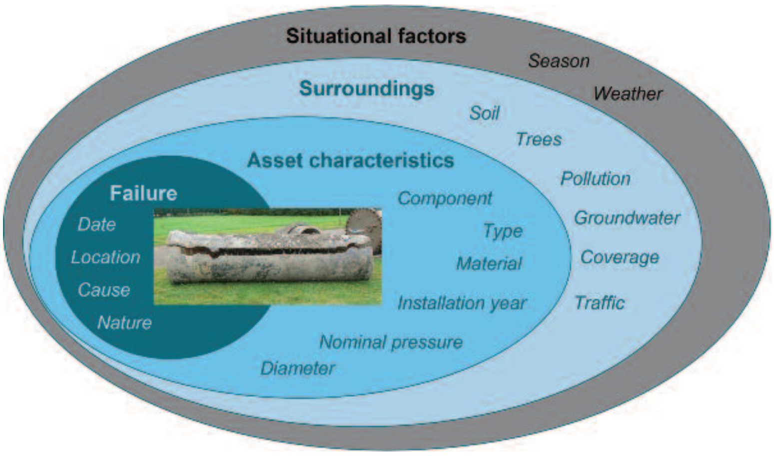

Figure 1 Parameters considered to have an influence on the occurrence of failures (Vloerbergh et al., 2012)

Table 1 Overview of network and failure data available within USTORE (October 2014)

data Company	Network data Period	Network length [km]	Failure Period	Number of failures
A	2010 – 2012	18,150	Q1 2010 – Q2 2014	3053
B	2009 – 2012	4620	Q1 2009 – Q4 2013	1231
C	2009 – 2012	9945	Q1 2009 – Q3 2014	2828
D	2010 – 2012	3380	Q1 2011 – Q4 2013	621
E	2010 – 2012	5720	Q1 2009 – Q2 2014	983
F	2009 – 2012	4915	Q1 2009 – Q3 2014	2366
G	2009 – 2012	8740	Q1 2009 – Q3 2014	3930
Total		55,470		15,012

NB. This table is an updated version of the one presented in the original paper data analysis results is presented and discussed. Finally, an overview of possible USTORE improvements, potential research directions and main conclusions are given.

USTOREin practice

Registration cycle

The entire USTORE system can be broken down into six steps, see Figure 2. Steps 1 and 2 are organized within the participating companies. Based on a template approved by the water companies, failures are registered by field workers. These field workers should be well trained and have sufficient time reserved in their daily schedule to register the parameters as encountered in the field. This is a crucial step since errors in the failure registration are hard to correct afterwards. Steps 3 to 5 are provided by USTOREweb; a web-based platform to upload and analyse all available (anonymous) failure data. Water companies are only able to access and analyse their own data in more detail; KWR acts as a database administrator. Step 6 is the final goal of failure registration: support of AM decisions. More details on the lessons learned in the process of designing the USTORE system, implementing it in the water companies and developing USTOREweb can be found in Vloerbergh et al. (2012).

Network and failure data

Besides the registration of failures, information on the network is also required to be able to compute failure frequencies of cohorts. Up till now 20 cohorts of pipes have been defined (Vloerbergh and Blokker, 2009). The currently available network parameters are limited to the following five: company name, material, diameter, installation year and length. Table 1 gives an overview of network and failure data currently available within USTORE. Up till October 2014 15,012 failures from seven water companies were collected in the USTORE database. Two additional water companies had agreed to participate in USTORE at the time of writing, but were not yet ready to upload their data.

Figure 3 shows the distribution of the summed pipe length as a function of decade of installation for all materials as present in 2012. The figure clearly shows the shift in material preference from cast iron (CI) and asbestos cement (AC) pipes towards PVC, PE and ductile iron pipes.

