Report to ACTPLA as Technical Regulator under Part 5 of the Utilities Act 2000

Asset Renewal - ACT Water Mains Reticulation Infrastructure

September 2007 **Atech Group**

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Note from Technical Regulator

This report was commissioned by ACTPLA to provide analysis in support of input to the ICRC review of water and wastewater pricing. The views expressed in this report are those of the author. The Technical Regulator views are set out in the separate ACTPLA submission to ICRC.

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Executive Summary

Much of Australian utility mains infrastructure is rapidly aging, and frequent references is made to chronic under-investment in such renewals by experts and commentators.

In-depth analysis by Ofwat on this subject has been conducted in the UK utility sector under the Common Framework approach to asset renewals. The broad findings are that ‘age and condition’ alone are not a good guide measuring future renewals requirements and that a more rigorous analysis based on historical performance (trend in recent break history) and net economic benefit of renewal is a better approach.

This study is an overview to apply this Ofwat analysis approach (as far as possible) to the ACTEW water reticulation mains. Broad findings are as follows:

1. Compliance to meet asset performance standards (a mandatory target) is not required under ACT requirements for ACTEW water mains assets, and performance is measured only at a high level for WSAA and NWC benchmark reports. Benchmark data (and a rising cost of reactive maintenance of burst mains) suggests that ACTEW has a gradually declining asset service level
2. Asset data is not in a form that is readily interrogated for historical analysis of asset service performance. Much of the historical record is partial or missing, and site references for geographic locations are often incomplete, or inaccurate. Digital data and mapping programs do enable interpolation and a

best available picture of a breaks history can be extrapolated from existing data.

3. The ACT water mains reticulation historical record was 'mapped' in this study to identify hotspots (here defined as greater than 5 breaks per 'shut' in the last decade. (A shut is the length of pipe where a burst will result in an outage to set of affected customers.)

4. The analysis revealed that 90% of 'hotspots' occurred within easily identified specific locations in North and South Canberra , and appear to be associated with a specific cohort of pipe – Cast Iron pipe with Tylon joints used between 1965 and 1981. It is difficult to more closely define the pipes affected except to note that the main suburbs affected were gazetted between 1966 to 1975. The areas affected are almost exclusively residential suburbs, few hotspots are evident in commercial or retail town centres.

5. The ActewAGL cost of repairs ($4000 per break) and renewal ($350 metre) is broadly in line with WSAA industry benchmarks for utilities with a similar reporting and cost structures, and economic analysis suggests that the customer cost of mains renewal in residential areas will not be significant. The question if repair or renew then a least cost management decision for ACTEW.

6. Application of the ActewAGL costs (in an NPV analysis) suggest that an optimum rule for renewal is to renew where trend evidence suggests 8 breaks per 100 M in the decade, – ActewAGL use a comparable rule of thumb of 1 to 1.5 breaks per shut per year over a decade based on an undiscounted analysis. In effect, for situations where less than 13 breaks per shut are experienced , repairs are effected.

7. Hotspot information suggests that the known (>5 breaks) sites account for some 50Km of pipework would have a replacement cost of $17.5 million if fully replaced. The full extent of the replacement is not known until further investigation is undertaken

8. Regardless, the older suburbs housing much of the infrastructure to cater for important commercial centres and government offices (Civic, Barton, Parkes, Acton, Reid) dates from the 1920s and 1930's , and is at an age where the risk profile of future failures suggests an investigation of the need for precautionary renewal .

This evidence suggests that a strong case may be made for precautionary renewal of 'hotspot' shuts in affected areas, if existing service standards are to be maintained , otherwise service standards will decline rapidly in coming years.

The analysis completed is a helicopter overview, and but this needs to be tested and fully researched.

Important conclusions are that :

- There does appear to be an emerging water reticulation main renewal problem, and thorough investigation is warranted;
- Asset service performance measures are not in place capture such trends or support evaluation of trends against standards or performance measures,
- Shareholders, regulators, the utility ACTEW, its contractor ActewAGL and customers are not fully informed of current asset status and may be making key decisions without full recourse to the essential facts.
- A substantial program of expenditure may be called upon to address the decline in hydraulic asset performance

Chapter 1 Introduction

Objectives of the study

This study arises from concern by ACTPLA (the Office of the Chief Executive charged with technical regulation under the *Utilities Act 2000* - the "Technical regulator") that asset serviceability for below-ground pipe infrastructure is degrading and that:

- in the case of the water mains, the current lack of any work to rehabilitate or replace the mains will lead to a wholly unacceptable cost burden when replacement eventually becomes inevitable; and
- in the case of the sewers, despite the level of sewer renewals being undertaken, the level of service currently being maintained is significantly worse than by any other Australian utility against which ACTEW is benchmarked.

This submission is framed from the context of the particular interests of the Technical regulator and is directed to informing the price path determination process to ensure there is adequate funding for:

- maintaining network serviceability at a stable level;
- achieving compliance with any regulatory requirements TIGHTENED since the previous price determination; and,
- undertaking capital project options (including new works, capacity augmentations, infrastructure renewals) that represent the least all-of-life cost.

The study refers extensively to:

(a) the level / balance of resources / expenditure devoted to asset information verification and upkeep, asset renewal, and asset maintenance; and

(b) how matters of interest (serviceability/ performance) manifest in components and elements of the networks.

Of particular interest to the Technical regulator is a rigorous investigation of the factors contributing to any decline in asset performance / serviceability. These will in turn require policy or action needed to revise standards or targets, address technical problems, assess the financial and economic cost/benefit status of remedies, and lead to an adjustment in the level and balance of expenditure (eg between maintenance and renewals).

Interest of the Technical regulator

While not explicitly defined in the *Utilities Act 2000,* the charter of the Technical regulator is seen as being to oversight:

1. the serviceability of networks over the long term; and
2. the deployment by the responsible utility of technical skills, systems and resources in delivering required performance.

Where:

Serviceability of the network means the ability of the physical infrastructure of the network in terms of sizing nature and condition to provide the required performance; and,

Required performance means the delivery of utility services to required technical standards in relation to:

- health and safety of utility workers, customers and the protection of public and private property;
- provision of utility service to customers, and for any relevant community service obligation; and
- environment performance.

It is appropriate for the interests of the Technical regulator be presented in the forum of utility price regulation. The key concern of the Technical regulator is that a focus in price setting on meeting customer service standards and compliance at least cost may not be fully informed of the asset status of the networks, and the nature of relationships between precautionary asset renewal and levels of serviceability / performance. Aggregate serviceability and asset performance indicators sometimes mask underlying trends occurring in specific areas or zones, in cohorts of materials, or for construction methods. Aggregate performance measures that are interpreted, as a progressive growth in unplanned interruptions due to aging infrastructure may be indicative of pending network collapse in a particular cohort of pipe-work, or area.

General areas of interest to the Technical regulator are that price and technical regulation function in concert are to:

- Maintain network serviceability at a stable agreed level;
- Ensure that proposed funding increases to allow for expenditure for "regulatory" driven works are restricted to cases where there has been a real tightening of standards[1] (and not meeting existing standards) - maintaining network serviceability should not be viewed as a "tightened regulation".
- Ensure that options evaluation for capital expenditure be assessed on the basis of a least cost ‘whole of life” analysis for the network.

Should evidence suggest declining serviceability, costs of ‘catch-up’ should be at the cost of the utility and not be passed on to the consumer through water charges.

Specific areas of interest where the technical and price regulator should operate in concert are:

- Where there is evidence that asset serviceability is declining;
- Where necessary or adequate serviceability / performance targets are not in place, or relevant indicators not available[2]; and
- Where asset management decisions are based on information that is not technically proven, and subject to appraisal to establish the best ‘whole of asset life’ net benefit solution.

[1] The draft AMP lists numerous projects as regulatory driven - in fact, at most, some projects may be able to claim a tightening in sewer odour requirements; there have not been any other tightened requirements.

[2] Relevant indicator for watermains is available (breaks/100km) - better breakout would be preferable, but in this case we do have something to hang a hat on. On sewerage, bearing in mind that compulsory blanket CCTV'ing may not be practical, we have the next best thing: breaks & chokes /100km.

Specific focus of this study

This study is to:

- Conduct an helicopter or overview analysis and assess the status of water main asset performance in ACT water main assets;
- Initiate a strategic framework approach for infrastructure renewal undertaking of ACTEW, and
- Identify issues, trends, and 'hotspots' worthy of further investigation.

The primary function of the study is to inform ICRC in its price determination process. In addition, the study direction and findings would (a) bring to ACTEW's attention the concern of ACTPLA with measurement and monitoring of hydraulic asset performance, and (b) stimulate a response to reassure the Technical regulator that the matter is being addressed.

This draft report concentrates on the issue of water mains but also makes reference to sewerage pipe infrastructure renewals in Attachment 1.

International perspective

Price regulation of the water sector has become the coordinating centre of asset renewal investment in modern utility management. Technical standards are considered as a key input element, along with asset performance, asset serviceability, risk and customer service.

In the UK, price regulation and efficient asset performance have come to play a key role in asset renewal. This role has been carried forward through the Office of Water services (Ofwat) and the privatised regional water companies. The main tool has been the Common Framework - a risk based analysis methodology that focuses a forward outlook for renewals and the net economic benefit of expected outcomes.

This methodology followed the UK Environmental Audit Committee's view:

- that Ofwat's previous "no deterioration" approach was not a logical or acceptable means for assessing the amount of investment required to meet [service standard] requirements; and
- that support for developing a new approach that needed to be forward looking and to enable the utilities to adequately prepare for asset renewal / rehabilitation.[3]

In other words, there was realisation that setting prices solely with regard to costs for staffing and reactive maintenance to meet customer levels of service such as interruptions, service pressures and call-out times (as had previously been the practice) was not sustainable without also making provision for the costs of proactive network maintenance and renewals.

The UK has adopted more of a leadership role and has nominated a preferred methodological approach for the client to follow.