Figure 4 shows the total number of failures as a function of age for all materials. Although the summed length of installed PVC over recent decades is high (see Figure 3), the

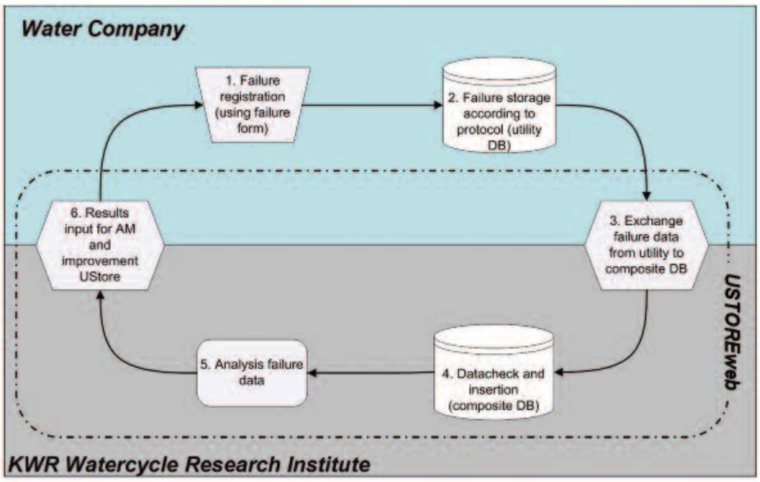

Figure 2
The USTORE system is broken down in six steps; 1) failure registration, 2) collection, 3) exchange, 4) controlled & composition, 5) analysis and 6) support of decision taking (Vloerbergh et al., 2012).

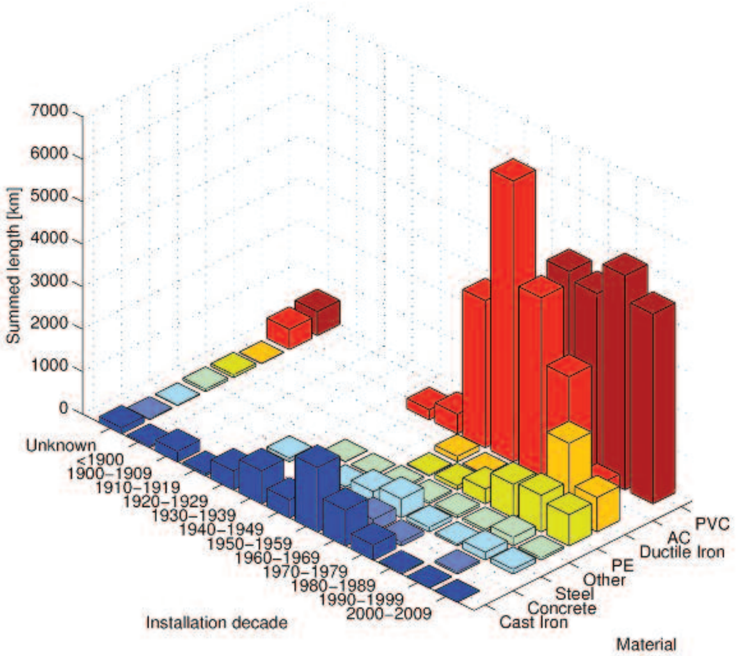

Figure 3
Summed pipe lengths as a function of installation decade for all materials as present in 2012

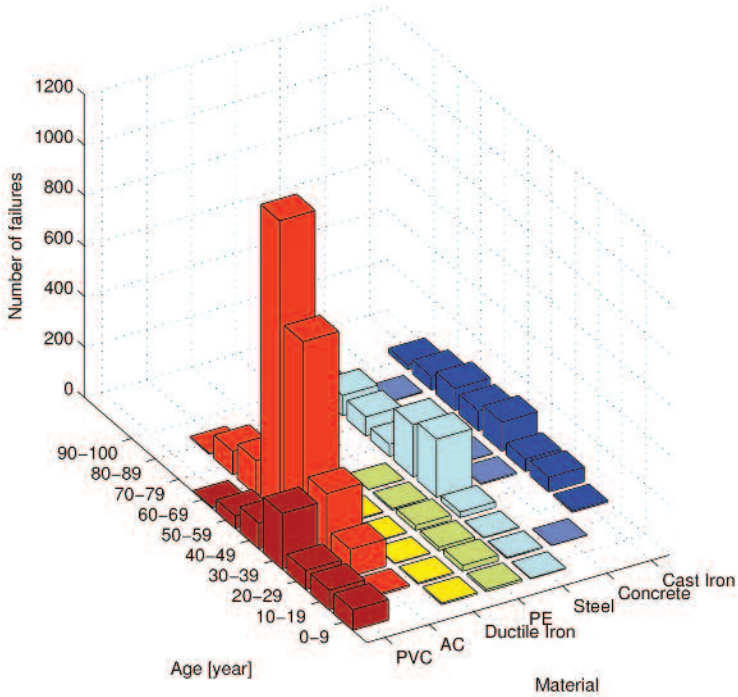

Figure 4
Total number of failures as a function of age decade and material (July 2013)

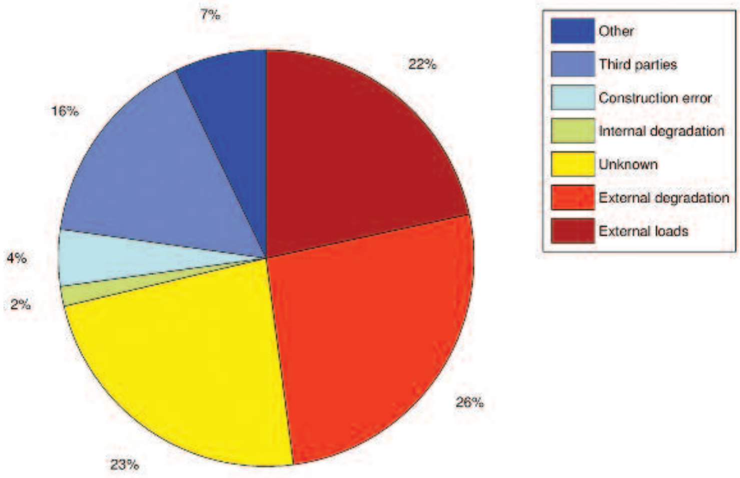

Figure 5
Distribution of failure causes as registered in USTORE (July 2013)

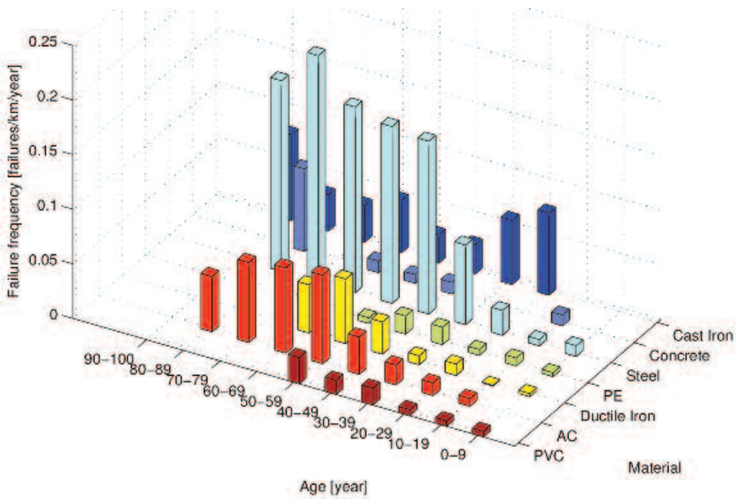

Figure 6
Failure frequency (spontaneous failures only) as a function of age for all materials (July 2013)

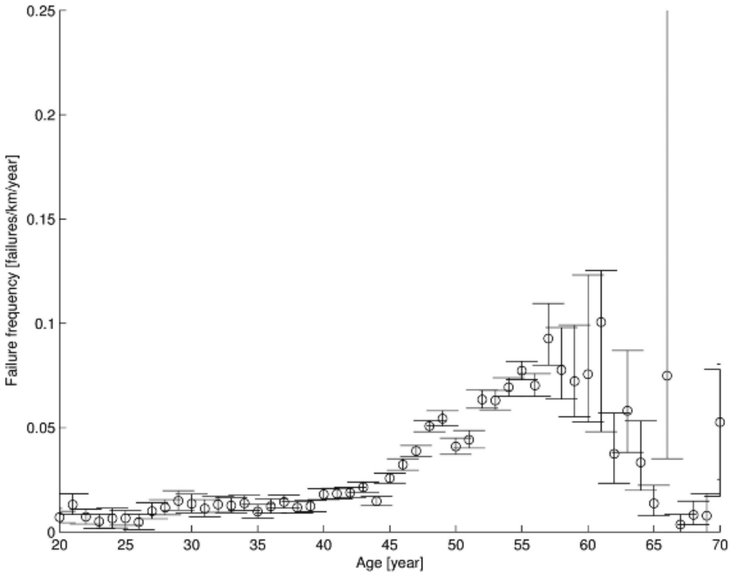

Figure 7
Relation between age of AC pipes (without the joint) and failure frequency (spontaneous failures)

number of failures over the last three decades is almost constant. A poor PVC production process is probably causing the peak in the number of failures between 30-39 years. This relates to poor manufacturing in the 1970s.