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[3] Referred to and discussed in WILLIAMS Will (WRC Director of Asset Management), The WRC approach to integrated asset management, Presentation at Sydney Water, 9 April 2002.

Private water companies have responded to the Ofwat common framework by adopting different approaches. The most successful were found to be[4] :

- *Service modelling* for asset types where there is potential for the asset failure to affect service to customers or the environment. These approaches include the estimation of the service consequences of asset failure and the identification of interventions required to maintain levels of service, taking account of asset deterioration; and
- *Least cost alone* approaches for assets with negligible service consequences of failure, or where the consequences are avoided by operational responses. These approaches seek to minimise the cost to the company.

Least successful approaches were found to be:

- *Age based maintenance* approaches in which interventions are planned on the basis of standard asset lives, or asset lives modified according to condition, risk or performance; or
- *Prioritisation only* approaches that separate those renewal interventions deemed in the next 5 years, and those that can be deferred to a later period.

The US has been slow to take up risk-based analysis of water asset renewal, and uptake has lagged behind UK and Australia. Investment drivers are set to maintain service quality and to control costs in the face of rising water rates. Much new infrastructure has been funded through developer finance, but this source of funds is not available for renewals of aging system components.

Leading edge utilities and regulators are soon expected to accelerate the uptake of risk based asset renewal methodology. However, the uptake is often limited because of the poor quality of historical asset performance data, and a low priority placed on asset service performance by utility managers.

This task is being made easier as planning, service contracts and management systems rely on a comprehensive database of assets and asset performance. A brief overview of mains performance in various locations is given below. Clearly, most modern developed centres have been observing breaks in the order of 20 – 30 breaks per 100 km per year.

Table 1 Historical Breaks per 100 Km

Country / City	Year	Mains breaks /100 Km
Chile , Santiago	1994	31
Colombia , Bogotá	1994	187
Belarus	1993	
Minsk	1993	70
Gomel	1993	25
Belgium, Brussels	1991	21
Singapore	1990	17
USA (average)	1990	17
Denver, Colorado	76-83	7

[4] "Overview of infrastructure asset management and risk based approaches in investment decisions – a view from both sides of the Atlantic", Ian Aikman, Dennis Doherty, Paper to 2006 AWA Annual conference

Oakland California	73-86	16

Source: World Bank Water and Wastewater Utility Indicators 1996

A note of caution needs to be added to treat international comparisons as indicative. Indicators are compiled for different materials, climates, and geology, using differing installation methods and subject to a wide variety of governance and administrative oversight.

Australian Perspective

The Australian regulatory approach is closely aligned with the UK, with few important differences. Because of the State Government based administration structure, Australian price regulators do not have a formalised common framework, but the approach and methodology across states is consistent and coordinated. Key coordination is via the WSAA at industry level and a number of measures have been introduced by NWC at a national policy level. The Australian price regulators have adopted a consistent 'building block' methodology for price setting that incorporates a 'return of capital', 'return on capital' and 'recovery of operating costs' and including corporate overheads.

Price regulation in the ACT is via the Independent Competition and Regulatory Commission 1997 and through the Utilities Act 2000. ICRC is closely modelled on IPART in NSW and shares a common approach to price setting and related tasks.

Increasingly, risk is being introduced into the Australian regulatory approach and the principles of cost effectiveness and cost benefit adopted to assess investments against competitive delivery options , and efficiency from a net benefit and customer perspective.

The increasing focus on risk based approach calls for a data and information resource to support and enable the analysis. In particular, historical data regarding spatial references and failure modes needs to be checked and verified, and additional information is needed from willingness to pay surveys to establish a 'demand curve' for level of investment, risk and expected consequence. Considerable investment is needed to enable an 'analogue to digital' data and system analysis migration, and then to capture, validate and correlate data and information to achieve the desired analysis output.

In Australia the water sector is in a stage of transformation with the formation of the National Water Commission, the Federal Department of Environment and Water, and a planned institutional overhaul of water sector administration. Much of the planned focus is on application of knowledge-based technologies for better asset performance in the water sector.

In the UK, the driver for improved asset performance was the backlog of under-investment in infrastructure as evidenced by pollution, flooding and sewer collapses. In Australia various "report cards" have also concentrated upon poor infrastructure condition, viz:

> The Australian Water Association concluded: "on a very practical, immediate level, reinvestment is problematic. If infrastructure has a life expectancy of 100 years, then we should be spending, or setting aside funds, to ensure that 1% of the total asset value is replaced each year. … Recent reforms have improved the profitability of utilities … however, these results do not necessarily take into account adequate asset renewal …"[5].
>
> Institution of Engineers Australia rated Australian potable water infrastructure at C- to B- (2001-2004) and sewerage at C- (consistent every year)[6]. Associated comments were[7]: "expenditure on renewals is not keeping up with the rate of asset deterioration" and "many sewerage systems are … old and nearing their useful service lives".
>
> The Barton Group[8] found concerns that "the average annual renewal expenditure allocated by the major utilities for water supply and wastewater assets is about 0.5% of replacement value …" while "over the last decade the large water utilities have been able to reduce operating costs by 24% and increase their contributions to government … by over 360%" suggesting that renewals expenditure is "on the low side".

The theme of aging infrastructure nearing the end of its effective life is often repeated by mostly without quantitative supporting evidence. Minister Turnbull[9] is quoted in the Melbourne Review in November 2006 saying " … most of the major water infrastructure is already old or rapidly aging. The need for planned renewal and maintenance is self evident".

ACTEW Water Mains Status

The ACT water reticulation supply system consists of a network of 3500 km of water mains, which have been successively added to the system since establishment in the 1920s. Growth has not been linear and as development has occurred, materials and techniques were changed to avail of new technology to meet standards of the day.

The age of the network components and materials employed are shown in Tables 1 to 3.

Figure 1 indicates the rate of growth of the network. Modest growth was experienced until the early 1960's, followed by a period of accelerated growth to about 1980, followed by a sustained but lower growth rate.

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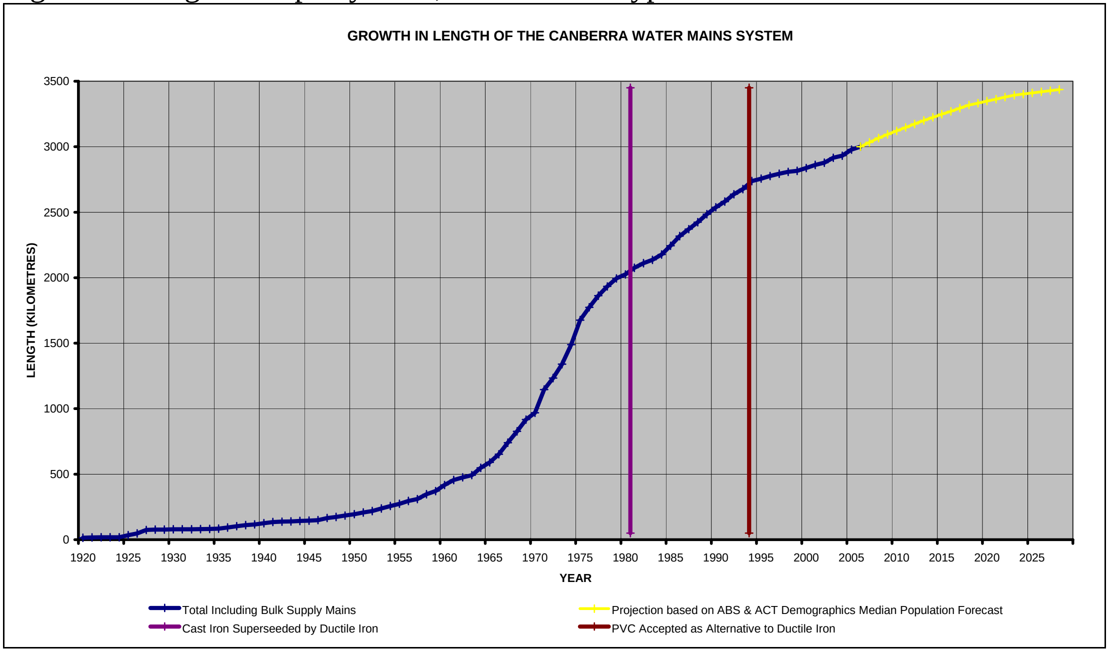
[5] Australian Water Association, Submission to the NSW Standing Committee on public Works Inquiry into urban water infrastructure, 2002.
[6] PINZONE Tom, Report cards guide the way, Infrastructure Australia, Special issue, May 2005.
[7] TAYLOR Peter, 2005 Australian infrastructure report card, Address to the National Press Club, Canberra, 7 Sep 2005.
[8] Barton Group, Australian water industry road mapping project, Discussion paper
[9] Turnbull Malcolm, The role of the private sector in developing water resources infrastructure, pp13 – 17, The Melbourne review, November 2006.

Figure 1 Length of Pipe by Year, and Material type



Source Ian McRae, ActewAGL Water division

Table 2 shows the composition of pipe infrastructure by pipe size. As shown, 100 and 150 Mm pipes make up greater than 70 % of the entire system and comprise the bulk (76%) of the water reticulation system (2760km). Larger size pipes make up the trunk mains and bulk mains transmission system

Table 2 - Water Mains Composition by pipe size

Pipe Size (mm)	% of system
100	45.5
150	25
225	9.5
300	5
375	2.5
450	2.5
500 & 600	3
Other sizes various (675 – 1650)	5

Source: Ian McRae, ActewAGL Water Division

The composition of pipe material is shown in Figure 1 above and Table 3 below. While the progression from cast iron, to ductile iron to the current use of plastic pipes is evident, significant changes have occurred in bedding, jointing and trenching technologies to impact on the expected life of the pipes.

Early use of cast iron relied on hand jointing with molten lead, and was successively updates with rubber jointing, concrete lining, sleeving and increasingly mechanised trenching bedding. Similarly renewal has evolved from pipe replacement to spot repairs, clamped patched sleeve sections, lining and fracture, and modern trench-less technologies.