Figure 5 shows the distribution of the failure causes as registered in USTORE. Of the 10,766 failures, about 16% (1675 failures) were caused by third parties. Furthermore, about 50% (5109 failures) can be regarded as 'spontaneous' (caused by internal / external degradation or external loads). These spontaneous failures can be useful to study the ageing of pipes, as will be shown in the next section. Furthermore, about 30% of the failure causes is unknown / other, which indicates that improvements are possible.

Data analysis and discussion

Failure frequency per age decade

By combining network and failure data, it is possible to compute failure frequencies for specific cohorts. Figure 6 shows the (spontaneous) failure frequency as a function of age for all materials. Overall, steel has the highest failure frequencies. However, this concerns only a relatively small group of post-war small diameter mains and not the more recent transport mains. Since about 32% of the Dutch network consists of AC, its relative high failure frequency warrants a more detailed investigation of this material.

Failure frequency of AC

Figures 7 and 8 show the relation between the age of AC pipes and joints, respectively. The failure frequency is computed by dividing the number of failures per year of a specific age by the total pipe length with that age (circles). The error bars show the sensitivity of the failure frequency to plus-minus one failure and plus-minus 10km of the total pipe length with that age. These figures show that AC pipes are more sensitive to ageing than AC joints, which is caused by leaching. For AC pipes the failure frequency shows a strong increase for pipes older than 45 years (pipes with installation years before approximately 1965). The failure frequency of joints is more constant, although a higher failure frequency is seen over 50 years of age (probably related to the degradation of natural rubber used in these joints). Of all spontaneous AC failures, about 80% occur in pipes and only 20% in joints.

Several hypotheses on failure causes formed the basis of the USTORE registration system. One hypothesis was that AC pipes are sensitive to the lime content and / or pH of the soil. To study this hypothesis a dataset was obtained from two water companies, which included location data of mains. This dataset was combined with a soil map. Figure 9 shows a result of combining USTORE data with GIS, which allows the computation of failure frequencies of more detailed groups (cohorts). The average failure frequency of AC pipes is 0.044 failures/km/year. By subdividing soil data in three categories based on lime content (low, medium, high) and by defining two age bins (pre/post 1965), the failure frequency of AC pipes in each group can be computed. As the figure shows, no influence was noticed of the lime content on AC pipes with construction years after 1965. However, AC pipes with construction years before 1965 fail more often in soils with a lower lime content.

Failure frequency of PVC

Another hypothesis is that PVC fails more often in regions with large differential soil settling. The average failure frequency of PVC is 0.021 failures/km/year. Figure 10 shows a subdivision in three groups based on the differential soil settling, which were computed by a GIS analysis on a 100x100m grid. Although this figure indicates that regions with larger differential settling show higher failure frequencies, the choice of boundaries between the three groups showed to affect results. Therefore, more detailed investigations (based on more failures and better settling data) are required to obtain a better understanding of the influence of soil settling on failures.

Discussion and conclusions

To be able to perform AM, an increased understanding of ageing and failure mechanisms of underground assets is required. When mains fail, valuable data becomes available. Analysis of systematically and uniformly stored failure data gives information for strategic AM. It reveals relations between pipe material / placement conditions and failures. These relations enable the prediction of the residual lifetime of mains under similar circumstances. Therefore, seven out of ten Dutch water companies have developed USTORE. In four years, over 10,000 failures were registered, which makes it possible to study the ageing and failure mechanisms of mains. It was shown that AC pipes fail more often than AC joints, especially when the pipes are older than 45 years. The degradation of AC pipes is accelerated in soils with low lime content (acid soils). For the total dataset, the majority of spontaneous failures are due to failures at the barrel of the pipe. This indicates that leaching is a more dominant failure mechanism than problems at joints (like natural rubber rings). PVC appears to fail more in regions with high differential soil settling; however this hypothesis needs more detailed investigation.

Three developments can accelerate the understanding of ageing and failure mechanisms of underground assets: increasing the amount of failures; improving the quality of the registration of these failures; and the application / development of more advanced data analysis methods. Currently, seven water companies upload their data on a regular basis and two companies have agreed to do this in the near future.

By these efforts the amount of data

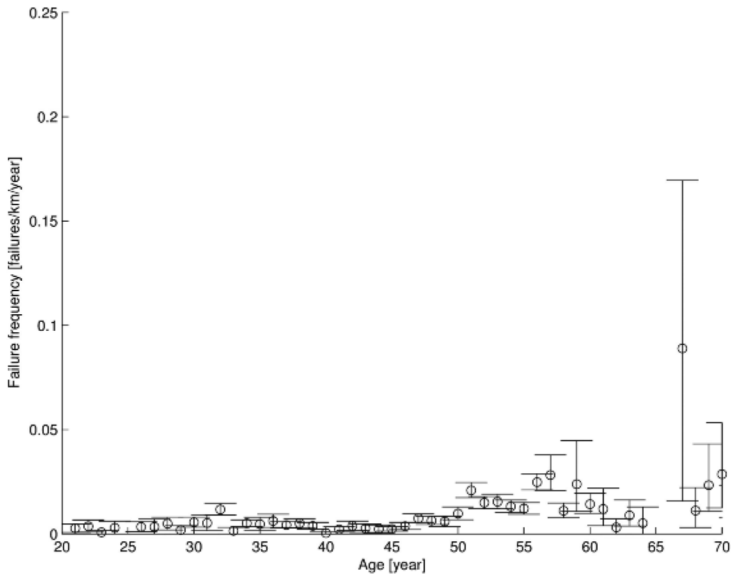

Figure 8 Relation between age of AC joints and failure frequency (spontaneous failures)

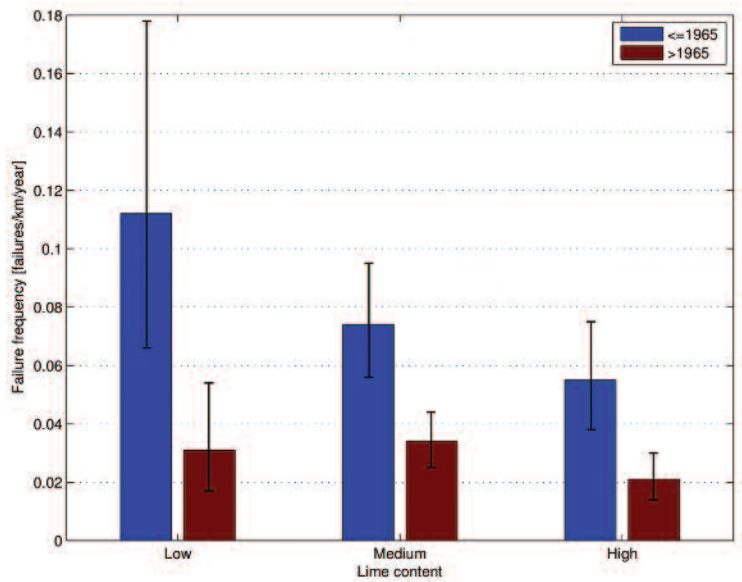

Figure 9 Failure frequency (incl. 95% confidence interval based on a Poisson model) for AC pipes subdivided into groups based on construction year (pre/post 1965) and the soil lime content (groups based on CaCO3 content, where low: <0.5% CaCO3, medium: 0.5-1.5% CaCO3, high: >1.5% CaCO3)