Table 3-Water Mains materials composition (% of total)

Pipe Material	Period of use	% of system
Cast Iron	1915 – 1982	63.5
Ductile Iron	1983 – present	20.0
PVC	1994 – present	0.5
Mild steel	1954 – present	9.0
Asbestos cement	1939 – 1961	7.0

Source Ian McRae ActewAGL Water Division

Concrete and glass reinforced plastic have been used in very small (>1km) sections of main.

The asset performance of various material types has been monitored and to date only asbestos cement (12km) has been nominated for precautionary replacement.

Regulatory & Performance Standards, Benchmarks

Regulatory standards in the ACT are administered under the Utilities Act 2000, which sets only a very limited set of performance standards for ACTEW (and pressure/flow requirements in relation to technical regulation concerns). Standards that are in place relate only to certain service quality standards (excluding reliability) and customer impact. On asset renewal, regulatory standards are completely silent.

This represents a significant weakness in the strategic framework to inform the asset owners and managers of the long-term status of water main assets and the need for asset renewal.

In the UK a mains breaks standard of 20 /100 km applies to all utilities. In Australia, a formal standard is only applied for Perth (20/100km).

Performance standards are important as these are incorporated in management agreements and works contracts as deliverable for service quality. ACTEW Water main breaks per 100 km. is reported as a statistic for industry benchmark performance. However, the measure is not applied to ActewAGL as a contractual performance standard to drive renewals investment

The ACTEW-ActewAGL contractual performance measures linked to targets are listed below in Figure 2 . As shown in Figure 2, there is no requirement in the contractual agreement to report on water mains breaks per 100 km and/ or water mains breaks per 1000 customers.

Voluntary performance measures are applied as target in a number of Australian water utilities. Utilities report against these targets in meeting KPI measures to customers and other stakeholders.

Figure 2

Level of Service	Target Measure	Current Level	Gap	Mandatory or Discretionary	Source
Water Supply					
No. of unplanned interruptions per 1000 properties rolling 12 month average	<150	141	-	D	UMA KPI 32
Percentage interruptions corrected within 5 hours	>95%	92.53%	2.47%	D	SCI
Average response time to priority 1 event – rolling 12 month average	<105 min	39 min	-	D	UMA KPI 33A
Attendance at burst or leaking water pipes - Maximum response time to priority 1 events	240 min.	Not exceeded	-	D	UMA KPI 33B
Attendance at burst or leaking water pipes – Percentage of response times within 24 hours priority 1 events	100%	100%	-	D	UMA KPI 33C
Attendance at burst or leaking water pipes – Maximum response time for each priority 1 event	48 hrs	Not exceeded	-	D	UMA KPI 33C
Water service unplanned interruption time - Average interruption time in a month on a 12 month rolling average	<2.5 hrs (150 min)	75.3 min	-	D	UMA KPI 34A
Water service unplanned interruption time - Maximum interruption time for priority 1 events; percentage of events complying	%<6 hrs	100%	-	D	UMA KPI 34B
Planned interruptions to utility services – No of occurrences failing to notify of planned interruption at least 2 business days prior	0	5	5	M	CP Code; UMA KPI 35
Planned interruptions to utility services – No of occurrences failing to restore service after planned interruption within 12 hours	0	0	-	M	CP Code; UMA KPI 36
Failure to restore service after unplanned interruption within 12 hours	0	0	-	M	CP Code
Ensure water supply is available 24 hours a day, every day of the year,	100%	100%	-	M	SS Code
Comply with the requirements of the Drinking Water Quality Code of Practice 2000	100%	100%	-	M	SS Code
Googong WTP compliance with NSW EPA license	100%	100%	-	M	License
Meet ADWQ Guidelines for aesthetics	95%	99.89%	-	D	SCI
Meet ADWQ Guidelines for health	100%	100%	-	D	SCI

Source : Actew Asset management Plan 2007

Utilities to report breaks per 100 km as KPI targets are Perth (20/100 km), Pine Rivers (30/100km) Gold Coast (12/100km) Hobart (30/100km).

NSW local government authorities are now required to report water mains breaks per 100 km as part of the social component of ESD reporting under the State of Environment reporting program.

As indicated, ACTEW also reports on the number of unplanned interruptions per customer as a rolling average in the ACTEW - ActewAGL contract. The statistics indicate a target of less than 150 outages per 1000 properties and a realised rate of 141 per 1000 properties.

Industry Performance Benchmarking collects and published a standard data set across Australian (and NZ) water utilities for comparative reference.

Key parameters reported are:
Main Breaks

Water Mains breaks have been reported in WSAAfacts since 1998 and provide a measure of comparative performance with benchmarks data for the Australian water industry.
Definition of main breaks includes breaks bursts and leaks (from all failure modes) requiring a service shutdown to the affected areas. Data definitions for mains breaks were changed after 2005 to hydrant, valve, and stopcock failures.

Australian utilities report and average water mains breaks of 29.6 and 31.7 per 100Km for the 2000 and 2001. A summary of asset performance for the period 2000 to 2006 is given below.

Table 4 Australian Utility Water Mains breaks per 100 KM

Utility	1999 – 00	00 - 01	01 – 02	02 – 03	03 - 04	04 - 05	05 - 06
ACTEW	11.7	18.4	18.8	26.3	26.3	23.8	19.9
Sydney	42.3	37.7	37.5	50.7	38.0	37.8	

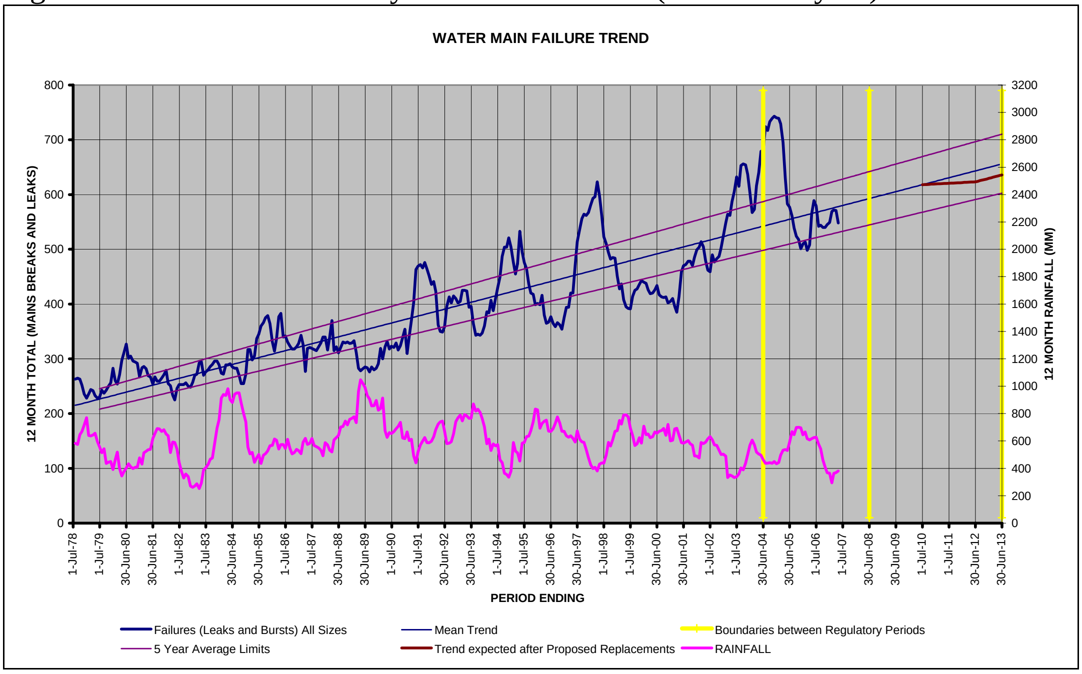
Water							
Brisbane	35.9	37.6	36.5	36.7	34.3	40.1	
Gold Coast	11.4	9.5	13.9	16.6	15.5	18.5	
SA Water	24.6	24.5	22.1	24.2	23.4	24.6	
Yarra Valley	42.1	55.9	40.7	56.2	51.3	41.4	

WSAA Facts 2005 – to WSAA data definitions

A detailed series of the incidence of mains breaks indicates a steadily rising trend since 1978

Costs of repair or renewal; are also often collected in benchmark studies, but different cost data definitions and data collection systems make the value of such comparisons less ideal

Figure 3 ACTEW history retic mains breaks (# breaks ./ year)



Source: ActewAGL draft report on water mains 2007

The water failure trend series is graphed with the rainfall series in Figure 3. It is evident that there is a rising trend in water mains failures. A clear relationship can be identified between dry weather and high failure incidence in the period up to 2000 after which the relationship is less evident.

The logistics of water mains failure replacements favours repair of breaks rather than planned renewal. It is important to note that a planned replacement program calls for a much greater level of preparation and planning, especially in commercial and areas of high economic significance. In suburban areas, issues relating to protecting street trees and effective community consultations are of some concern.

ActewAGL Process mapping

Until recently, ActewAGL has not employed a formal decision process to manage planned or precautionary renewal. Critical mains were nominated, inspected and managed (mostly by planned joint replacement) to ensure ongoing service performance.

Mains failures for other ‘non critical’ mains were poorly referenced and documented and thus not readily analysed as an ‘asset class’.

The conventional wisdom was that the water mains fleet was relatively new and subject to occasional random failure. Planned renewal was considered unnecessary except where an evident ‘hotspot’ exhibited an increasing trend of repeated repairs and warranted replacement. Major limitations of this planning system were that the ‘shuts’ were not identified as a management set, that data for failure mode was poorly defined or referenced to an exact location, and it was difficult to document a failure history as a basis for a planned renewals program. This process resulted in the identification of a few acute ‘hotspots’ and the reliance on reactive repair as the principle response to water main asset renewal.

Improved data collection, analysis and the availability of the spatial data analysis systems have improved the capacity for management decisions to benefits from analysis.

The process whereby ActewAGL identifies, evaluates and selects assets for renewal is critical in the development of a renewals plan.

The ActewAGL process is as follows:

- Review of historical breaks data to identify ‘hotspots’ or customer clusters approaching breach or compliance for interruptions or service quality.
- Quantify a task specification at hotspot locations.
- Conduct an assessment against financial decision criteria (approximately 1 to 1.5 breaks per year per shut).
- Assign tasks to work program as planned renewal via the (CWA) Capital Works Approval process.

The weak links in the existing CWA process are that:

- only direct costs to ActewAGL are considered. Economic cost to customers would assist in the evaluation of breaks in commercial areas and areas of critical economic importance (largely ICT centres, and similar national decision nodes), and
- the process is not capping the steadily increasing rate of main breaks /100km in the system as a whole.

Further areas where the treatment of Asset renewals could be strengthened are:

(a) Undertaking of a periodic strategic overview of system performance to interrogate system data, follow ‘leads’ and investigate unexpected results.
(b) Development of robust analysis tools to draw upon asset failure system information, aggregate reports trend by failure mode, materials type and location; and
(c) Development of decision tools (including economic and customer impact parameters) to direct action to renewal or maintenance streams.
(d) Development of monitoring and evaluation tools to ensure that works identified as necessary are prioritised and completed.

Accounting Treatment of Public Infrastructure Assets

Until recently, utilities (including ACTEW) operated under the public sector finance arrangements for government agencies. Here, provision for utility asset renewals was via a depreciation provision, which was assessed and collected in charges or taxes; and then made available for public expenditure on the basis that future renewals would be funded through government finances when the need for asset renewal arose.

This arrangement functioned satisfactorily for most tradeable capital assets, but the privatisation of water businesses has left the ownership of underground infrastructure in an area of ‘no mans land’. Historical accumulated depreciation provisions are not available to the water companies to fund renewals and they are required to source funds for renewals from government borrowing or in capital markets.

The net effect was that asset renewal was deferred - a practice supported by reliance on age and condition asset criteria, an expected low risk of failure, and a low priority assigned for asset renewal. This reliance of government on access to utility ‘depreciation reserves’ to fund public spending and the reluctance to borrow for asset renewal has been criticised by Professor Peter Cullen[10] as ‘asset stripping’ by government and a cause of chronic under-investment by water utilities.

The theme of asset under-investment in water asset renewal is frequent in the recent literature, but generally is not support by factual evidence. This is in part due to the lack of strategic perspective on the part of asset managers, and in part due to the difficulties associated with assembling consistent series of historical data to establish the true condition trends of water mains assets.

Now that the mapping of networks and asset databases to digital format is advanced, digital asset performance analysis (initially fostered by Ofwat) has revealed that the asset ‘age and condition’ alone is a poor guide to asset renewal requirements and that histories of asset performance and service delivery trends are also important.

The methodology nominated for the study was to replicate as much as possible the Ofwat methodology for implementing the common framework and an economic approach to investment planning.

The Common Framework Process which entails three stages:

A. Historical analysis
B. Forward looking analysis, and
C. Conclusions

[10] The Urban Water Agenda in 2007, Prof. Peter Cullen , WSAA, Presentation to Strategic Planning Workshop Sydney 2000

Chapter 2 Historical Analysis

Asset categories

ACTEW identifies asset categories in accordance with the Australian standards and are readily translated to the Infrastructure (underground) and Non Infrastructure (above ground) assets as defined by Ofwat.

ACTEW infrastructure includes: Water mains (3060 km), Hydrants (17,100), Valves Maincocks, Stopcocks, (27,150), Service lines, Service valves and meters (90, 000) servicing some 110,000 service off-takes. The asset register differentiates between trunk mains (the bulk supply network) and reticulation mains, which distribute water between reservoirs and services to properties.

From a strategic perspective, the water mains are of key importance as
- these constitute the significant value asset base
- constitute the links upon which accessories and ancillary items are attached; and,
- being underground are least likely to attract external attention ("out of sight, out of mind").

Minor asset augmentation

Mater main renewal is associated with related tasks of renewal of main cocks, valves and hydrants. Breaks are usually repaired under maintenance programs as these are experienced, minor asset but planned renewal is necessary where pipe infrastructure is also to be renewed.

Augmentation of minor assets is necessary where increasing urban density or similar growth increases the number of service connections. The installation of additional valves will also have a minor impact in reducing the incidence of outages per customer from water mains failures. Additional valving will not reduce the break incidence per 100 Km.

Historical and current expenditure

Historical expenditure on asset renewal has been on reactive repairs to bursts .The incidence of breaks is related to seasonal and cyclical factors as well as asset condition. Peak demand in summer results in more breaks and cyclical droughts induce significant earth movements, pipe stress, and failures.

Table 5 Reactive maintenance – retic. mains

Reactive maintenance retic water mains	2002/03 $	2003/04 $	2004/05 $	2005/06 $	2006/07 $
Item Total	9,950	6,543,899	4,544,117	3,844,965	4,211,417
Burst and leaking Mains				2,852,802	3,026,048

Valves & hydrants				305,149	370,515
Burst & leaking services				687,015	814,853

It is noted that in 2005, planned water main asset planned renewal expenditure was substituted for an urgent drought contingency project (Cotter Googong Bulk Transfer). It is also noted that this followed an agreed process, but the status of the works displaced is unclear.

Planned maintenance

Expenditure on water reticulation mains renewal has been minimal $ 80,000 in 2006 - 2007 , and little has been spent on reticulation mains renewal in the past decade.

Planned expenditure for precautionary replacement has been first introduced in the 2007 AMP expenditure forecast and is for small total lengths of main. Planned expenditure is budgeted as $8.5 for the coming 5 years of the regulatory period. Most of this expenditure is for the planned replacement of Asbestos Cement mains ($5.1M) and approximately $325,000 per annum on other water mains replacement.

Indicators

Indicators collected by ACTEW are those relating to service quality as demanded by the Utilities Act, and those reported under WSAA/NWC reporting on the number frequency and duration of customer interruptions

Importantly, the only measure collected for infrastructure is reporting of the number of breaks and leaks in water mains per annum. Reporting is in aggregate and the type of main or the pipe type is not reported.

The important indicators of interest for reticulation water mains are those which indicate a long term trend. This measure rises from 14 breaks per 100km in 1987 to the present rate of about 20 breaks per 100 km. This indicates a rising trend in the incidence of breaks and decline in infrastructure service quality.

Current and expected trends

Since 2000, the breaks per 100km trend line has been rising, but perhaps some portion of this may be caused by the severe drought experienced for much of that time. It is important to monitor the future trend path after the drought breaks to identify any threat of sustained asset performance decline.

Forecasting by ACTEW (Asset Management Plan 2007) continues to reflect the ‘age and condition of asset life and exhibits a slowly declining service level typical of the expected life time analysis for such infrastructure

However, this approach is not supported by the UK notion that ‘age and condition’ alone are a less than satisfactory guide to future asset performance, and that a methodology based on recent failure trend history and economic customer impact approach is a better basis for renewals planning.

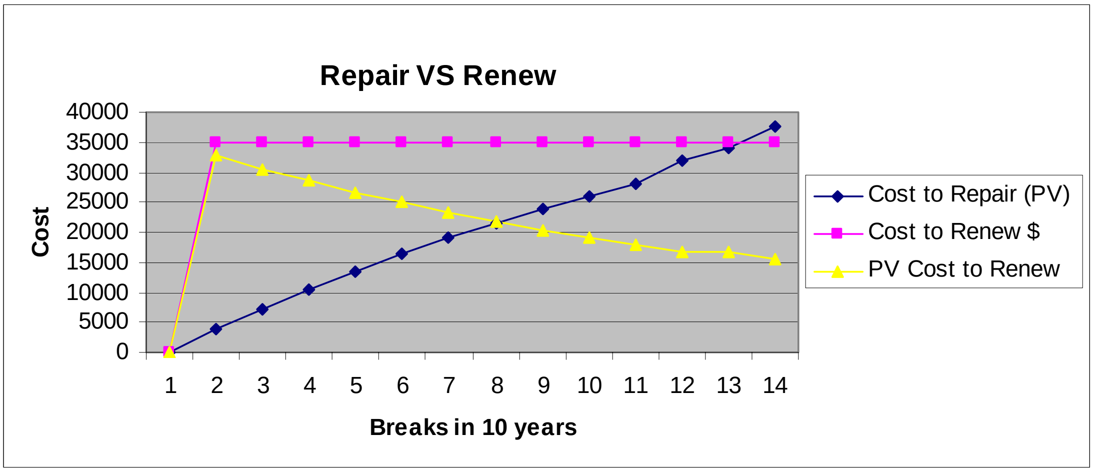
ACTEW Decision tools for Precautionary Pipe Renewal

The decision of whether to repair or renew a water main has historically been driven by the ‘age and condition’ of the water main. The expected life of a given pipe was determined by technical factors related to materials, laying techniques and known parameters of decay , causes of failure and management actions to protect and preserve the pipe. Where a pipe performed to specification, random breaks are repaired until a planned renewal is executed.

The rule of thumb for ActewAGL pipe renewal is to renew a ‘shut’ as it have experienced 1 to 1.5 breaks per annum in the decade following the first break. This equates to a breaks per 100 km parameter of approximately 300 breaks per 100 km during the decade. (Assuming a 100 metre shut), Under this decision rule, a break in a shut is repaired its first break, and then monitored the frequency of breaks in the coming decade. If the breaks were sustained to a rate of 1.5 per year, the shut would be investigated further and a decision made to replace part or all of the pipe in the shut.

The costs of pipe repair and renewal are estimated (2007) by ActewAGL as $ 350 per metre for water mains renewal , and $4000 per site for spot repairs of water mains bursts.