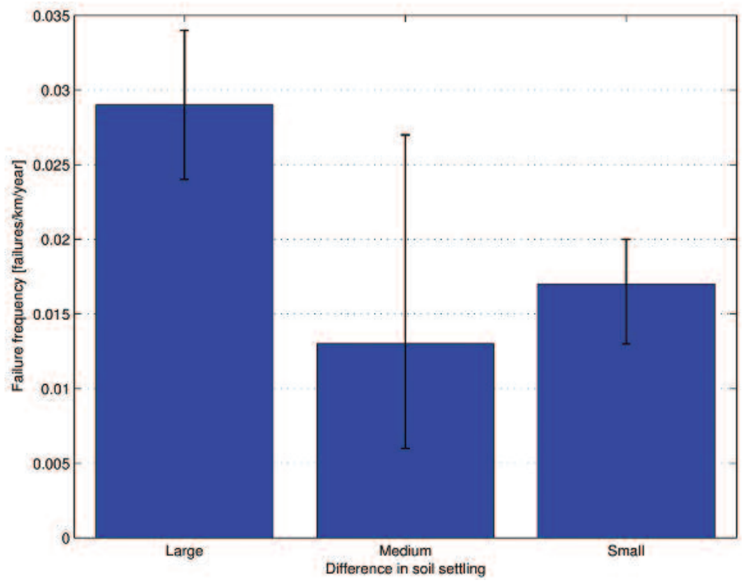

Figure 10 Failure frequencies (incl. 95% confidence interval based on a Poisson model) for PVC pipes subdivided in groups based on the differential soil settling (boundaries between groups selected such that the number of failures in each group is equal)

steadily increases, thereby increasing the opportunities for data analysis. In time, this could lead to a complete national database, to which all Dutch water companies upload their data. Another possibility to obtain more data is to cooperate with other national and international sectors. Second, water companies that already participate in USTORE have been discussing how the quality of registration can be assured. KWR supported this discussion by investigating what could be altered to achieve a more reliable registration. This evolution of the USTORE system will optimise the registration process, thereby making it easier and more efficient for other possible contributors. By coupling USTORE data with spatial and meteorological data (recently investigated by Wols and van Thienen, 2013), data analysis opportunities can be expanded. Currently, the network data within USTORE does not contain information on the location of mains. However, to be able to compute failure frequencies for specific pipe groups such data is required. The benefit for data analysis is emphasised by the presented results (AC degradation due to acid soils, PVC failures due to soil settling). Finally, by the application of more advanced data analysis techniques (like data-driven modelling) additional and unforeseen insights can be obtained. To increase the returns of the registration investments by our contributors, all three developments will be pursued. ●

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NEC and Gutermann release water leak detection solution

NEC Corporation and Gutermann AG, a Switzerland-based provider of advanced leak detection technologies, have announced the release of the NEC Water Leakage Detection Solution, which analyses data from a large number of ZONESCAN sensors to detect leaks in water supply systems.

The loggers transmit data on minute vibrations and sounds from leaks in water supply pipes to a cloud-based system, where this data is automatically analysed, allowing for the quick and precise identification and location of water leaks (within the range of approximately one meter) and their display on user-friendly screens, say the companies.

Gutermann says that its correlating ZONESCAN loggers are up to 30 times more sensitive than conventional noise loggers and can be attached to the metal fittings inside manholes. This enables the daily accumulation of real noise data from pipes as well as its analysis using sophisticated correlation algorithms. Furthermore, this improves the filtering capabilities of the system, increases sensitivity by a factor of three and helps to eliminate false alarms, it says. ●

www.nec.com
www.gutermann-water.com

Ice Pigging acquired by Aqualogy Environment Ltd

UK ice pigging company PCIP Ltd has been acquired by water management company Aqualogy Environment Ltd for an undisclosed sum.

Ice Pigging, developed and patented by the University of Bristol spin-out company, PCIP Ltd, is an innovative process for cleaning pipes that uses slush ice. It has wide-reaching applications in the water industry, food and beverage industry, energy, oil and gas sectors, and has potential across a variety of applications where pipes are used, says the company. The acquisition now gives Aqualogy full rights to use the technology across industry sectors.

The process was invented and developed by Joe Quarini, Professor of Process Engineering in Bristol University's Department of Mechanical Engineering. The technology differs to conventional pipeline cleaning methods by using slush ice to clean pipe walls without the use of disinfecting chemicals, with little risk, and with much improved effectiveness, he says. ●

www.aqualogyuk.com

Itron and i2O Water announce new alliance for smart pressure management solutions

Technology and services company Itron, Inc has announced a new alliance with i2O Water, a UK company specialising in smart pressure management for water networks.