Figure 7 Breakeven analysis repair / renew



On the basis of a history of repeated failures, the economic breakeven point between repair and renew is 13 breaks in 10 years, based on a undiscounted cost of renewal; and at 8 breaks in 10 years when the present value of the future cost of renewal is taken into account (7% discount rate) .

The breakeven point between repair and replace broadly supports the ACTEW decision rule to replace once the incidence of breaks reaches more than 1 break per year over 10 years, after experiencing the first break.

Another important factor to be taken into account is the expected remaining life of the asset.

Where an asset is at less than half of its expected average life, the discounted cash flow impact of costs avoided by early renewal are negligible, and the analysis favours repair. However, should the first break occur in the second half of the asset life, the costs avoided by early replacement might be a significant factor in favour of renewal.

ACTEW repair and renewal costs

The ACTEW costs repair and renewal reference costs (respectively $4000 per repair and $350 per metre) are slightly higher than industry standards for similar tasks elsewhere, and where utilities include a contribution to overheads in costs.[11] The treatment of overheads, and the differing extent of outsourcing to service contractors makes comparison of benchmark costs for water-mains renewal problematic.

The ACTEW / ActewAGL service agreement is structured to incorporate an allocation for overheads in individual task budgets. ACTEW has accepted the need to maintain a standing capacity to undertake repairs and renewals because of the small specialist skills pool in the ACT, and to meet service needs at a reasonable cost.

Water revenue forgone

The volume of water lost as unaccounted for water varies considerably depending on the size of the pipe, the seasonal demand, time of the day and pressure location of the break. If a major main breaks, unaccounted for water may represent flows of 4 Ml per hour during the outage. This amounts to a lost revenue potential of some $15,000 – $20,000 per failure.

Most outages are in small pipes and readily managed through system valves and prompt action. Financial losses through lost water sales are not an asset renewal matter but an issue to be addressed in maintenance works management.

Customer Impact

Costs to Business

Costs for business disruption from burst water mains were estimated by CSIRO in 2002[12] by based on a survey of a typical urban commercial (strip shopping) centre in Adelaide, and the impact of a 4 Hr outage on the occupants of the centre.

The costs considered were (a) lost turnover form commercial premised affected by the outage, and (b) traffic congestion costs caused by the outage.

[11] URS, GHD Pty Ltd, WSAA Civil Maintenance Benchmarking Study, (confidential) 2006.
[12] Burn Et Al, The cost of customer preferences: The development of pipeline asset risk management system – PARM CSIRO

The main costs estimated were the cost of lost business. The costs estimated for the Adeliade centre provides a reasonable proxy to infer the cost of a similar outage in Canberra.

[13]The methodology employed was to assess dependence of the connection on water and ranked from negligible to extreme :

Table 6 Impact on Shopping of a 4 hr Water Main burst

Impact class	Description of Shop affected	Impact on business income /hr in First 2 hrs	Impact on business income / hr in Second 2Hrs	Shops / Properties in Class (% or total)
Negligible	retail, newsagent, pharmacy, real estate, office services.	<1%	<1%	70%
Minor	Petrol, garage, nursery, grocery	1% – 20%	1% – 20%	3%
Significant	Café , bakery, surgery, supermarket	20% – 40%	20% - 60%	$%
Major	Butcher, vet , hotel	20% – 40%	60% – 80%	10%
Extreme	Food service, café, beauty salon, dentist, laundry	20% – 40%	80% – 100%	13%
Not impacted	Vacant			12%

The study found that only a relatively small proportion of total customers had a major impact (23%) on net business income, and these were businesses related to food and hospitality services. The great majority of premises affected had negligible impact (70%) on business income.

The precinct has 215 water supply connections and employed an estimated 784 full time employees.

To calculate the cost to business in the shopping precinct, the financial impact of sales or turnover forgone during the outage was estimated. In the analysis :

- Business turnover is estimates as 2.5 employee wages
- Wages were assessed as average employee wages (in ACT $29/hr)

Tabel 7 Business Cost on a 4 Hr Interruption

Impact Class	Connections	Employees	Impact 1st 2 hrs % of value added	Impact 2nd 2 hrs % of value added	Cost / break	Cost per shop
Negligible	135	512	.01	.01	742	5
Minor	6	27	.10	.10	392	65
Significant	8	44	.30	.40	2233	279
Major	18	87	.50	.70	7569	421
Extreme	24	114	.70	.90	13224	551
No Impact	19					
	215	784			24160	112

[13] . It is assumed that sites of national (economic, social, or cultural) significance are not in this analysis and would have assessed the impact of temporary water loss on their activities and developed disaster recovery plans to accommodate a water system outage.

Note : Average wages updated to $29/Hr (2006 ACT govt submission to Fair Pay Commission)

For a 200 shop Adeliade shopping precinct, an economic business cost of ‘lost’ turnover is approximately $25,000 connection for a 4-hour service interruption . Costs are borne predominantly by a small group of high impact customers in the food service and hospitality sectors. Cost per connection that was dependent upon water is $325 per premises for a 4 hr outage.

Should a benefit transfer be implied for the ACT, it would be reasonable to infer a commercial loss of $25,000 should a water main fail in Civic or one the major town centres. It would be reasonable to scale the commercial loss downward for a smaller centre.

This estimate is indicative and depends upon many supply factors (valving and the duplicate supply sources) and demand factor (time of day and numberof water dependent activities).

Cost of Traffic Interruptions

Methodology for the evaluation of traffic interruptions is well established and a suitable estimation model has been developed by the RTA[14]. The traffic congestion results when using the RTA model is presented in Table 8.

Table 8 Cost of Traffic Flow interruption $ /hour (a)

Time	CBD	Arterial	Strip Shops	Residential street
6.00 – 9.00	768.0	2028.0	2028.0	2.5
9.00 – 1600	846.6	760.5	2259.0	10.0
1600 – 1800	1302.4	3043.2	3814.9	6.2
1800 –2000	53.7	18.7	18.7	5.0
2000- 0600	1.2	1.2	0.0	0.0

(a) These costs reflect the cost time in travel to occupants of vehicles and value to freight businesses.

Economic costs for traffic interruptions are quite site specific, but for residential mains bursts cost incurred as traffic disruption are assessed as minor. Representative RTA studies assess the cost as less that $10 per hour per disruption where the inconvenience is minor.

Costs are higher where town centre and arterial roads are affected. Congestion costs add up to 10% to economic costs borne by stores directly affected, but the impact is diffused amongst road users.

[14] RTA (1999) Economic Analysis Manual, version 2, Sydney.

Cost to residential customers

The economic cost to residential customers of water mains failures is not thought to be significant, and will mostly affect home based businesses. Few are water dependent, and have flexibility to adjust schedules and manufacturing to minimise adverse affects. Minor costs are incurred by traffic congestion and interruptions to supply chain for services and goods.

The above cost estimates suggest that cost of reticulation main interruptions are only significant in shopping and commercial centres, and that cost of outages should be factored in as well as ACTEW direct costs.

In assessing the cost of a 4 hr interruption, it may be reasonable to infer that a cost of $ 40 would be adequate to represent the cost to residential customers.

Chapter 3 Forward looking analysis

Introduction

In order to initiate a forward looking analysis of the underlying trends of water main failure it is necessary to identify the historical incidence of breaks, by location, and by pipe type and age. The intent of this analysis is to test the contention that infrastructure is aging in line with maker's life cycle performance; and to establish where a relationship exists between pipe age, material or other factor and the incidence of water mains failures.

Such strategic analysis relies heavily on historical data and the ability to interpret data to overcome data omissions, changes in definitions and materials specifications, and to identify particulars of work practices or contracting arrangements that may have an impact on asset service life and performance.

It is noteworthy that a 'random' structural failure of water mains is an unpredictable event, and a background incidence of random failures will underlie all pipe infrastructure. Other failures are related to identifiable causal factors (e.g. corrosion, pressure, earth movement, inadequate bedding, etc.), and these need to be monitored and managed as part of a strategic asset program.

Once a failure has occurred, and a causal factor identified, the probability of repeated failures (related to the causal factor and at that location) is significantly increased. In this way 'hotspots' develop where maintenance is concentrated and precautionary renewal needs to be considered.

Data sources

Up until 1988, pipe break records were maintained separately for North and South Canberra.

- Records are available for the North Canberra since 1975.
- Records for South Canberra are available since 1997 (prior records are lost)

The date of individual water main installation in the various suburbs is not always recorded. Where dates are unavailable, cross-reference is made to the date of installation of drainage infrastructure, as this was usually laid at the same time, and more consistent records are available.

The installation of water mains was closely linked with the development and growth of Canberra and shows periods of active construction, and periods of consolidation. Earliest construction was in the early 1920's followed by slow growth until the mid 1960's and a period of rapid expansion into the Belconnen and Weston Creek / South Canberra districts up to mid-1980's. Further growth expanded into the Tuggeranong Valley in the 1990's and to Gungahlin district into 2000 and beyond.

Mains Breaks data

The land tenure system of the ACT is tied to a system based on suburb, section and blocks or individual land parcel.

In the event of a burst, the section of pipe affected is termed an operational 'shut' to denote the service connections between valves necessary to isolate the affected section to effect repairs. A section may be made up of a number of shuts each of which will supply up to 10 –15 service connections, and of length of 100 to 150 metres of main.

Reference of pipe breaks to a section is available, but further reference to a precise location is problematic as such a level of precision was difficult until GPS technology was readily available. At best, a break was referenced to the block as reported by the customer, or to a convenient reference point in the shut where the break was in open space and not readily identified.

Historical data for the location of breaks is therefore often imprecise, with the unit of 'shut' as the common denominator, and records available for the number of breaks per shut.

To complete the analysis, the reticulation network area was dissected into a grid 140m by 140m 'tiles', and the data shut data by section was transferred to the 'tiles'. The incidence of breaks in individual tiles over the last 10 years was calculated, and a frequency of breaks database created. For the purposes of this analysis, a tile is assumed to approximate a 'shut' of some 150 metres of pipe. The frequency of breaks has been grouped under breaks per tile as 0 through to 15 per tile in that last 10 years.

The incidence of breaks by pipe material is presented in Figures 4 and 5 , and a summary of hotsport findings is given below in Table 6

Table 6 Incidence of 'Hotspot' Failures Approximate

Breaks per 140 m tile	South Canberra	North Canberra	Total	Not in Cohort	% in Cohort
10+	3	7	10	1	90
9	10	8	18	4	78
8	10	16	26	0	100
7	23	18	41	9	78
6	32	49	81	14	83
5	90	80	170	35	79

Source : Ian McRae ActewAGl water division 'Hotspots' database

For incidence of failures of less than 4 breaks in 10 years, the impact on the area under review is only slightly higher in the background impact for the un-affected pipes.

It is noteworthy that the cohort of pipe affected appears almost exclusively in residential areas with little impact on commercial premises, or social institutions.

Interpretation

There appears to be cause for concern with Cast Iron pipes 1965 –1981 with Tyton rubber ring joints. This represents almost 1100 km pipes or 35% of the existing system. Hotspots in these locations indicate failure rates of 150 to 300 breaks per 100 km per annum:

Key findings of the study are:

- Older suburbs (Inner South and Inner North Canberra) pipe infrastructure seems to be not experiencing excessive breaks, but decay may be near at hand as the asset age is critical and the loading is increasing with redevelopment.
- Significant failures are occurring in the Belconnen and Weston Creek areas in pipe made of Cast Iron and fitted with Tyton Rubber ring joints. The cohort by age of construction appears to be between 1965 and 1981, with particular areas of interest:
    - On the North side are Kaleen (Gazetted 1974) , Melba (Gazetted 1971), Flynn (Gazetted 1971), Charnwood (Gazetted 1971), Hawker (Gazetted 1971), Weetangera (Gazetted 1968), and Cook (Gazetted 1968);
    - In Weston Creek are Duffy(Gazetted 1971), Holder (Gazetted 1970), Waramanga (Gazetted 1968),and Pearce(Gazetted 1966);
    - In South Canberra are Fadden (Gazetted 1975), Wanniassa (Gazetted 1974), and Gowrie (Gazetted 1975),.

- Another clusters of failures, which are interest is that occurring in Narrabundah (Gazetted 1928), and related to AIS type spun cast iron pipes and lead joints.

The analysis suggests that the 'normal' failure mode is typical in the affected areas other than the CI Tyton ring pipe cohort.

If the failure rate has taken 25 years to manifest in its current status, it is likely that the coming decade will exhibit a similar evolution of an increasing failure rate, reduced asset performance, and a decline in service standards.

Until a study is made which incorporates (a) consistent accurate data and (b) ground truth verification of recorded breaks and current asset condition information, further analysis of the existing breaks data is largely speculative.

The pipe establishment information suggests that some 1000 Km of water mains was laid in the period under investigation and that perhaps 60% (based on pipe composition) is likely to be affected. At a current replacement cost of some $400 per metre, a potential replacement cost of up to $250M is possible.

Economic Impact

In a forward-looking analysis, precautionary renewal may be warranted where:

- The asset is not performing to specification and needs to be renewed

- The asset is considered as part of ‘critical infrastructure’ and system security of economic/social cost of failure outweighs the cost of precautionary renewal
- Economic costs incurred by customers justify the cost to the utility of precautionary renewal.

In each case the economic analysis is based on a comparison of the present value of the cost of precautionary renewal versus the net present value of the cost of repeated repairs (and eventual planned renewal) (a) as incurred by the utility, and (b) plus the economic costs incurred by stakeholders affected. Such costs will usually comprise losses from lost economic activity , traffic disruption, ‘make-good’ of adverse environmental consequences, and direct real costs incurred by households.

- Precautionary asset renewal because of non-performance to specification is a straightforward comparison of the NPV of the cost of asset renewal, less the cost of maintaining the cost of the existing infrastructure to meet standards.

- Critical parameters are the probability of future failure, and costs avoided at the expected life of the asset by replacing early i.e. the PV of costs not incurred. Precautionary renewal here is the converse of deferral of costs, and incurs considerable economic cost if the estimation of the probability of future expected life is inaccurate.

- Critical infrastructure deemed necessary for system security is managed through a special renewals program, and does not usually include reticulation mains. Critical economic infrastructure for specific sites (ICT and communications sites, commercial decision nodes) is best dealt through the disaster recovery planning in place for those sites. Options for preserving service to these areas include duplicate feeds, additional valving or on-site contingency arrangements.

- Where economic costs incurred by customers are significant these are included with the costs to the utility in estimating the unity cost of each failure event.

Interpolation of Findings

There appear to be about 85 ‘hotspots’ (approximately 7 or more breaks per shut in the last 10 years) where there is evidence to suggest that water mains are not performing to expected asset service levels and where precautionary is justified on economic grounds.

A larger number of ‘hotspots’ (250) is following close behind with a break history of 5 to 7 breaks per shut in 10 years . These may be expected to develop a trend on declining performance as time progresses.

The future impact “hotspots’ is unknown, but cost of remedial action to bring existing ‘hotspots’ to an acceptable service standard is an estimated $3.0 M.

Chapter 4 Conclusions

This study presents an overview of the status of water main asset failure. The analysis is a high-level interpretation of data derived from many historical and proxy sources, and interpolated to present a picture of the status of the infrastructure assets.

- The analysis represents a ‘heads up’ to a possible significant asset management problem that appears undetected by existing processes.
- A specific problem is indicated by -
  - An uninterrupted trend of deteriorating mains (with 330 hotspots identified),
  - replacement costs not allocated to meet planned renewals,
  - reactive repair costs rising to meet forecast rise in mains breaks.

- More data validation and analysis is needed to determine best strategy to resolve problem, but clearly it must centre on increased renewals of reticulation mains.
- The investigation calls for a process strengthening in the AMP, and the need for a strategic overview and high level conditional analysis of water mains assets as a policy guide to inform asset renewals.

- The study also points to a need for process strengthening at operations planning level to the decision tools which drives investigations and monitoring of sewer asset performance

- The fact that an apparent asset failure condition has emerged undetected suggests that performance measures to monitor and investigate such failures need to be strengthened.

- In the interim, a stopgap position should be considered:
  - A voluntary standard of 20 breaks/100km would be a useful performance measure until the full extent of the ‘65-81 pipe cohort’ question is clarified and understood; and
  - When the problem is fully understood, the ACTEW response in adopting and enforcing the voluntary standard will be monitored, the impact on water main service performance evaluated and reviewed (say in 5 years).

- Following the UK's Ofwat position, a utility should be required to maintain a network in a stable condition of serviceability. The big question should not be if the trend should be arrested, but at which level it should be arrested or to which level it should be returned. Specifically, should the decline be :
  - Capped at its present level; or
  - Returned to the level existing just prior to the issue of the Utilities Act license.

Attachment 1 Overview of Sewerage reticulation Infrastructure

Historical analysis

Asset categories

The reticulation sewer system comprises pipe of 150 mm to 300 mm and is made up of 2730 km of reticulation sewer, and 52,000 manholes, and 104,000 property connections.

Earliest pipe was laid in the1920,s but most pipe infrastructure was commissioned in the 1920,s but little progress was made until the post war period when suburban development and sewerage infrastructure expanded dramatically. This growth chart is shown in Figure A 1

Figure A1

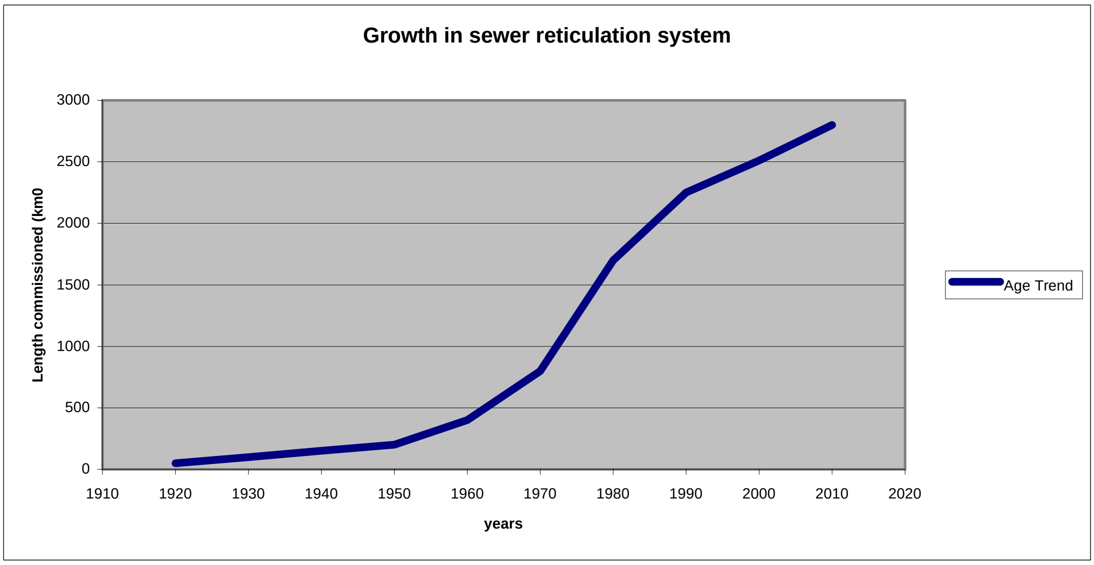
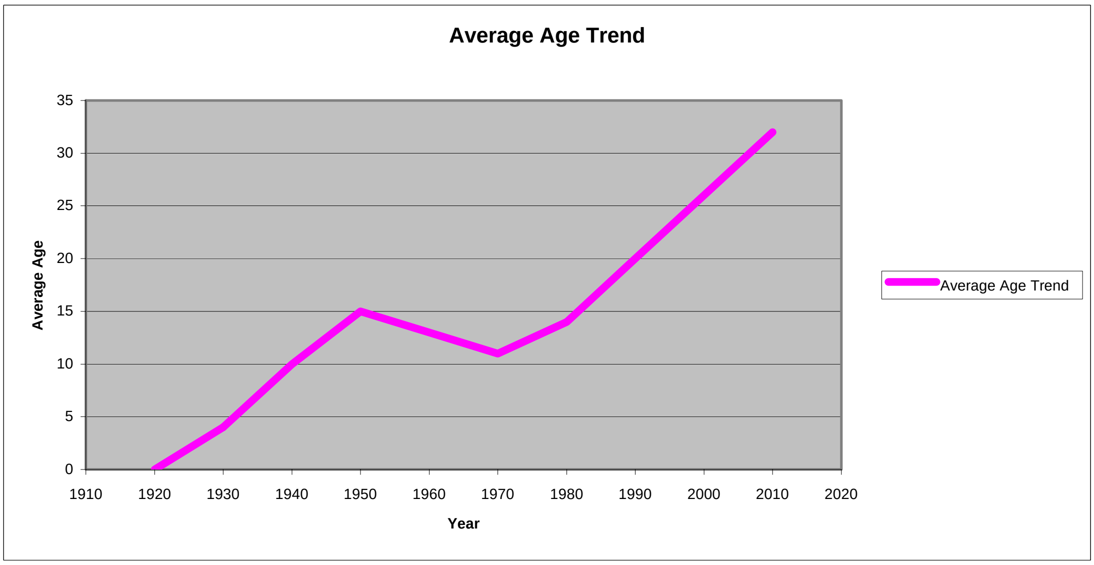