The partnership is based on a five-year agreement to distribute i2O's Smart Pressure Management products and the collaboration between the two companies will expand Itron's water portfolio while also rounding out its non-revenue water (NRW) offering. This will enable utilities to more effectively and efficiently manage water resources around the world. i2O's innovative technology helps minimise non-revenue water by reducing physical water losses in the distribution network.

It joins Itron's suite of NRW products, including acoustic leak detection, district metering and analytics.

The solution automatically and continuously optimises water pressure according to consumption and day-to-day changes in flow and provides utilities with visibility into network performance and remote control of pressures to reduce operating costs, better serve customers and extend the life of network infrastructure. It also conserves water resources through reduced leakage and bursts, cutting the energy consumption associated with water distribution and reducing the carbon footprint of operating distribution networks. ●

www.itron.com
www.i2owater.com

Detectronic work with Metrica to supply sewer network monitoring, maintenance and flood prevention in Athens

Detectronic is working in partnership with its Greek agent, Metrica, to supply sewer monitoring and maintenance in support of flood prevention in the country's capital, Athens, for the Athens Water Supply and Sewerage Company (EYDAP SA).

The company invited Metrica and other suppliers to look at long-term monitoring and maintenance of the city's trunk sewers with a view to appointing a suitable delivery partner. The project is particularly complex and challenging in that pipes in the existing sewer network vary from 1000mm to 3500mm in diameter, with invert levels of up to 9000mm. Furthermore, the shape of the pipes in the sewage network varies from circular, to egg-shaped and bonnet-shaped pipes, which makes flow calculating more difficult.

Additionally, Detectronic is not allowed to enter either the existing access chambers or the sewer pipes to install the monitoring equipment. However, Metrica have devised a solution to measure flow in the pipes away from the intersections and access chambers. This involves excavating and digging down to the sewer pipe, after which engineers will drill into the crown of the pipe using a 200mm core-drill. They will then insert a vertical shaft and feed the sensor, which is fixed on a special bracket. Following calibration, the engineered solution will provide accurate measurement even in surcharged conditions, due to the unique mounting arrangement of the sensor which is fitted inside an IP68 barrel- type housing that, if the water level reaches the sensor, will retract via buoyancy to protect the electronics. Ten such monitoring 'stations' have been installed so far with promising results. ●

www.detectronic.org

HWM launches new electronic controller for pressure reducing valves

The water and asset monitoring specialist HWM has launched a new electronic controller for pressure reducing valves (PRVs). The Pegasus+ enables detailed multi-point PRV control without a flowmeter, either by flow or by time, together with sophisticated closed loop control. It also permits immediate control of pressure within a distribution network and automatically adapts to network changes and events by analysing data from up to three critical points (CPs).

By controlling PRV output pressure, the new controller maintains CP targets defined in terms of time, flow or a combination of the two. Networks can be optimised to reflect changing demand throughout the day or week. A latching solenoid output enables vales to be fully opened or closed in extreme or emergency situations, according to controller settings. Bidirectional GPRS telemetry can be used to trigger alarms or remotely control the valve. Pegasus+ features a secondary channel, in addition to its main logging channel, for fast logging down to one-second intervals. This allows a more detailed investigation of events such as pressure spikes while helping to establish minimum night flow. The controller also offers the ability to control a network from any web-enabled device via the HWM Online web viewer whereby users can check and alter system and component configurations and settings. Controller set-up and programming can be conducted via a tablet or PC-based app. ●

www.hwm-water.com

PUBLICATIONS

Alternative Water Supply Systems

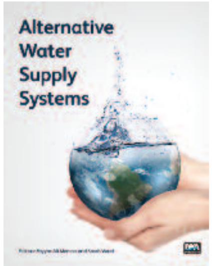
Editors: Fayyaz Ali Memon and Sarah Ward

Owing to climate change related uncertainties and anticipated population growth, different parts of the developing and the developed world (particularly urban areas) are experiencing water shortages or flooding and security of fit-for-purpose supplies is becoming a major issue.