Figure A 2



As indicated in the chart above, the average age of pipes in2007 is about 27 years and is rising quickly. This means that most infrastructure is entering and age when the incidence of failure may be expected to increase.

Materials used in the construction of the system are listed in table A 1.

Table A1 Pipe materials and expected life

Pipe material	Period of Use	% of Existing System by Length	Mean life (Yrs)	% of Assets
Concrete	1920 to Present	24	85	24
Earthenware	1920 to 1964	11	65-85	12
Vitrified Clay	1960 to Present	56	75	57
PVC	1994 to Present	8	55	6
Other (AC, PE)	1965 Onwards	1	50	1

The great bulk of the system is (70%) is clay or earthenware, with the balance being mostly concrete, and at present small portion of earthenware and concrete pipe is nearing the end of its expected life.

The major problem affecting the reticulation system is tree root incursion. The problem is intensified by the promotion of street trees as a feature of the ACT’s urban landscape. This is the most important factor in the cause of customer service interruptions, either as sewer blockages or less frequently as major contributor to structural collapse.

Sewer chokes derived from tree roots are controlled by ‘jet-rodding’ (high pressure root cutting removal) and ‘foaming’ with a chemical agent to impede root regrowth. The root incusion problem is endemic and root control is an ongoing program, in the maintenance calendar. Structural cracking and ultimate collapse is the result of a combination of factors including cracking, earth movement, materials decay and corrosion and possible poor workmanship in construction.

Jet-rodding and foaming is experienced more frequently than sewer collapse by a factor of about 4:1.

Condition assessment

The ACTEW condition assessment method for reticulation sewers has been based on a monitor of ‘age and condition’ and CCTv investigation of areas experiencing problem. In addition a sample of CTTV footage is taken in areas not reporting as a reference control upon which to calibrate the severity of problem sites against normal pipes.

CCTV is extensively used to investigate areas with reported problems. Investigation entails examining video footage using the ‘SEWRAT’ condition assessment methodology[15]. This methodology reports defects on a standard scale and is widely

[15] Sewer inspection reporting code of Australia, WSAA, September 2006

used by Australian utilities. The scale comprises a progressive ranking for structural defects (cracks, joint movement gas attach) and service defects defects (eg tree roots, fatty build-ups, blockages, and infiltration) with through to major defect (eg an open cavity) with a weighted allocation of points for each defect. The service scoring system is not critical for the ACT as service defects other than tree root incursions are not a major problem (encrustation, scale, silt, grease and obstructions) and can be managed by maintenance.

The results are presented in three forms :

Peak score - the maximum score for any one meter of pipe
Mean score - the total score divided by the length of pipe
Average score - the total score divided by the number of defects.

In the scoring system, a mean score of 4 indicates an acceptable level of minor defects, and an average score above eight 8 indicate that the pipe should be considered for renewal. In this analysis, a site with a 'Sewrat' <u>structural</u> score of greater than 8 is termed a 'hotspot'

Information regarding the ACTEW sewer assessment is presented in Figure 3 Map of CCTV coverage by mean 'SEWRAT' score, and Figure 4 . Map of pipe network by pipe material.

Sewer Gravity Main Scores from CCTV Reports (150,225 & 300 Mains only)