The emphasis on decentralised alternative water supply systems has increased considerably. Most of the information on such systems is either scattered or focuses on large scale reuse with little consideration given to decentralised small to medium scale systems. *Alternative Water Supply System* brings together recent research into the available and innovative options and additionally shares experiences from a wide range of contexts from both developed and developing countries.

*Alternative Water Supply System*s covers technical, social, financial and institutional aspects associated with decentralized alternative water supply systems. These include systems for greywater recycling, rainwater harvesting, recovery of water through condensation and sewer mining. A number of case studies from the UK, the USA, Australia and the developing world are presented to discuss associated environmental and health implications.

The book provides insights into a range of aspects associated with alternative water supply systems and an evidence base (through case studies) on potential water savings and trade-offs. The information organized in the book is aimed at facilitating wider uptake of context specific alternatives at a decentralised scale mainly in urban areas.



This book is a key reference for postgraduate level students and researchers interested in environmental engineering, water resources management, urban planning and resource efficiency, water demand management, building service engineering and sustainable architecture. It provides practical insights for water professionals such as systems designers, operators, and decision makers responsible for planning and delivering sustainable water management in urban areas through the implementation of decentralized water recycling.

IWA Publishing January 2015
Pages: 496. Hardback
ISBN: 9781780405506
Price: £145.00 / US$261.00 / €195.75
IWA members price: £108.75 / US$195.75 / €146.81
To order, visit: www.iwapublishing.com

A Practitioner's Guide to Economic Decision Making in Asset Management

Part 1: Background Document

SAM1R06b1

Author: David Marlow

IWA Publishing February 2015
200pp
ISBN: 9781780405285

Part 2: Guidance Document

SAM1R06b2

Author: David Marlow

IWA Publishing February 2015
200pp
ISBN: 9781780406275

For many water service providers (WSPs), meeting the financial demands of maintaining, extending and upgrading infrastructure systems is increasingly challenging. Furthermore, the remit of WSPs is broader than just financial considerations, so there is also a need to take societal impacts and values into account in the way investments are justified.

These challenges mean that there is an increasing need for asset managers to embrace new approaches to decision support. With this in mind, work has been undertaken to develop a Practitioners Guidelines for Economic Decision Making. The guidelines are presented in two parts. Part I provides background discussions on concepts, frameworks and tools. The guidelines themselves are presented in Part II.

As discussed therein, economic decision making can only be achieved within a consistent policy framework that reflects stakeholder requirements and regulatory and other business constraints. Insights into how such a framework can be developed are therefore provided. The guidance also includes a logical way of classifying and structuring different types of asset management decisions.

The Guidelines also summarise a range of other tools and approaches that can be used in support of economic decision making, including a range of tools developed by the research team. Importantly, the guidelines differentiate between economic decision making and economic analysis. Economic decision making should underpin all decisions made by WSPs, while economic analysis will only be required for a subset of decisions.

WERF Research Report Series
IWA Publishing December 2014
80pp. ISBN: 9781780405124

AM DIARY

A listing of upcoming asset management-related events and conferences. Send event details to WAMI for inclusion.

New Developments in IT and Water
8-10 February 2015, The Hague, The Netherlands
Web: www.iwcconferences.com

7th Global Leakage Summit
17-18 March 2015, London, UK
Web: www.global-leakage-summit-2015.com/

IWA Specialist Conference on Water Efficiency and Performance Indicators / Benchmarking
19-25 April 2015, Cincinnati, Ohio, USA
Web: www.iwaefficient.com/2015/

Cities of the Future - Transitions to the Urban Water Service of Tomorrow
28-30 April 2015, Mulheim an der Ruhr, Germany
Web: https://conference.trust-i.net

Regional Utility Management Conference Improving Performance in Emerging Economies
13-15 May 2015, Tirana, Albania
Web: http://utilityconf.al

9th IWA Symposium on Systems Analysis and Integrated Assessment
14-17 June 2015, Surfers Paradise, Australia
Web: www.awmc.uq.edu.au/conf / watermatex2015

LESAM 2015
17-19 November 2015, Yokohama, Japan
Web: www.lesam2015.org

For a full list of water sector events taking place in 2015, visit: www.iwapublishing.com