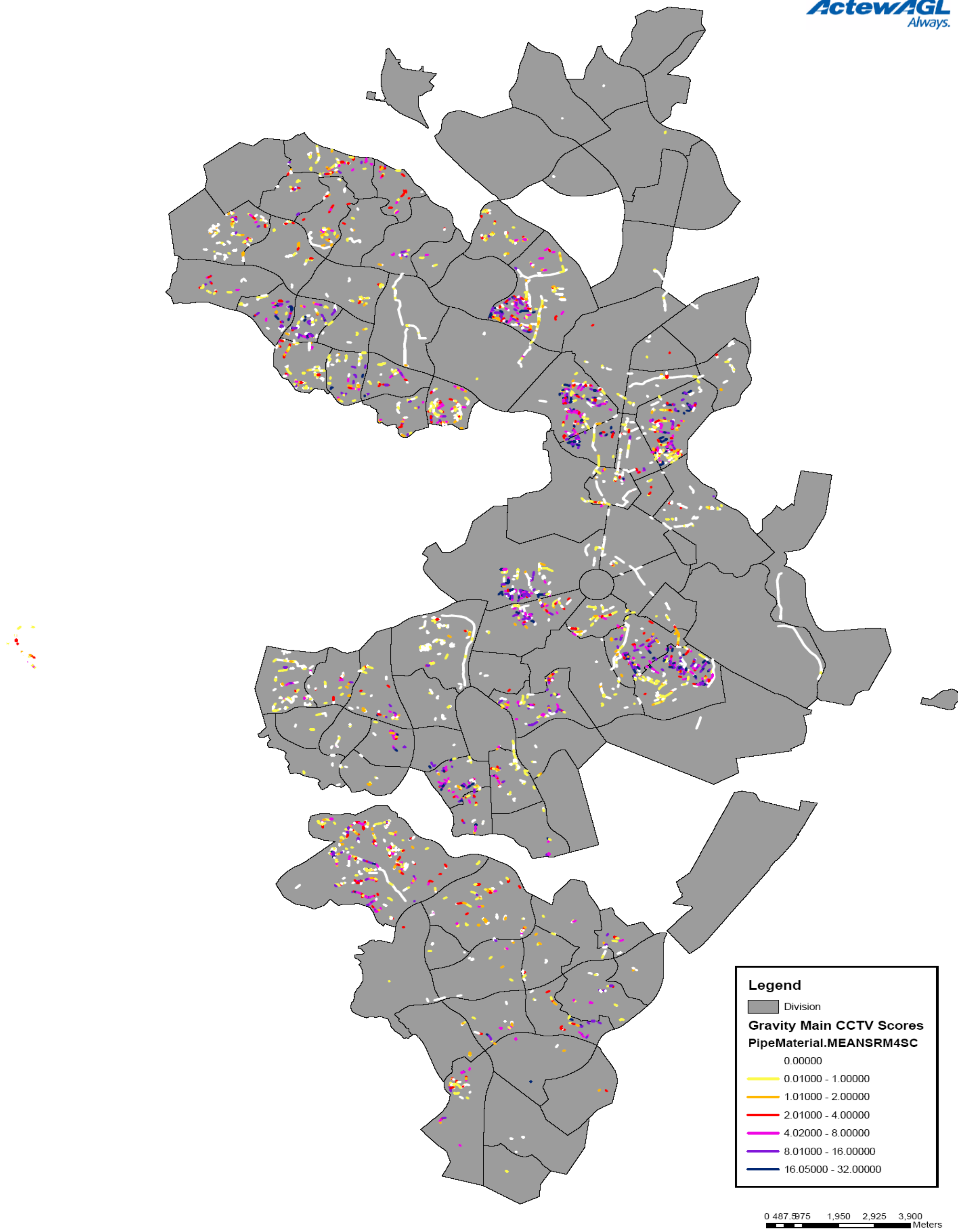


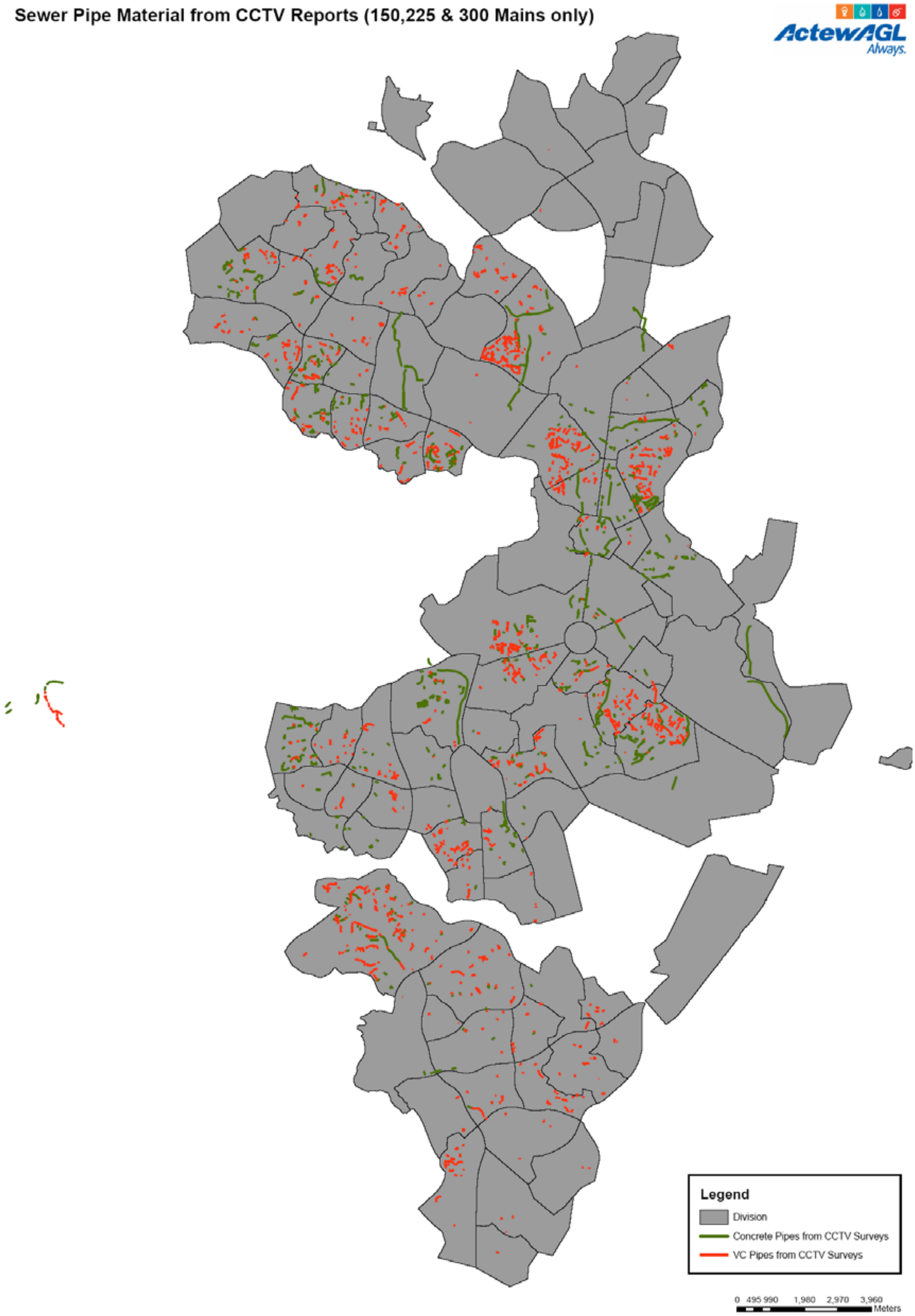
Figure A 3

Figure 3 indicates that 'Sewrat' scores for the areas that have been covered by CCTV footage.Findings from Figure 3 are as follows:

- Hotspots with mean (sewer structural defects greater than score 8) occur in Ainslie , O'Connor, Kaleen and Narrabundah, Yarralumla, Pearce and Kaleen
- Almost all hot spots are located in VC pipes (and very few in concrete pipes, PVC pipes as yet not experiencing blockages)

- Hotspots appear to be associated with age and perhaps ground condition.

A representation of corresponding composition of pipe materials is given in Figure 4 .



Historical and current expenditure

Capital renewal

A program of sewer replacement has been in place for some time and since 1990 an annual replacement of 3 to 4 km of reticulation sewer has occurred to 2000 mostly to restore service to sites with actual or imminent pipe collapse. .

Historical annual renewal is shown in Tabel A2.

Table A2   Reticulation Sewer Renewal

Reactive maintenance retic sewer	2002/03 $	2003/04 $	2004/05 $	2005/06 $	2006/07 $
Item Total	50,092	3,830,466	3,440,947	2,294,112	3,040,477
Jet rodding & Foaming				1,684,229	2,218,686
Mains repairs				406,634	504,874
Hole repairs & covers				203,248	316,734

Planned maintenance retic sewer	2002/03	2003/04	2004/05	2005/06	2006/07
Item Total	Na.	149,852	90,257	180,469	287,721
CCTV				80,966	209,795
Jet rodder				87,947	76,056
Rot foaming				11,556	1,870

There has been a modest program of planned renewals for reticulation sewer, and this has been driven by evidence of CCTV in hotspot areas

.Beyond 2007, annual planned sewer replacement is expected to grow to about 13 km to 2014, and to 17 and 20 km pa in the next 2 regulatory periods. For the 5 year period following 2008/09, planned sewer renewal is $4.2M per annum.

Indicators

As with water mains, there is no specific mandatory compliance standards for structural elements of sewerage reticulation mains performance. Mandatory reporting is required for a number of service quality matters including for the response to time to sewerage overflows to dwellings.

Discretionary targets are set under the UMI for service interruptions as sewer mains breaks/chokes per 1000 properties (<35) ; and a total number of breaks/chokes per 1000 properties (<50).

The percentage of reticulation sewer breaks and chokes reported as caused by tree roots is 95% in 2004/05 and 91% 2005/06.

The AMP makes reference to structural performance on page 5.1-2 of the 2007 asset management plan

> “ Ageing of the sewer reticulation system is resulting in an increasing number of structural failures and problems associated with root intrusion. Unless preventative action is taken , the resulting increase in blockages will soon exceed the capacity of the existing resources to correct interruptions within the agreed response times…. “
>
> The report continues …
> “Poor materials and workmanship affect parts of the system built in the early post war period and in the 1970’s and 1980’s. The effect of these has been allowed for in the effective life distribution of the assets involved.”

These statements acknowledge problems with asset performance and suggest that a more robust set of asset performance measure is needed to monitor structural performance and indicate the location of the problem and underlying causality.

The findings of this study suggests that problems are being experienced in a small concentrations in specific locations and not on a broad scale basis across suburbs built in ‘early post war and in the 1970’s and 1980’s.

Forward looking analysis

Data sources
The data used in this analysis is a composite of CCTV analysis taken over the past 10 years and geographic asset information derived from the digital asset database.

This analysis is only possible for aggregate data and for those historical records that are available. It is beyond the resources of this analysis to follow up with more intensive analysis such as the frequency of breaks after the first and subsequent breaks. Similarly, more detailed investigation of the causality of repeated failures in hotspots needs to be further investigated and bench mark comparisons made with other suburbs with similar risk profile.

Hotspots analysis
The CCTV coverage shows that frequent breaks are occurring is a hotspot locations and not in other where a similar age and condition assessment would be expected. The response to chokes is an effective filter to identify causality and focus investigation on those areas where there are problems.

In depth analysis of the hotspot data for O’Connor indicated that areas previously identified as exceeding score 8 had been renewed or were scheduled for renewal in current plans.

Reactive Repair or precautionary replacement

The rule of thumb is to replace sewer ratings with a score of greater than 8 on the 'Sewrat' methodology. This is consistent with the decision criteria adopted by other a number of other Australian utilities.[16]

Cost of replacement of reticulation sewers is estimated by ActewAGL as $3000 per repair site, and renewal at $ 300 per metre. A typical sewer pipe of 50M would cost $15000 (manhole to manhole).

This is consistent with the WSAA civil maintenance cost benchmark for Australian water utilities with similar cost reporting methods.

The ACT has no real industrial or manufacturing sewer load , and economic losses to customers arising because of declining asset performance in commercial precincts are unlikely Where considered a strategic issue, such matters could be addressed under critical infrastructure programs, or indeed under a trade waste management program.

Conclusions

ACTEW acknowledge that asset performance is declining and demanding more resources for reactive maintenance

Before committing more reactive maintenance resources, a study is warranted to consider the decline in performance in some detail. The breaks and CCTV data is a valuable resource that has not been fully interrogated for management purposes. Much valuable management information could be interpolated and extrapolated from existing records and the judicious use of control studies to supplement this data.

A next step would then be to develop a strategy to address the asset performance decline and nominate a KPI (or if later necessary mandated target) to drive an appropriate asset an renewal program.

There is a also need for a tested and robust decision tool to facilitate planning to renew or repair assets. This tool needs to be based on "age and condition' for (a) the asset class (b) specific asset in question, (c) to take account of recent trend in break frequency, and (d) cost of repair vs. cost of renewal. It is expected that under such a decision tool, a mid life asset with an average score of 8 would replaced, but a aging asset with a low 'Sewrat' score and a high probability of repeated future failures would be replaced

On the basis of information on the O'Connor site investigated, most of the sewers with greater than 8 'Sewrat' score has been renewed as soon as these identified. If this situation is typical for other hotspot locations, additional support for investment precautionary renewal may be needed to remediate sewers requiring urgent replacement.

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[16] Ross McPherson GHD, Determining the effective life of sewers, Redcliffe City Council 2005.

Nonetheless, a trend of emerging hotspots is evident and a strategy and program is needed to deal with these. That strategy would need to set a service standard as a target and develop a works plan to deliver service to within an acceptable tolerance.

Put these comments in a letter

Letter to Price commissioner

In the past, Canberra's water supply experienced fewer interruptions than in other cities, but this situation is changing as other cities manage to improve their water supply networks while evidence is that Canberra's is gradually degrading. This might be viewed as a case of the historic "gold-plated" infrastructure referred to by the chief Minister in his 2007 2008 budget speech being allowed to wear down to "normal" standards.

Alternatively it might be viewed as running down of assets.

The findings of this study are that reticulation water mains failure ‘hotspots’ are developing, and that a more fundamental process than an adjustment from gold-plated assets to a normal service delivery is being experienced.

While not relevant to this submission on price determination, it is noted that part of the problem lies in the absence of specific infrastructure performance standards from the Utilities Act framework. ACTPLA will seek to introduce such standards within the context of reviews to part 5 of the Act.

Work to maintain compliance with current regulatory requirements is part of normal operations & maintenance and capital expenditure in this area should not be funded from price increases. Any catch-up should be funded by the utility itself and not by consumers. Also, if a regulator focuses on a particular aspect of compliance, that is not the same as a tightening of the regulatory framework. Keeping the network serviceable has always been a utility responsibility. (NB ACTEW's draft AMP includes many items for which the driver is indicated to be regulatory)